
ABSTRACTS OF INTERNATIONAL CONFERENCE ON THIN FILMS & NANOTECHNOLOGY: KNOWLEDGE, LEADERSHIP, & COMMERCIALIZATION
Prof. Somnath C Roy

ABSTRACTS OF INTERNATIONAL CONFERENCE ON THIN FILMS & NANOTECHNOLOGY: KNOWLEDGE, LEADERSHIP, & COMMERCIALIZATION

Prof. Somnath C Roy

ISBN: 978-93-91303-85-3
First Published: October 2023
DOI:
www.doi.org/10.47715/JPC.B.978-93-91303-85-3

Jupiter Publications Consortium
22/102, Second Street
Venkatesa Nagar, Virugambakkam
Chennai 600 092, Tamil Nadu, India
Website: www.jpc.in.net

Name of the Book:

ABSTRACTS OF INTERNATIONAL CONFERENCE ON THIN FILMS & NANOTECHNOLOGY: KNOWLEDGE, LEADERSHIP, & COMMERCIALIZATION

Editor: Prof. Somnath C Roy
ISBN: 978-93-91303-85-3

Volume: I
Edition: First
Published by:
Jupiter Publications Consortium.

Jupiter Publications Consortium
Address: 22/102, Second Street, Venkatesa Nagar, Virugambakkam, Chennai 600 092, Tamil Nadu, India. Email: director@jpc.in.net| Website: www.jpc.in.net

Program Schedule- July 6, 2023 (Day 1)

	Sessions	Time	Talk type/Abstract No.	Speaker	Title
		Inauguration			
Morning	P-1	9:00 -9:30 am	Opening Ceremony	Prof. Nilesh J Vasa Director Incharge, IIT Madras, Prof. Bodh Raj Mehta VC JIIT Noida, and Prof. AN Tiwari EMPA Zurich, Prof. Shanthi Iyer NCAT, USA	Welcome address and Remarks about the conference
(TTJ Auditorium)		9:30 -10:30 am	Plenary	Prof. Manijeh Razeghi (Northwestern University, Illinois, USA) *Chaired by Prof. M. S. Ramachandra Rao (IIT Madras)*	Semiconductor Quantum Science and Technology for Optoelectronics Devices from deep UV to THZ
10:30 - 11:00 AM TEA BREAK					
Solar Energy Materials -1 *(Dr. Satyendar Kumar, Sourya Ener Tech. Gurugram)*					
		11:00-11:30 am	Invited	Dr. Oomman K Varghese (University of Houston, Texas, USA)	Low dimensional ceramic semiconductors and heterostructures for emerging energy applications
		11:30-12:00 pm	Invited	Dr. Jatindra Kumar Rath (IIT Madras)	Thin Film PV for > 20% PCE
Morning	**Session 1**	12:00-12:20 pm	J-025 Oral	Dr. Abhinav (Vellore Institute of Technology)	Evidence for the Band-Edge Exciton of CuInS2 Nanocrystals Enables Record Efficient Large-Area Luminescent Solar Concentrators
(TTJ Auditorium)		12:20-12:40 pm	J-029 Oral	Dr. N. Sivakumar (Sri Sai Ram Engineering College, Chennai)	Development of MAPbI3. H2O and MAPbI3 perovskite solar cells using TiO2 and P3HT as charge transport layers
		12:40-1:00 pm	Oral	Mr. C D Athreya (IIT Madras)	Lattice Phonons in Cs2B'B''X6 Lead-Free Halide Double Perovskites
Thin Film Growth and Characterization *(Dr. P. Murgavel, IIT Madras)*					
		11:00-11:30 am	Invited	Dr. Durga Basak (IACS,Kolkata)	Crossover between band and various hopping conductions in Mo doped ZnO thin films owing to carrier localization at defects
Morning	**Session 2**	11:30-12:00 am	Invited	Dr. K C James Raju (University of Hyderabad)	The Problem of High Crystallization Temperature of Oxide Thin Films and a Means to Lower It with Lasers
		12:00-12:30 pm	Invited	Dr.Seema Vinayak (SSPL, Delhi)	Compound semiconductors and thin film technology in products for strategic applications
(Hall 1)		12:30-12:45 pm	L-012 Oral	Dr. Bal Singh (Nagoya Institute of Technology, Japan)	Study of dislocations distribution in (211) CdTe/ Si epitaxial layer and their reduction methods
		12:45-01:00 pm	L-055 Oral	Ms. Chaitali Vishwas Jagtap(Savitribai Phule Pune University, Pune)	Development of Ru-doped Titania Photoanodes for Dye Sensitized Solar Cell Application for various Internet of Things
Electrochemical Energy Storage *(Dr. Sudakar Chandran, IIT Madras)*					
		11:00-11:30 am	Invited	Dr R Kothandaraman (IIT Madras)	1-2-1 Pathway: Electrically Refurbishing Organic Redox Couples for Energy Storage in Flow Battery
Morning	**Session 3**	11:30-12:00 am	Invited	Dr. Atanu Dutta (VIT, Chennai)	Enhanced performance of Doped LSM for Low temperature SOFC cathode application
(Hall 3)		12:00-12:30 pm	Invited	Dr. Pushpendra Kumar (Manipal University, Jaipur)	Nano Ceramic Hydroxide and its Applications
1:00 – 2:00 PM LUNCH					
2:00 – 3:30 PM POSTER SESSION (Hall 4 : Exhibition Hall)					
3:30 – 4:00 PM TEA BREAK					
Computational Materials Science *(Dr. B.R.K Nanda, IIT Madras)*					
		4:00-4:30 pm	Invited	Dr. Kavita Joshi (CSIR-National Chemical Laboratory)	DFT and ML: A Journey in Materials Discovery
		4:30-5:00 pm	Invited	Dr. Sharat Chandra (IGCAR Kalapakkam)	Properties of 2D CdTe nanostructures
Afternoon	**Session 4**	5:00-5:20 pm	C-008 Oral	Dr. Subhadeep Roy (Birla Institute of Technology and Sciences Pilani, Hyderabad)	The Co-Moving Velocity in Immiscible Two Phase Flow in Porous Media
(TTJ Auditorium)		5:20-5:40 pm	Oral	Mr. V G Abhijitha	Design of cathode materials for Aluminium-ion batteries using graphyne host: A computational approach
		5:40-6:00 pm	C-020 Oral	Ms. Monisha Nayak (Diamond Harbour Women's University, South 24 parganas)	Perovskite Solar Cell Exceeding 30% Efficiency With Graded Bandgap Absorber And Inorganic Charge Extraction Layers Using Scaps-1D
Sensors and Actuators - Materials and Devices *(Dr. Mahveer K Jain, IIT Madras)*					
		4:00-4:30 pm	Invited	Dr. Asish K Sen (IIT Madras)	Acoustomicrofluidics - ultrasound meets microfluid
		4:30-5:00 pm	Invited	Dr. Dillip K Satapathy (IIT Madras)	Multi-vapour sensitive soft actuators: physics and applications
Afternoon	**Session 5**	5:00-5:20 pm	Oral	Dr. Jitendra Kumar (CEERI Pilani)	Simulation of surface acoustic resonator with ZnO sensing layer using COMSOL Multiphysics for gas sensor application
(Hall 1)		5:20-5:40 pm	I-002 Oral	Ms. Vinita (AcSIR-CEERI, Pilani, Rajasthan)	Solidly Mounted BAW Resonator as Ozone Sensor
		5:40-6:00 pm	I-003 Oral	Dr.Prabhat Kumar(FZU - Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic)	Tactile Sensor based on 3D-Graphene Aerogels
Electron Transport in Nano and Correlated Systems *(Dr. R Nirmala, IIT Madras)*					
		4:00-4:30 pm	Invited	Dr. Atindra Nath Pal (SNBNCBS,Kolkata)	Large area hybrid two-dimensional optoelectronic devices
		4:30-5:00 pm	Invited	Dr. Pranaba K Muduli (IIT Delhi)	Spin to charge conversion using quantum materials
Afternoon	**Session 6**	5:00-5:20 pm	F-026 Oral	Dr. Soumya Jyoti Ray (IIT Patna)	Wide bandgap Semiconductor Metalohydrogel for non-volatile memory design
(Hall 3)		5:20-5:40 pm	F-004 Oral	Dr. Dhritiman Gupta (Vellore Institute of Technology)	Copper oxide thin films and nanostructures and their application in solar cells and resistive switching devices
		5:40-6:00 pm	F-021 Oral	Ms.Parul (IIT Jammu)	Opto-electrical properties of solution-processed $CuFe_2O_4/TiO_2$ heterojunction thin films

Program Schedule- July 7, 2023 (Day 2)

	Sessions	Time	Talk type/Abstract No.	Speaker	Title
07/07/2023 *(Dr. K Sethupathi,IIT Madras)*					
Morning	P-2	8:30-9:10 am	Plenary	Dr. Shanthi Iyer (NCAT State University, USA)	GaAsSb Nanowires-based Short Wave Infrared Photodetectors
(TTJ Auditorium)		9:10-9:50 am	Plenary	Dr. M. Batzill (University of South Florida, Florida, USA)	Modification of 2D-Transition Metal Dichalcogenides by Excess Metal Incorporation
		9:50-10:30 am	Plenary	Dr. T. Pradeep (IIT Madras)	Atomically Precise Metal Clusters
10:30 – 11:00 AM TEA BREAK					
2D Materials and Applications *(Dr. Abhishek Kumar Mishra, IIT Madras)*					
Morning	Session-1	11:00-11:30 am	Invited	Dr. M. M. Shaijumon (IISER Thiruvananthapuram)	2-Dimensional Materials and their Heterostructures for Electrocatalysis
		11:30-12:00 am	Invited	Dr. Satyaprakash Sahoo (IoP Bhubaneswar)	Opportunity and challenges in 2D material for advanced memory and computing applications
(TTJ Auditorium)		12:00-12:15 pm	A-016 Oral	Dr.Ajeet Kumar Srivastav (Visvesvaraya National Institute of Technology, Nagpur)	Raman analysis for the defects in electrochemically exfoliated graphene
		12:15-12:30 pm	A-004 Oral	Dr. Sudhir Sharma (New York University Abu Dhabi)	Synthesis of One Atom Thick 2D Gold Nanostructures- Goldene
		12:30-12:45	A-023 Oral	Ms.Renu Yadav (IIT Madras)	MoO2 -MoS2 metal semiconductor hetero nanowires
		12:45 -1:00 pm	A-002 Oral	Ms. Lalita (Indian institute of Technology, Gandhinagar)	Selective transport of water molecules through interlayer spaces in graphite
Novel Materials and Thin Films for Photocatalysis *(Dr. Jatin K Rath, IIT Madras)*					
Morning	Session-2	11:00-11:30 am	Invited	Dr. Karthik Shankar (University of Alberta)	Plasmonic metal-semiconductor nano-heterojunctions for solar energy harvesting and quantum sensing
		11:30-12:00 am	Invited	Dr. Manika Khanuja (Jamia Millia Islamia Delhi)	Photocatalytic Degradation of Toxic Pollutants Using 2D Nanomaterials:Textile Dyes, Heavy Metal Ions, and Antibiotics
		12:00-12:20 pm	Invited	Dr. Surendra Babu (IIT Madras)	Opportunities in Two-dimensional Materials for Harvesting Solar Energy
(Hall 1)		12:20-12:40 pm	Oral	Dr. Vipul Kheraj (Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat)	Surface photovoltage spectroscopy to probe laser-induced surface treatments on single crystals materials and polycrystalline *p-n* junctions
		12:40-01:00 pm	Oral	Ms. Amutha S (St. Joseph's College, Trichy)	Unravelling the effect of soxhlet extracted Pisolithus arrhizus fungi in bio-sensitized solar cells in response to diverse polar solvents
Micro and Optoelectronic devices *(Dr. Dillip K Satpathy, IIT Madras)*					
Morning	Session 3	11:00-11:30 am	Invited	Dr. Samaresh Das (IIT Delhi)	Fast and Broadband Photodetectors based on Layered material/Group-IV Semiconductor Heterojunctions
		11:30-12:00 am	Invited	Dr. K. J. Sankaran (CSIR-IMMT Bhubaneswar)	Electrically Conducting Diamond Hybrids for Optoelectronic Devices
		12:00-12:20 pm	Invited	Dr. Sanju Rani (SRMIST Ramapuram)	Metal-oxide nanostructures for photodetector
(Hall 3)		12:20-12:40 pm	Oral	Dr. Nirupama (BM Munjal University, Gurugram)	Demonstrating an affordable nanopatterning technology for patterning nanocluster carbon based field emitter
		12:40-01:00 pm	Oral	Dr. Dilip Kumar Singh (Birla Institute of Technology Mesra, Ranchi)	High efficiency photodetector based on CVD grown continous monolayer WS2
1:00 – 2:00 PM LUNCH					
2:00 – 3:30 PM POSTER SESSION (Hall 4 : Exhibition Hall)					
3:30 – 4:00 PM TEA BREAK					
Thin Films for Aerospace Applications *(Dr. M V Hanumantha Rao, Dayananda Sagar University, Bangalore)*					
Afternoon	Session 4	4:00-4:30 pm	Invited	Dr.Girish M. Gouda (ISRO, Bangalore)	Optical thin films for Space Applications
(TTJ Auditorium)		4:30-5:00 pm	Invited	Dr. B Venkataramana (CSIR-NAL, Bangalore)	Enhanced erosion resistance of Ti/TiN nanolayered coating
Ion Beam Modifications of Materials *(Dr Durga Basak, IACS, Kolkata)*					
Afternoon	Session 5	4:00-4:30 pm	Invited	Dr. D. Kabiraj (IUAC Delhi)	Ion beam engineering of nanoscale structures
(Hall 1)		4:30-5:00 pm	Invited	Dr.Aloke Kanjilal (Shiv Nadar University, Noida)	Opportunities and challenges of porous and thin film alumina for ion beam dosimetry
Leadership in Education and Energy - Insight into The Future *(Dr. C Vijayan, IIT Madras)*					
Afternoon	Session 6	4:00-4:30 pm	Invited	Dr. N Asokan (SRMIST Ramapuram)	A Study on the Emerging Characteristics of Leaders Towards Preparedness in a Learning Agility Environment
(Hall 3)		4:30-5:00 pm	Invited	Mr. Sujoy Ghosh (First Solar, India)	First Solar In India - solar energy for India's future
5:00-5:30 pm- Group Photograph					
6:00-9:00 pm- Banquet Dinner					

Program Schedule- July 8, 2023 (Day 3)

08/07/2023 *(Dr. Nandita Das Gupta, IIT Madras)*					
	Sessions	**Time**	**Talk type/Abstract No.**	**Speaker**	**Title**
Morning	**P-3** (TTJ Auditorium)	8:30-9:10 am	Plenary	Dr. Ayodhya Nath Tiwari (EMPA, Switzerland)	Thin film photovoltaic technologies: progress, opportunities and industrial challenges
		9:10-9:50 am	Plenary	Dr. M. S. Ramachandra Rao (IIT Madras)	A Paradigm Shift in Thin Film Based Technologies
		9:50-10:30 am	Plenary	Dr. Gouri Sankar Kar (IMEC)	System Scaling: Opportunities for new materials
10:30 - 11:00 AM TEA BREAK					
Research and Commercialization (Tech and Industry) *(Dr. Rajnish K Sharma, Global Foundries Corp. Bangalore)*					
Morning	**Session 1** (TTJ Auditorium)	11:00-11:30 am	Invited (Sponsor)	Dr. Milind Acharya (Milman Thin Film Systems Pvt.Ltd.)	Thin Films - from Lab to Technology
		11:30-12:00 pm	Invited	Dr. Ratheesh. R (CMET Hyderabad)	Resource Efficiency and Circular Economy in e-waste Management: A new Sustainable Business Mode
		12:00-12:20 pm	Invited (Sponsor)	Dr. H C Sudeeksha (Horiba International)	HORIBA Raman microscope for 2D materials applications: Why is it
		12:20-12:40 pm	Invited	Mr. Ikram Khan (ISMO Bio-Photonics)	3D Printed Microfluidic Bioreactors: Pioneering Advancements in Bio-Photonics
		12:40 -1:00 pm	Invited (Sponsor)	Mr. Jagadesh O E (Laser Science Services Pvt Ltd)	Role of PLD from Scientific Lab to Industry
Photochemical and Photoelectrochemical Systems *(Dr. Manika Khanuja, JMI Delhi)*					
Morning	**Session 2** (Hall 1)	11:00-11:30 am	Invited	Dr. M C Santhosh Kumar (NIT Trichy)	Photocatalytic activity of indium doped zinc oxide seed layers and one-dimensional nanorods under solar irradiation
		11:30-12:00 am	Invited	Dr. Aruna Ivaturi (University of Strathclyde, Glasgow, UK)	Recycling light and wastes for sustainable energy generation and storage
		12:00-12:30 pm	Invited	Dr. Aravind K Chandiran (IIT Madras)	Novel PEC materials for solar energy conversion
		12:30-12:45pm	Oral	Dr. Rama Krishna Chava (Yeungnam University, Gyeongsan-Si, South Korea)	Integrated Design and Synthesis of O-doped Graphitic Carbon Nitride Nanostructures for Solar to H2 Conversion Reaction
		12:45 -1:00 pm	Oral	Mr.Ragul Krishnan (IIT Madras)	CO_2 conversion using hydrophilic - hydrophobic heterojunctions
Hybrid/Perosvkite PV Materials *(Dr. M. M. Shaijumon (IISER Thiruvananthapuram))*					
Morning	**Session 3** (Hall 3)	11:00-11:30 am	Invited	Dr. P. Malar (SRMIST Kattankalathur, Chennai)	Energy applications of Antimony Chalcogenide
		11:30-12:00 am	Invited	Dr. Trilok Singh (IIT Delhi)	A paradigm shifts in efficiency and stability of air ambient fabrication of Perovskite Solar Cells
		12:00-12:20 pm	Invited (Sponsor)	Mr.Yatin Nakhare (Pfeiffer Vacuum)	Turbopumps: Lowest vibration and highest uptime made with laser balancing technology
		12:20-12:40 pm	J-015 Oral	Ms.Ruchi K. Sharma (CSIR-National Physical Laboratory, New Delhi)	Graphene Oxide as an Effective Interface Passivation Layer for Organic/Si Hybrid Solar Cells
		12:40 -1:00 pm	J-015 Oral	Mr.Akash (Manipal University Jaipur)	Band Gap Tuning in Calcium Hydroxide-Nitrate Nanocomposite Materials
1:00 – 2:00 PM LUNCH					
2:00 – 3:30 PM POSTER SESSION (Hall 4 : Exhibition Hall)					
3:30 – 4:00 PM TEA BREAK					
Materials for Energy (Non-Solar) *(Dr. K. J. Sankaran (CSIR-IMMT Bhubaneswar))*					
Afternoon	**Session 4** (TTJ Auditorium)	4:00-4:30 pm	Invited	Dr. Rajagopalan Thiruvengadathan (Southern Utah University, Utah, USA)	The Road Ahead for Nanothermite-based Energetics: From Materials to Applications
		4:30-5:00 pm	Invited	Dr. Charu Lata Dube (Central University, Gujarat)	Synthesis of Tungsten nanocomposite for future fusion reactors by employing fast sintering method
		5:00-5:30 pm	Invited	Dr. Pritty Rao (SSPL, Delhi)	Thermal induced morphological modification in Covellite
Optoelectronic Materials *(Dr. M C Santhosh Kumar (NIT Trichy))*					
Afternoon	**Session 5** (Hall 1)	4:00-4:30 pm	Invited	Dr. Shubra Singh (Anna University)	Fenton-process adapted Fe-Cu heterostructures and retrievable films for deactivation/removal of emerging categories of persistent organic pollutants
		4:30-4:50 pm	Oral	Dr. Vinod Kumar (National Institute of Technology, Hamirpur, Himachal	Geometric and dielectric engineered high performance gate all around field effect transistor
		4:50-5:10 pm	L-022 Oral	Ms. Ishita Chopra (Manipal university jaipur)	Decoration of steel with TiO2 for corrosion protection in inhibitors-based solution: Experimental studies
Ceramic Materials and Applications *(Dr Sharat Chandra (IGCAR Kalapakkam))*					
Afternoon	**Session 6** (Hall 3)	4:00-4:30 pm	Invited	Dr. Ranjeeta P Chatterjee (PRM-ACS College, Pune)	Catalytic Materials for bio-diesel synthesis
		4:30-4:50 pm	L-070 Oral	Mr.Shubham Gupta (Manipal University Jaipur)	Optimized and Efficient Silicon Nanostructures integration for antibacterial behavioural study using Metal Assisted Chemical Etching
		4:50-5:10 pm	L-081 Oral	Mr.Lalit Kumar (Manipal University, Jaipur)	Synthesis molecular sieve -based metal doped nanocomposite materials for thermocatalytic conversion of glycol to valuable chemicals
5:30 -7:00 pm - Valedictory Session (TTJ Auditorium) (Poster Awards Announcement and Vote of Thanks)					

INDIAN INSTITUTE OF TECHNOLOGY MADRAS
DEPARTMENT OF PHYSICS

INTERNATIONAL CONFERENCE ON THIN FILMS & NANOTECHNOLOGY: KNOWLEDGE, LEADERSHIP, & COMMERCIALIZATION

JULY 6-8, 2023

ICTN- KLC 2023

IC&SR Building, IIT Madras

Padma Shri
Professor Kasturi Lal Chopra

ABSTRACT

We are honored to announce that the 2nd International Conference on Thin Films and Nanotechnology: Knowledge, Leadership & Commercialization (ICTN: KLC 2023) will be held July 6-8, 2023. Encouraged by the grand success of the first edition of ICTN-KLC 2021, which was held online, this fully in-person event will be held at the beautiful campus of the Indian Institute of Technology Madras (IITM), India. The conference will have eminent speakers from all over the world who are experts in their field of research, creating an opportunity for early-stage researchers to expand their understanding, generate new ideas, and strengthen their collaboration with peers.

The conference originated with the idea of celebrating the life and work of Padma Shri Professor Kasturi Lal Chopra, widely considered the pioneer of thin film research in India. He initiated basic and applied research in thin films and created technologies based on them which included three vital components: Knowledge, Leadership and Commercialization.

Dr. Somnath Chanda Roy,
Professor, Department of Physics, Indian Institute of Technology Madras, Chennai 600036 India
Off: HSB 119B, Lab: HSB 102A; Tel: +91-44-2257-4886 (Off), -5890 (Lab) -4850 (Physics Dept.)
Semiconducting Oxide Materials, Nanostructures and Tailored Heterojunction (SOMNaTH) Lab

http://www.ictn-klc.org/

TECHNOLOGY IS A VERB NOT NOUN

PADMA SHRI PROFESSOR KASTURI LAL CHOPRA

ABOUT THE CONFERENCE

We are honored to announce that the 2nd International Conference on Thin Films and Nanotechnology: Knowledge, Leadership & Commercialization (ICTN: KLC 2023) will be held July 6-8, 2023. Encouraged by the grand success of the first edition of ICTN-KLC 2021, which was held online, this fully in-person event will be held at the beautiful campus of the Indian Institute of Technology Madras (IITM), India. On behalf of the organizing committee, we are pleased to invite participants from all over the world to take part, engage and enlighten in this scientific gathering. We expect that the event will attract about 500 participants from diverse fields allowing academicians, researchers, scientists, and industrial representatives to exchange ideas and establish new networks. The conference will have eminent speakers from all over the world who are experts in their field of research, creating an opportunity for early-stage researchers to expand their understanding, generate new ideas, and strengthen their collaboration with peers.

The conference originated with the idea of celebrating the life and work of Padma Shri Professor Kasturi Lal Chopra, widely considered the pioneer of thin film research in India. He initiated basic and applied research in thin films and created technologies based on them which included three vital components: Knowledge, Leadership and Commercialization.

CONTACT US

Prof. Somnath C Roy
8056081266

The Organising Chairs,
ICTN-KLC:2023
Dept. of Physics
Indian Institute of Technology Madras,
India 600036

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

Advisory Board

http://www.ictn-klc.org/

Dr. D. K. Pandya, IIT Jammu
Dr. B. R. Mehta, IIT Delhi
Dr. Ankit Kumar, IMEC Belgium
Dr. K Vamsi Krishna, IIT Delhi
Dr. Sujeet Chaudhary, IIT Delhi
Dr. Vivek Malik, IIT Roorkee
Dr. Tarsame Singh, Rudra Group
Dr. Pushpendra Kumar, Manipal Institute Jaipur
Dr. Sunil Singh Kushvaha, NPL Delhi
Dr. Sanjay Kumar Srivastava, NPL Delhi
Dr. Trilok Singh, IIT Kharagpur
Dr. Sandeep Chokar, JIIT Noida
Dr. Manika Khanuja, JMI Delhi
Dr. Rupali Nagar, Symbiosis Pune
Dr. Sanjeev Srivastava, ISTEM , IISc Bangalore

Dr. Seema Vinayak, SSPL, Delhi
Dr. Suman Kumari Mishra, CSIR-CGCRI Kolkata
Dr. Balwinder Gogia, USA
Dr. D Sakthi Kumar, Toyo University, Japan
Dr. Rakesh Kumar Joshi, UNSW Sydney
Dr. Xinjian Feng, Soochow University, China
Dr. Sorachon Yoriya, MMTC, Thailand
Dr. H S Lee, NTS University, Taiwan
Dr. T Rajagopalan, SUU, Utah, USA
Dr. Aruna Ivaturi, University of Strathclyde Glasgow, UK
Dr D Kanjilal (IUAC Delhi)
Dr Harish Barshilia (CSIR-NAL Bangalore)
Dr. Girish M Gouda (LEOS-ISRO)
Dr. Sharat Chandra (IGCAR Kalpakkam)

INDIAN INSTITUTE OF TECHNOLOGY MADRAS

DEPARTMENT OF PHYSICS

Knowledge Leadership Commercialization

http://www.ictn-klc.org/

Local Organizing Committee

Dr. Somnath C Roy, IIT Madras (Convener)
Dr. Mahaveer K Jain, IIT Madras (Co-Convener)
Dr. P Murugavel, IIT Madras (Co-Convener)
Dr. Abhishek Misra, IIT Madras (Co-Convener)
Dr. M S Ramachandra Rao, IIT Madras
Dr. K Sethupathi, IIT Madras
Dr. P N Santhosh, IIT Madras
Dr. B R K Nanda, IIT Madras
Dr. Sudakar Chandran, IIT Madras
Dr. Jayeeta Bhattacharyya, IIT Madras
Dr. Manu Jaiswal, IIT Madras
Dr. Dillip K Satapathy, IIT Madras
Dr. Prasanta Muduli, IIT Madras
Dr. Panchanana Khuntia, IIT Madras
Dr. Jatin Rath, IIT Madras
Dr. Shantanu Mukherjee, IIT Madras
Dr. R Nirmala (IIT Madras)
Dr. Prahallad Padhan (IIT Madras)
Dr. Shubra Singh, CGC Anna Univ.
Dr. Sanju Rani, SRMIST Ramapuram
Dr. N. Asokan, SRMIST Ramapuram

Invited International and National Speakers

Dr. Manijeh Razeghi (Northwestern)
Dr. Ayodhya Nath Tiwari (EMPA)
Dr. Mathias Batzill (USF)
Dr. Oomman K Varghese (Houston)
Dr. Shanthi Iyer (North Carolina)
Dr. Aruna Ivaturi (Strathclyde)
Dr. Gouri S Kar (IMEC)
Dr. T Rajagopalan (Southern Utah)
Dr. MSR Rao (IIT Madras)
Dr. T Pradeep (IIT Madras)
Dr. M M Shaijumon (IISER Tvm)
Dr. Samaresh Das (IIT Delhi)
Dr. Ranu Nayak (Amity University Noida)
Dr. N Asokan (SRMIST, Chennai)
Dr. Durga Basak (IACS Kolkata)
Dr. Shubra Singh (Anna University)
Dr. Jatindra Kumar Rath (IIT Madras)
Dr R Kothandaraman (IIT Madras)
Dr. Pushpendra Kumar (Manipal University Jaipur)
Dr. Sharat Chandra (IGCAR Kalapakkam)
Dr. Asish K Sen (IIT Madras)
Dr. Dillip K Satapathy (IIT Madras)
Dr. Pranaba K Muduli (IIT Delhi)
Dr. Aravind K Chandiran (IIT Madras)
Dr. Atindra Nath Pal (SNBNCBS,Kolkata)
Dr. Satyaprakash Sahoo (IoP Bhubaneswar)
Dr.Girish M. Gouda (ISRO, Bangalore)
Dr. B Venkataramana (CSIR-NAL, Bangalore)
Dr. D. Kabiraj (IUAC Delhi)
Dr. Trilok Singh (IIT Delhi)
Dr. P. Malar (SRMIST Kattankalathur, Chennai)
Dr.Aloke Kanjilal (Shiv Nadar University, Noida)
Dr. Sanju Rani (SRMIST Ramapuram, Chennai)
Mr. Sujoy Ghosh (First Solar, India)
Dr. Milind Acharya (Milman Thin Film Systems Pvt.Ltd.)
Dr. H C Sudeeksha (Horiba International)
Mr. Ikram Khan (ISMO Bio-Photonics)
Mr. Jagadesh O E (Laser Science Services Pvt Ltd)
Mr.Yatin Nakhare (Pfeiffer Vacuum)

ABSTRACTS

ICTN- KLC 2023
July 6-8 2023

Abstract Shortlisting Committee

Dr Shubra Singh (Anna University, Chennai
Dr Manika Khanuja (JMI University Delhi)
Dr Rupali Nagar (SIT, Pune)
Dr Sanju Rani (SRMIST, Chennai)

Abstract Booklet Design

Dr N Asokan (SRMIST, Chennai)

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

Semiconductor Quantum Science and Technology for Optoelectronics Devices from deep UV to THZ Past, Present and Future trends

Manijeh Razeghi
Walter P. Murphy Professor, Department of Electrical Engineering and Computer Science, Director, Center for Quantum Devices, Northwestern University, Evanston, IL 60208
email: razeghi@northwestern.edu

Nature offers us a full assortment of atoms, but Quantum engineering is required to put them together in an elegant way to realize functional structures not found in nature.

A particular rich playground for Quantum era, is the so-called III-V semiconductors, made of atoms from columns III and V of the periodic table, and constituting compounds with many useful optical and electronic properties in their own right. Guided by highly accurate simulations of the electronic structure, modern semiconductor quantum devices are literally made atom by atom using advanced growth technology to combine these materials in ways to give them new proprieties that neither material has on its own. Modern mastery of atomic engineering allows high-power and highly efficient functional devices to be made, such as those that convert electrical energy into coherent light or detect light of any wavelength and convert it into an electrical signal. This talk will present the present and future trends of latest world-class research breakthroughs that have brought semiconductor quantum optoelectronics engineering to an unprecedented level, creating IR light detectors and emitters over an extremely wide spectral range from 0.2 to 300 microns. As well as their integration with Si photonics.

Indian Institute of Technology Madras
http://www.ictn-klc.org/
Department of Physics

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

GaAsSb Nanowires-based Short Wave Infrared Photodetectors

Shanthi Iyer
Nanoengineering, Joint School of Nanoscience and Nanoengineering, North Carolina A&T State University, USA
email: iyer@ncat.edu

Nanowire-based structures offer opportunities to create the next generation of advanced devices by exploiting scale-dependent unique material properties that arise due to its anisotropic geometry in the nanoscale regime. In addition, the large surface-to-volume of the NW configuration relaxes lattice mismatch constraints, expanding the material combinations that can be used and enabling the implementation of a variety of architectures, which are not conceivable in thin films. These, combined with their remarkable quantum, surface, and optical absorption properties, permit innovative bandgap engineering of the NW-based heterostructures to achieve high-performance III-V-based optoelectronic devices integrated onto Si and other 2D substrates.
This talk will be focused on our ongoing research findings on the Ga-assisted molecular beam epitaxial growth of GaAsSb nanowire heterostructures on Si and graphene in axial and core-shell geometries. The performance of NW-based short wavelength infrared region photodetector devices, namely p-i-n junction, and avalanche photodiodes for low signal detection will be presented.

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

Modification of 2D-Transition Metal Dichalcogenides by Excess Metal Incorporation

Matthias Batzill
Department of Physics, University of South Florida, Tampa, FL 33620, USA
email: mbatzill@usf.edu

The reduced structural constraints in 2D (van der Waals-) materials enable the incorporation of excess atoms into the 2D-lattice. These excess metals may result in point- and extended- defects or cause a transformation into new stoichiometric phases. In this talk we discuss different mechanisms to induce compositional variations by reacting transition metal dichalcogenides (TMDs) with metal atoms or by removing chalcogen atoms. Not surprisingly, given the broad nature of the TMDs, different transition metal groups respond differently to metal rich conditions. The early transition metal dichalcogenides (group 5 transition metals) have a preference to insert excess metals in between TMD layers [1,2]. Group 6 TMDs may incorporate elements at interstitial sites which may cause restructuring into metal-rich mirror twin grain boundary networks [3,4]. While the group 10 $PtTe_2$ can transform into a different stoichiometric phase, i.e., 2D Pt-monotelluride [5,6,7]. Understanding the processes by which TMDs react with excess metals shine light on synthesis processes and point towards methods for modifying or synthesizing novel 2D materials with new desirable functionalities.

References

[1] M. Bonilla, et al. Adv. Mater. Interf. 7, 2000497 (2020)
[2] K. Lasek, et al. ACS Nano 14, 8473 (2020)
[3] P.M. Coehlo, et al. ACS Nano 12, 3975 (2018)
[4] V. Pathirage, et al. Mater. Today Nano 22, 100314 (2023)
[5] J. Li, et al. Chem. Mater. 33, 8018-8027(2021)
[6] K. Lasek, et al. ACS Nano 16,9908 (2022)
[7] K. Lasek, et al. Nano Letters 22, 9571 (2022)

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

Atomically Precise Metal Clusters

T. Pradeep
Indian Institute of Technology Madras, Chennai, 600 036, India
email: pradeep@iitm.ac.in

Research in the recent past has resulted in a large number of nanoparticles whose properties depend on the number and spatial arrangement of their constituent atoms. This distinct atom-dependence of properties is particularly noticeable in ligand protected atomically precise clusters of noble metals, which I will refer to as nanomolecules in this lecture. They behave indeed like molecules as revealed most elegantly by mass spectrometry. They show unusual properties such as luminescence in the visible and near-infrared regions. Their molecule-like behavior is most elegantly shown by atom and structure conserving chemical reactions between them. Several clusters, which are archetypal nanoparticles, Ag25(SR)18 and Au25(SR)18 (-SR = alkyl/aryl thiolate) have been used for such reactions. Despite their geometric robustness and electronic stability, reactions between them in solution at room temperature produce alloys AgmAun(SR)18 (m+n = 25), keeping their M25(SR)18 composition, structure and topology intact. We captured one of the earliest events of the process, namely the formation of the dianionic adduct, [Ag25Au25(SR)36]2-, by electrospray ionization mass spectrometry.

Exploring this science further, we have studied rapid solution state exchange dynamics in nanoscale pieces of matter, taking isotopically pure atomically precise clusters as examples. As two isotopically pure silver clusters made of 107Ag and 109Ag are mixed, an isotopically mixed cluster of the same entity is formed, similar to the formation of HDO, from H2O and D2O. This spontaneous process is driven by the entropy of mixing and involves events at multiple timescales.

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

Thin film photovoltaic technologies: progress, opportunities and industrial challenges

Ayodhya Nath Tiwari and collaborators
Laboratory for Thin Films and Photovoltaics, Empa-Swiss Federal Laboratories for Materials Science and Technology, Ueberlandstrasse 129, 8600 Duebendorf, Switzerland
email: ayodhya.tiwari@empa.ch

Thin film solar cells based on CdTe, Cu(In,Ga)Se2 (called CIGS) and organic-inorganic hybrid Perovskite semiconductors have shown remarkably high photovoltaic conversion efficiencies on glass and flexible substrates in "monofacial", "bifacial", and "tandem" configurations. Thin film photovoltaic (PV) technologies show great potential for low cost manufacturing and their widespread use for terrestrial and space applications. Different from well-established Si wafer based technologies they offer new opportunities to industries but also pose various challenges. Bringing the academic lab's excellence of small area champion devices to industrial scale manufacturing requires adaptations of processing tools and coating processes. The talk will present the recent developments in CIGS and Perovskite thin film PV, especially highlighting the emerging trends in bifacial, lightweight flexible and tandem devices, and will discuss the challenges and opportunities for industries.

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

A Paradigm Shift in Thin Film Based Technologies

M.S. Ramachandra Rao
Department of Physics,
Quantum Centre for Diamond and Emergent Materials (QuCenDiEM)
Nano Functional Materials Technology Centre
India Centre for Lab-grown Diamond (InCent-LGD)
and Materials Science Research Centre
Indian Institute of Technology (IIT) Madras, Chennai-600036
email: msrrao@iitm.ac.in

Materials in thin film form provide a plethora of technological applications. Understanding the physics of thin film growth is imperative to envisage industrial solutions based on thin films and coatings. Our group focusses on the physics, doping and electronic correlations, defect-engineering and applications of thin films and nano-structures of TMOs and diamond. In this talk, I will give a brief overview of our research activities on the exploration of the effect of doping and atomic scale control of defects in crystal lattices and heterostructures. Apart from many interesting optical properties, upon doping, TMOs can also act as a spin transport layer and quantum tunnel barriers. Followed by this, I will talk about diamond which is a very fascinating material that offers half a dozen different applications. Diamond, despite being one of the most resistive materials, is driven to a semiconducting to superconducting state by boron doping and boron doped diamond (BDD) is considered as the most useful next generation granular superconductor useful for quantum-interface devices requiring high surface inductance. It is all about doping and exploring wide and ultra-wide bandgap ‘quantum’ systems.

www.physics.iitm.ac.in/~msrrao

Indian Institute of Technology Madras
http://www.ictn-klc.org/
DEPARTMENT OF PHYSICS

International Conference on Thin Films & Nanotechnology: Knowledge, Leadership, & Commercialization

July 6-8, 2023

Plenary Speaker

System Scaling: Opportunities for new materials

Gouri Sankar Kar
Imec, Leuven, Belgium
email: gouri.kar@imec.be

Oxide semiconductors, 2D materials, Magnetic, and Ferroelectric materials have emerged as significant areas of research in recent years, revolutionizing the field of electronics and paving the way for numerous technological advancements.

Moore's Law predicts that the number of transistors on a chip doubles approximately every two years, leading to increased performance and reduced cost. However, traditional silicon- based technologies face limitations in further scaling down due to fundamental physical constraints. 2D-based materials, with their ultrathin atomic layers, offer a promising solution to continue the miniaturization trend beyond the limits of silicon, enabling the development of smaller and more efficient transistors. 2D materials possess superior electrical properties, such as high carrier mobility, tunable bandgaps, and ballistic transport. These properties enable faster electron movement and better control over the flow of current, resulting in improved transistor performance, reduced power consumption, and higher device speeds.

Researchers are exploring various 2D materials to replace or complement conventional silicon-based transistors, enabling the development of more advanced and energy-efficient electronic devices. Oxide semiconductors, such as indium gallium zinc oxide (IGZO), exhibit excellent electrical properties, including reasonable carrier mobility, BEOL compatibility and low off-state leakage current. These properties make them ideal for high density memory and low pawer BEOL logic applications.

MRAM is a non-volatile memory technology that uses magnetic materials to store data. It offers fast read and write operations, high endurance, and non-volatility, making it suitable for applications such as cache memory and storage in various electronic devices. FeRAM is a non- volatile memory technology that utilizes the electric polarization reversal in ferroelectric materials to store data. It offers fast read and write operations, high endurance, and low power consumption. FeRAM is suitable for applications where fast and non-volatile memory is required, such as in embedded systems and smart cards.

On or off-chip high density low power embedded memory solutions (MRAM & FeRAM) will be able to address the high value memory wall issue in the high-performance compute system architecture.

Low dimensional ceramic semiconductors and heterostructures for emerging energy applications

Oomman K Varghese

Nanomaterials and Devices Laboratory, Department of Physics, University of Houston, Houston, Texas 77204, USA.

Texas Center for Superconductivity, University of Houston, Houston, Texas, 77204, USA.

E-mail: okvarghese@uh.edu

The quest for sustainable energy technologies to mitigate the challenges posed by fossil fuel burning prompts the use of earth-abundant, inexpensive and environmentally friendly materials for energy applications. Several ceramic materials (e.g. oxides, nitrides and carbides) have these qualities. They are also recognized for their chemical, mechanical and thermal stability. While ceramic materials are commercially employed as insulators, substrates, packaging materials and so on in numerous applications, their use as semiconductors in solar energy conversion technologies is limited. This is primarily because of their poor photon harvesting and/or charge transport properties. It is now a proven fact that these materials could exhibit remarkable performance upon reducing their one or more dimensions to nanometer scale. This presentation provides an overview of the performance of low dimensional semiconducting ceramics and their heterostructures in photovoltaics and solar photoelectrochemical fuel generation. Experimental and simulation results revealing unique photon-matter interactions and the potential of these materials in steering high-energy ions are discussed in detail.

Crossover between band and various hopping conductions in Mo doped ZnO thin films owing to carrier localization at defects

As-Deposited V_2O_x Thin Films by Thermal Evaporation: A Promising Carrier-Selective Layer for Silicon Heterojunction Solar Cells

Rajesh Kanakala [#], Narendra Bandaru [#, *], **Rajesh Maurya, Jatindra Kumar Rath***

Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu -600036, India

[#] - Equal contribution; * Corresponding authors: jkr@iitm.ac.in ; narendra.bandaru05@gmail.com

This study investigates the use of as-deposited vanadium sub-oxide (V_2O_x) thin films as a carrier-selective layer in silicon heterojunction (SHJ) solar cells. V_2O_x thin films were deposited onto n-type crystalline silicon wafers and characterized for thickness variation, composition, carrier-selective properties, metal-semiconductor contacts, and surface topography. The smooth surface morphology of the as-deposited V_2O_x thin films (RMS roughness: 0.5 nm to 2.5 nm) is indeed advantageous for fabricating polycrystalline TCO films in SHJ solar cells. The results indicate that, even below 10 nm, we have achieved 302 µsec, which could be attributed to the low-charged defect density that leads to the low activation energies (i.e., 0.50 eV to 0.46 eV). This ensures field-effective passivation caused by a sub-stoichiometric SiO_x interlayer that forms when silicon bonds with oxygen. The findings of the lifetime mapping demonstrate that lifetimes are homogeneous, however locally low lifetime spots due to defects are encountered. Our data demonstrate that as-deposited V_2O_x thin films, even without further treatment, can be a replacement to the conventional carrier-selective layers in SHJ solar cells.

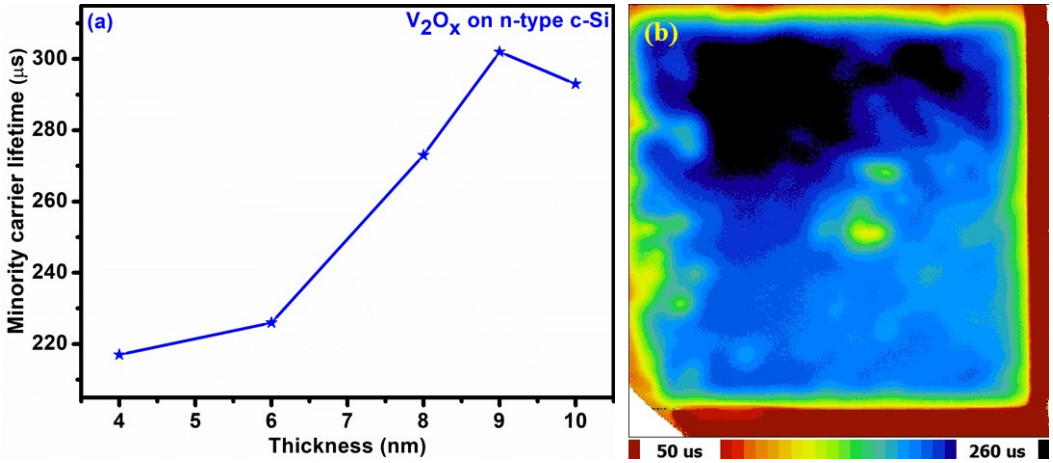


Figure 1. (a) Effective lifetimes (τ_{eff}) of the V_2O_x thin films deposited on n-type c-Si wafer substrates by varying the thickness from 4 nm to 10 nm and (b) Lifetime mapping of a 9 nm thick V_2O_x film.

Crossover between band and various hopping conductions in Mo doped ZnO thin films owing to carrier localization at defects

Durga Basak* **and Santanu Pal**

School of Physical Sciences, IACS, Jadavpur, Kolkata-700032

Email: sspdb@iacs.res.in

Transparent conducting film (TCF) is useful for various optoelectronic and electronic devices such as solar cell, light emitting diode, flat panel display, transparent thin film transistors etc. To date, the industry standard TCF is indium tin oxide (ITO) which shows a low resistivity of ~10^{-4} Ω·cm and a transmittance of greater than 80%. Indium (In) being costly and its price fluctuations causing ITO as an expensive TCF, doped binary compounds such as trivalent cation (M^{3+}) doped zinc oxide has been emerged as the alternatives because of its wide bandgap (3.37 eV), high excitonic binding energy (60 meV), non-toxicity, availability in nature and low cost. However, due to ionized impurity scattering in this binary oxide mobility is quite low. Therefore, understanding the carrier transport mechanism is crucial for its application in various devices. Although, electrical transport mechanisms of various trivalent cation doped ZnO films have been reported adequately, transport mechanism in ZnO doped with higher valence (>+3) dopants needs a considerable investigation. Though having comparable electronegativity, and ionic radius values, Mo has also a decent ionization energy of 4.477 MJ/mol, 5.91 MJ/mol, and 6.641 MJ/mol for Mo^{4+}, Mo^{5+}, and Mo^{6+} states respectively, indicating sufficient doping efficiency for substituting Zn. However, studies on Mo doped ZnO (MZO) is quite a few in the literature. Moreover, substrate temperature plays a crucial role in the electrical properties of polycrystalline films. Therefore, in this study, the electrical transport mechanisms of radio frequency (RF) sputtered 1 at% doped MZO films have been studied as a function of substrate temperature. The film deposited at 573K shows the highest conductivity value of 167.22 $(\Omega.cm)^{-1}$ and the highest mobility value of 4.92 $cm^2/V.s$ with a carrier concentration of 2.12 × $10^{20} cm^{-3}$. Thermally activated band conduction (TABC), nearest neighbour hopping (NNH) and Mott variable range hopping (VRH) conduction mechanisms are present in various temperature ranges in all the films in contrast to trivalent doped ZnO films wherein metal insulator transition is commonly observed. Further, a modified ES VRH type of conduction mechanism is also shown to be prevailing in the lowest measured temperature range (~30–10 K). Intriguingly, the transition temperature from one type of hopping to another type of hopping is different for different films, indicating existence of various amounts of defects related disorder for carrier localizations in each film. The film grown at 698K shows the maximum NNH activation energy of 4.57 meV with hopping ranges of 1.21 × 10^{-6} cm and 1.12 × 10^{-6} cm for Mott VRH and modified ES VRH respectively, whereas the minimum values of 1.05 × 10^{-7} cm and 9.13 × 10^{-8} cm for the same are obtained for the film grown at 573K. From the RT photoluminescence (PL) and X-ray photoelectron spectroscopy (XPS) measurements, formation of a number of intrinsic defects such as zinc vacancy (V_{Zn}), oxygen vacancy (V_O), oxygen interstitial (O_i), and various compensating defect complexes such as Mo_{Zn}-V_{Zn}, Mo_{Zn}-O_i, etc. has been predicted at higher substrate temperatures. Further, it has been observed that the activation energies for various conduction mechanisms are higher at lower vacuum condition (~10^{-1} mbar) as compared to those measured at higher vacuum condition (~10^{-3} mbar) implying an additional role of the surface traps in the carrier transport process. Detailed results on the temperature dependent conductivity, supported by the X-ray diffraction, XPS and RT PL data will be discussed during the presentation.

The Problem of High Crystallization Temperature of Oxide Thin Films and a Means to Lower It with Lasers

James Raju K.C

CASEST, School of Physics, University of Hyderabad, Hyderabad, India-500046

Email: kcjrsp@uohyd.ac.in

Oxide thin films got in general high crystallization temperature and it acts as a barrier to their device integration owing to the temperature incompatibility issues. Added to that many phenomena exhibited by the oxide films gets manifested only in the crystalline phase. An example is the dielectric tunability exhibited by ferroelectric thin films like $Ba_{0.5}Sr_{0.5}TiO_3$ (BST5) which are paraelectric at room temperature. The property is a collective phenomena and hence crystallization is necessary. The normal crystallization temperature of BST is 700C. That prevents it's insertion in various substrates and processes. A feasible solution to this problem is to resort to non-thermal crystallization processes. One of them is irradiating the films prepared at a lower temperature with laser energy with photon energy high enough to break some of the bonds. Using an expanded excimer laser of 248nm, crystallization temperature of BST5 and similar materials were brought down to 250C. This laser based crystallization of BST5 thin films was successfully implemented to crystallize these films on a commercial polymer composite laminate used for Microwave Integrated Circuits called RT/Duroid 5880. The resulting films were used to fabricate varactors and High Overtone Bulk Acoustic Resonators (HBAR) on these films. Both of these devices make use of the properties of the material exhibited in it's crystalline state. This way this process can facilitate direct integration of these materials into devices for monolithic fabrication on such flexible polymer substrates. At present devices like varactors are added to them as lumped elements as there is no technology to monolithically integrate them on such flexible polymer substrates to realize active integrated circuits over them. The laser annealed films are XRD crystalline. The microwave dielectric properties are measured by fabricating circular patch capacitor (CPC) using these films and a maximum tunability of 34% is obtained at 2.5GHz frequency. The HBAR resonators fabricated have resonance peaks with Q values in the range of 25,000 at 2GHz which are important for quantum acoustic applications.

Keywords: Low temperature crystallization, Laser annealing, BST, Tunable Microwave Devices, Varactors, Microwave Resonators

Compound semiconductors and thin film technology in products for strategic applications

Dr. Seema Vinayak

Director, Solid State Physics Laboratory, Delhi

This talk will broadly cover the products developed at SSPL covering material growth, RF microelectronics, photonics and sensors based on MEMS, accoustic emission, SAW and CNTs.

1-2-1 Pathway: Electrically Refurbishing Organic Redox Couples for Energy Storage in Flow Battery

Abhilipsa Sahoo[1], **Kothandaraman Ramanujam**[2]

[1,2]*Department of Chemistry, Indian Institute of Technology Madras, Chennai 600036*

[2]*Advanced Centre for Energy Storage and Conversion, The Energy Consortium, IIT Madras, Chennai 600036*

Email: rkraman@iitm.ac.in

The major drawback of organic redox couples (ORCs) based energy storage is the degradation of ORC with cycling. Ubiquitous ORCs can be laden with energy if the degradation mechanism is understood to design the electrically/chemically robust ORCs. This talk will unfold the mechanism of degradation associated with 2,6-dihydroxyanthraquinone (2,6-DHAQ) and how we managed to rescue 2,6-DHAQ from the degradation pathway. With the above said knowledge, we could demonstrate a flow battery with 0.45 M (nearly saturated solution) 2,6-DHAQ reaching a capacity of ~ 19 Ah L^{-1}, which is otherwise difficult to achieve due to the capacity decay associated with dimer formation.

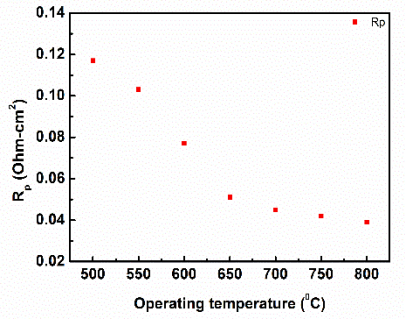
Enhanced performance of Doped LSM for Low temperature SOFC cathode application

S. Manishanma and **Atanu Dutta***

Division of Physics, School of Advanced Sciences, VIT Chennai, Chennai 600127, India

Email: atanudutta@vit.ac.in

Traditionally lanthanum strontium manganite (LSM) is considered as state of the art cathode material for YSZ based SOFC which normally performs well in the temperature range 700-800°C with anode-supported structure. However, intense efforts are on to use SOFC in the temperature range 500-600°C (LT-SOFC) using several new electrolytes such as Sm or Gd doped ceria (SDC, GDC), doped lanthanum gallate (LSGM). In such cases, efficient cathode oxygen reaction is a challenge and newer electrode materials are also being explored. In the present work, LSM was studied as LT-SOFC cathode using Ni^{2+} doped at manganese site of the ABO_3 perovskite structure. Lanthanum gallate with composition $La_{0.8}Sr_{0.3}Mg_{0.1}Ni_{0.1}O_3$ (LSGMN10) was used as electrolyte. The cathode compositions with 10-30 mol% Ni^{2+} doped LSM (e.g. LSMN7391, LSMN7382 and LSMN7373) were synthesized by combustion techniques and calcined at 1200°C for achieving complete phase purity. Crystallite size was estimated from the Rietveld refinement analysis using FULLPROF software and particle size from dynamic light scattering followed by transmission electron microscope analysis. Symmetric cell structure with LSGMN10 electrolyte was analyzed with the synthesized cathode materials screen printed on either side of electrolyte to find the polarization resistance (R_p) in air and mechanism of oxygen reduction reaction (ORR). Impedance spectroscopic analysis was done with 10 mV ac signal in the frequency range of 0.1 Hz to 5 MHz. The measurement was performed from 500° to 800°C and lowest value of R_p was obtained with LSMN7382 and its value at 500°C was found very low (0.117 Ω-cm^2) compared to other dopant condition. LSM without doping was also tested for reference and very high R_p value was obtained. Figure below shows how Rp value decreased fast for LSMN7382 cathode with operating temperature. The detailed analysis revealed that charge transfer resistance at the interface with electrolyte contributes most to the R_p value.



Nano Ceramic Hydroxide and its Applications

Pushpendra Kumar

Department of Physics, Manipal University Jaipur, Jaipur-303007, Rajasthan, India.

Email: pushpendra.kumar@jaipur.manipal.edu

Nano ceramics are solid materials that contain inorganic compounds of metal, nonmetal or metalloids with covalent or ionic bonds. Ceramics has applications in almost all the field that include the fields of engineering and industry, including those used in medicine, energy, defence, automotive, space, and the environment. Depending on the synthesis parameters, the size, shape, and microstructure of prepared material can be changed. In this work, the chemical precipitation technique is used to synthesize the phase pure nano $Ca(OH)_2$ powders using equimolar concentrations (e. g., 0.4 M, 0.6 M, 0.8 M and 1 M) of $[Ca(NO_3)_2 \cdot 4H_2O]$ and NaOH solutions. Several characterization techniques were used to study the effect of molarity on the properties of prepared material. Further the effect of molarity on the antimicrobial efficacy and waste water treatment efficacy of nano-$Ca(OH)_2$ was discussed. These results are discussed in terms of relative variations in the microstructure, lattice strain, thermal stability, optical band gap energy, defect structure, and the amount of (OH-) ions. The possible mechanisms of wastewater treatment and antimicrobial behaviour are suggested.

Keywords: Ceramics, Band Gap Engineering, Calcium hydroxide, wastewater, antimicrobial.

DFT and ML: A Journey in Materials Discovery

Kavita Joshi*

CSIR-National Chemical Laboratory, Pune, India

Email: k.joshi@ncl.res.in

Density functional theory (DFT) and machine learning (ML) are powerful tools for discovering new materials with desired properties. In this talk, I will discuss our journey with a focus on three specific applications:

- In silico design of catalyst: **DFT has been used to understand the reaction mechanisms of various industrially important reactions and design catalysts rationally. I will present two cases where we predicted a catalyst based on our DFT calculations and validated our predictions through experiments.**
- Cluster structure prediction: **Predicting the ground state structure of a cluster is an NP-hard problem. We have developed a model based on re-enforcement learning to predict the ground state structure of a cluster.**
- Solid-state hydrogen storage: **We have developed** ML-based models to predict H2wt%, enthalpy of hydrogenation and plateau pressure of a material to decide its suitability for solid-state hydrogen storage. Our predictions have been validated through experiments. Further, active learning is a promising way to improve the accuracy of our predictions.

By combining the power of these two tools, we can accelerate the discovery of new materials with desired properties, and we are working in that direction.

Properties of 2D CdTe nanostructures

Sharat Chandra
IGCAR Kalapakkam, India
Email: sharat@igcar.gov.in

CdTe materials find use in diverse device applications like solar cells, gamma ray detection, sensors, etc. We will discuss the structural, optical, vibrational properties of 2D nanostructures of CdTe formed by both the top down and bottom up approach which includes cluster assembled materials. Electronic conductivity of the CdTe clusters in tunnel junction devices will also be discussed.

Acoustomicrofluidics - ultrasound meets microfluid

Ashis Kumar Sen

Dept of Mechanical Engineering, IIT Madras, India

Email: ashis@iitm.ac.in

Acoustomicrofluidics which combines ultrasound with microfluidics has emerged as a powerful tool for the actuation of various kinds of interfaces. Microfluidic interfaces exposed to high-frequency sound waves reveal intriguing flow mechanics that can be harnessed for biochemical applications. The talk will focus on the use of ultrasound for the handling of particles, cells, and fluid streams inside microchannels.

Multi-vapour sensitive soft actuators: Physics and applications

Dillip K. Satapathy[1,2]

[1]*Soft Materials Laboratory, Department of Physics, IIT Madras, Chennai - 600036, India*

[2]*Center for Soft and Biological Matter, IIT Madras, Chennai - 600036, India*

Email: dks@iitm.ac.in

Polymer-based soft actuators based on polymeric materials have immense potentialfor various niche applications such as soft robotics, shape-morphing intelligent structures, smart textiles, and biomedical devices. Here, I will discuss our effort in developing multi- vapour responsive soft actuators using naturally available biomaterials. In this context, vapour-triggered locomotion/deformation of several biomaterials, such as silk fibroin ob- tained from the biopolymer Bombyx Mori silk, cassava starch and coconut pollens, will be discussed [1, 2, 3]. The sub-second response and actuation times, along with the vapour- selective actuation characteristics of silk and starch films, are unique [2, 4]. The excellent durability and consistent performance of the film without any noticeable fatigue are estab- lished by subjecting the films to more than a thousand continuous actuation cycles. Several potential proof-of-principle applications of vapour-responsive soft actuators, such as smart switches, intelligent textiles, autonomous crawlers, and caterpillar-like motion, will be demon- strated.

References

[1] G. Manikandan, Ravi Kumar, D. K. Satapathy, *Rapid Moisture-Responsive Silk Fibroin Actu-ators*, ACS Appl. Mater. Interfaces, **13**, 8880 (2021).

[2] Vipin Kumar, Sarah A Siraj, D. K. Satapathy, *Multi-vapour responsive starch-based soft actu-ators* (Under review).

[3] Sarah A Siraj, Vipin Kumar, D. K. Satapathy, *Fully reversible shape morphism of coconutpollen paper* (Under review).

[4] G. Manikandan, Ravi Kumar, D. K. Satapathy, *Bidirectional Actuation of Silk Fibroin Films:Role of Water and Alcohol Vapors*, Langmuir, **38**, 6066 (2022).

Large area hybrid two-dimensional optoelectronic devices

Atindra Nath Pal

Department of Condensed Matter and Materials Physics, S. N. Bose National Centre for Basic Sciences,Kolkata – 7000106

Email: atin@bose.res.in

Two-dimensional (2D) layered materials (graphene, TMDs etc.) offer a new viable alternative to the conventional semiconductors used in 2D optoelectronics due to their promising electronic and optical properties. While graphene is considered as an outstanding channel material for a transistor due to its ultrahigh charge carrier mobility, it has limitations in the field of optoelectronics because of its gapless nature, low absorption cross-section etc. Among various possibilities, a popular strategy is to create a noble device structure by incorporating light absorbing nanomaterials like Si quantum dots, natostructured PbS, ZnO etc. into graphene. In this typical hybrid structure, graphene is used for carrier transport channel and interaction between the photosensitive material and graphene is the prime factor for the ultrasensitive photodetection. Being layered semiconductors, some members of the transition metal dichalcogenide (TMDC) family (MX2; M = Mo, W; X = S, Se) are natural partners of graphene for optically active heterostructures. In this talk, I will discuss our recent works on large area gate tunable hybrid 2D/2D or 2D/0D photo transistor devices based on graphene/TMD heterostructure. Firstly, I will discuss the effects of morphology and quantum confinement of the TMD nanostructure on the performance of the device. Then we will discuss how alloy engineering can improve the device characteristics by modifying the defectlevels. Finally, I will describe how light-matter interaction mediated by exciton plasmon coupling enhancesthe light-absorption as well as the photo response of the large area devices. Additionally, the effect of mobile disorder, substrate and interfaces leading to low frequency noise will also be discussed.

References:

1. Shubhrasish Mukherjee, Didhiti Bhattacharya, Samit Kumar Ray and Atindra Nath Pal*, arXiv:2303.06692 (under review).
2. Shubhadip Moulick, Rafiqul Alam and Atindra Nath Pal, ACS Appl. Mater. Interfaces14, 45, 51105–51112 (2022), https://arxiv.org/ftp/arxiv/papers/2210/2210.09851.pdf.
3. Shubhrasish Mukherjee, Didhiti Bhattacharya, Samit Kumar Ray* and Atindra Nath Pal*, ACS Appl. Mater. Interfaces 2022, https://doi.org/10.1021/acsami.2c08933, arXiv:2206.15032
4. Shubhrasish Mukherjee, Didhiti Bhattacharya, Sumanti Patra, Sanjukta Paul, Rajib Kumar Mitra, Priya Mahadevan, Atindra Nath Pal*, Samit Kumar Ray*, ACS Appl. Mater. Interfaces 2022, 14, 5775-5784 (2022). https://doi.org/10.1021/acsami.1c18999; arXiv:2111.05159, 2021

Spin-to-charge conversion using quantum materials

Pranaba Kishor Muduli

Department of Physics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India

Email: muduli@physics.iitd.ac.in

Spintronics involves manipulating and controlling the spin degree of freedom for novel storage and computing applications [1]. The major challenge is the efficient generation and detection of pure spin current. Traditionally, nonmagnetic materials have been utilized for spin-to-charge conversion. Recently, the focus has shifted to novel quantum materials such as two-dimensional (2D) materials and non-collinear antiferromagnets (AFM) for efficient spin-to-charge conversion. These quantum materials offer several advantages like giant spin-charge conversion, unconventional spin-orbit torques (SOTs), and gate tunable spin-charge conversion. Considering the above advantages, we have investigated 2D transition metal dichalcogenides (TMDs) and non-collinear AFM Mn_3Sn for spin-to-charge conversion in detail. First, we report on the room temperature observation of a large spin-to-charge conversion arising from the interface of $Ni_{80}Fe_{20}$ (Py) and four distinct large-area ($\sim 5 \times 2$ mm^2) monolayer (ML) TMDs, namely, MoS_2, $MoSe_2$, WS_2, and WSe_2 [2]. We show that both spin mixing conductance and the Rashba efficiency parameter (λ_{IREE}) scale with the spin-orbit coupling strength of the ML TMD layers. The λ_{IREE} parameter is found to range between -0.54 and -0.76 nm for the four ML TMDs, demonstrating a large spin-to-charge conversion. Through Mn_3Sn thickness dependent ISHE measurements, we found a large and negative spin Hall conductivity, which can be explained by a shift of the Fermi level caused by a slight excess of Mn in our films [3]. Our findings demonstrate novel techniques for engineering spin-to-charge conversion using quantum materials for functional spintronic devices.

[1] I. Žutić et al., Rev. Mod. Phys. 76, (2004) 323.

[2] H. Bangar et al., ACS Appl. Mater. Interfaces 14 (2022) 41598.

[3] H. Bangar et al., Adv Quantum Technol. 6, 2200115 (2022).

2-Dimensional Materials and their Heterostructures for Electrocatalysis

M. M. Shaijumon

School of Physics, Indian Institute of Science Education and Research Thiruvananthapuram, Maruthamala PO, Thiruvananthapuram, Kerala, INDIA 695 551

Email: shaiju@iisertvm.ac.in

Atomically thin layered transition metal dichalcogenides (TMDs) such as MoS_2, WS_2, $MoSe_2$ and WSe_2 have been emerging as the cutting edge in materials science and engineering, due to their interesting electronic properties.[1] These materials open up new opportunities for a variety of applications, including optoelectronics, energy conversion, and catalysis. To realize their potential device applications, it is highly desirable to achieve controllable growth of these layered nanomaterials, with tunable structure and morphology. TMDs exhibit promising catalytic properties for hydrogen generation and several approaches including defect engineering have been shown to increase the active catalytic sites.[2,3] The talk will present some of our efforts on morphological and electrocatalytic studies of engineered 2D nanomaterials and their heterostructures.[4-7] I will discuss our recent work on the design and fabrication of electrocatalytic microcells using elemental 2-dimensional materials, for their application in electro- and photo-catalytic hydrogen generation. Our work highlights the opportunities for tuning the electrocatalytic properties of atomically thin electrocatalysts based on defect engineering and surface modification.

References

1. H. R. Gutiérrez, N. Perea-López, A. L. Elías, A. Berkdemir, B. Wang, R . Lv, F. López-Urías, V. H. Crespi, H. Terrones, M. Terrones, *Nano Lett*. 2013, 13 (8), 3447-3454.
2. P.V. Sarma, T.V.Vineesh, R.Kumar, V.Sreepal, R.Prasannachandran, A.K. Singh, and M.M. Shaijumon, *ACS Catalysis* (2020), 10,6753–6762
3. P. V. Sarma, A. Kayal, C. H. Sarma, M. Thalakulam, J. Mitra, and M. M. Shaijumon, *ACS Nano*, 13, 10448-10455 (2019).
4. R. Prasannachandran, T. V. Vineesh, A. Anil, B. M. Krishna and M. M. Shaijumon, *ACS Nano*, 12, 11511–11519 (2018).
5. R. Prasannachandran, T. V. Vineesh, M.B.Lithin, R. Nandakishore, M. M. Shaijumon, *Chem. Commun.*, 56, 8623-8626 (2020).
6. P.V.Sarma, N. Renjith et al., *2D Mater*., 9, 045004 (2022)
7. N. Renjith et al., *Unpublished* (2023)

Opportunities and Challenges in 2D Materials for Advanced Memory and Computing Applications

Satyaprakash Sahoo[1, 2]

Email: sahoo@iopb.res.in

[1] *Laboratory for Low Dimensional Materials, Institute of Physics, Bhubaneswar-751005, India*

[2] *Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai-400094, India*

In the era of big data and artificial intelligence the traditional Von-Neumann computing architecture is periodically confronted. Brain inspired Neuromorphic computing architecture integrated with in-memory computing capability could instigate unprecedented breakthroughs in AI technology. Although there has been progress in Neuromorphic computing, however, engineering the material aspect for its architecture remains a challenge. In this regard, the two-dimensional (2D) layered materials, consisting of atomically-thin layers, possess a plethora of exotic properties and have emerged as the leading contenders for the next generation of electronic devices. Specific attention has been given to the layered transition metal di-chalcogenides (TMDCs), has created numerous prospects for developing low-power electronics, cutting-edge memory device arrays and smart computing architectures with desirable miniaturization. In this talk I will discuss two approaches for achieving Neuromorphic computing with monolayer TMDCs mem-transistors; optoelectronic and thermal driven ionotronic approach. Two-dimensional TMDC transistors demonstrating optoelectronic artificial synapse and reconfigurable logic operation are fabricated. The persistent photoconductivity of these devices are used to achieve the long- short term synaptic plasticity behaviour. Furthermore, Pavlov's classical conditioning is demonstrated by using the broadband sensitivity of the devices. More importantly, reconfigurable Boolean logic gate operations are demonstrated within the same device. We also demonstrate a novel mem-transistor device using monolayer TMDCs as channel that offers multi-bit high density storage states and can perform key synaptic operations above room temperature. This novel integration of memory, synaptic behaviour, and processing within a single monolayer TMDC device put forth a new horizon for the Non-Von-Neuman type in-memory computing architecture for advanced AI applications at room temperature and beyond.

Photocatalytic Degradation of Toxic Pollutants Using 2D Nanomaterials: Textile Dyes, Heavy Metal Ions, and Antibiotics

Manika Khanuja

Centre for Nanoscience and Nanotechnology, Jamia Millia Islamia, New Delhi, 110025

Email: mkhanuja@jmi.ac.in

The untreated release of harmful pollutants into water bodies has caused irreparable harm to ecosystems. The escalating population growth has resulted in alarming concentrations of waste pollutants in water, posing risks to both humans and the environment. To address this issue, a range of 2D nanocomposites consisting of WS_2, $MoSe_2$, g-C_3N_4, and their nanocomposites with Polyaniline (PANI), Polypyrrole (PPY), and Metal Organic Framework (MOF) were synthesized using various synthesis method. The characterization techniques including High-resolution transmission electron microscopy (HRTEM), Field emission scanning electron microscopy (FESEM), Energy-dispersive X-ray (EDX) spectroscopy, X-ray diffractogram (XRD), Fourier transform infrared (FTIR) spectroscopy, Zeta potential, Tauc's plot, Photoluminescence (PL) spectroscopy, Time-Resolved Photoluminescence (TRPL), and BET were employed to analyze the synthesized nanocomposites. The 2D nanocomposites demonstrated exceptional photocatalytic activity for the degradation of various pollutants, encompassing textile dyes (both anionic and cationic types), heavy metal ions (such as Chromium VI), and antibiotics (Nitrofurantoin, Tetracycline, Metronidazole). The formation of photoinduced reactive oxygen species (•OH and O2•−) was confirmed through scavenger experiments. Notably, all the nanocomposites exhibited significantly enhanced photocatalytic activity, achieving 100% degradation efficiency. This improvement was attributed to the enhanced separation of photo-induced electron-hole pairs and increased surface area.

Opportunities in Two-dimensional Materials for Harvesting Solar Energy

Surendra B. Anantharaman

Low-dimensional Semiconductors Lab, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras 600 036, Tamil Nadu

Email: sba@iitm.ac.in

The exploration of materials for harvesting solar energy to generate electricity, fuels, or perform catalytic reactions has gained wide interest among materials scientists, physicists, and chemical engineers. Emerging two-dimensional (2D) semiconductors with strong exciton binding energy at room temperature are promising for solar energy harvesting. Also, they can meet stringent demands requiring high power to lightweight. In this talk, I will present the recent developments in 2D materials and how we can overcome intrinsic limitations in these materials by strong coupling light-matter interactions. Strong coupling without an external cavity to form exciton-polaritons quasiparticles for energy harvesting will be discussed.[1,2] I will present a simple device structure of 2D perovskites on the gold substrate which can absorb photons below the semiconductor's bandgap. Efficient charge and energy transfer in a few-layer graphene-2D perovskite heterostructure will be discussed.[3] Finally, I will conclude the talk on extending the concept of exciton-polaritons for large-area TMDC superlattices.[4]

References

[1] S. B. Anantharaman, K. Jo, D. Jariwala, *ACS Nano* **2021**, *15*, 12628.

[2] S. B. Anantharaman, C. E. Stevens, J. Lynch, B. Song, J. Hou, H. Zhang, K. Jo, P. Kumar, J.-C. Blancon, A. D. Mohite, J. R. Hendrickson, D. Jariwala, *Nano Lett.* **2021**, *21*, 6245.

[3] S. B. Anantharaman, J. Lynch, C. E. Stevens, C. Munley, C. Li, J. Hou, H. Zhang, A. Torma, T. Darlington, F. Coen, D. Jariwala, *arXiv preprint arXiv:2302.09442* **2023**.

[4] P. Kumar, J. Lynch, B. Song, H. Ling, F. Barrera, K. Kisslinger, H. Zhang, S. B. Anantharaman, J. Digani, H. Zhu, T. H. Choudhury, C. McAleese, X. Wang, B. R. Conran, O. Whear, M. J. Motala, M. Snure, C. Muratore, J. M. Redwing, N. R. Glavin, E. A. Stach, A. R. Davoyan, D. Jariwala, *Nature Nanotechnology* **2022**, *17*, 182.

Fast and Broadband Photodetectors based on Layered material/Group-IV Semiconductor Heterojunctions

Samaresh Das

Centre for Applied Research in Electronics, Indian Institute of Technology Delhi, India

samareshdas@care.iitd.ac.in

Layered materials such as b-As, In_2Se_3, including transition metal dichalcogenides (TMDs) have drawn intensive research interest for their potential applications in the next-generation nanoscale electronic, optoelectronic, and sensor devices. Layered 2D materials consist of covalent/ionic in-plane bonding with van der Waals (vdW) interlayer interactions. Most of the 2-D layered materials are semiconductors with varying bandgap and electron affinities, which along with vdW interlayer coupling allows for versatility in designing optimal strain-free and atomically sharp heterostructures for electronic and optoelectronic devices [1]. On the other hand, both silicon on insulator (SOI) and germanium on insulator (GOI) are suitable choices for on-chip optoelectronic device fabrication owing to their mature technology for waveguide based silicon photonic integrated circuit. To enhance the responsivity and attain wide-range wavelength detection, the integration of TMDs and 2-D layered materials with silicon and germanium could be highly efficient. A high-performance In2Se3/Silicon-on-Insulator (SOI) heterojunction phototransistor with dual band detection will be discussed [2]. The experimental results on integration of $MoSe_2$ [3] and b-As [4] with silicon and germanium will be presented to further increase the detection range towards short-wave infrared wavelengths. These results of layered materials heterojunction with Si or Ge have demonstrated the feasibility of achieving a high-performance photodetector in the range of visible to broadband infrared regime.

References

1. P Yadav, S Dewan, R Mishra, S Das, “Review of recent progress, challenges, and prospects of 2D materials-based short wavelength infrared photodetectors”, *J. Phys. D: Appl. Phys.* 55 31300 (2022)
2. V Dhyani, W. Uddin, P K Muduli, and S Das, “Self-powered room temperature broadband infrared photodetector based on $MoSe_2$/germanium heterojunction with 35 A/W responsivity at 1550 nm” *Applied Physics Letters*, 114(12), 121101 (2019).
3. A. Moudgil, S. Sharma and S Das, “In2Se3/Silicon-on-Insulator Heterojunction Phototransistor for Low Noise Dual-Band Detection” *IEEE Electron Device Letters* 42 755 (2021).
4. J W John, V. Dhyani, A. Jakhar, H. K. Sandhu, S. Dewan, S. K Ray, and S Das, “Black-Arsenic/Germanium-on-insulator Heterostructure Field Effect Transistor for Ultrafast Polarization Sensitive Short-Wave Infrared Photodetection” *IEEE Electron Device Letters* 43, 1495 (2022).

Electrically Conducting Diamond Hybrids for Optoelectronic Devices

K. J. Sankaran[1], K. Haenen[2], R. Bogdanowicz[2]

[1]*CSIR- Institute of Minerals and Materials Technology, Bhubaneswar, India-751013.*

[2]*Institute for Materials Research (IMO), Hasselt University, 3590 Diepenbeek, Belgium.*

[3]*Department of Metrology and Optoelectronics, Faculty of Electronics, Telecommunications, and Informatics, Gdansk University of Technology, 80-233 Gdansk, Poland.*

kjsankaran@immt.res.in

Electrons from cold cathode emitters are usually obtained by applying an electric field, which tunnels the electrons from the material surface into vacuum. A cold cathode emitter is expected to possess certain characteristics, namely, resistance against chemical attack and ion bombardment by residual gases, sustaining plasma discharges, and stability in various gas environments. Other than the low onset fields, the long-lasting stability and stable emission current with very little/no fluctuations are necessary for using cold cathode materials in field emission displays (FEDs). Among field emitting materials, diamond owns excellent physical as well as chemical properties such as good thermal conductivity, tunable negative electron affinity, high secondary electron emission coefficient, high hardness, high chemical inertness, and wide band gap. All these characteristics render diamond materials as a promising candidate for application as cathodes in FEDs and plasma displays.

Here I present the enhancement of field electron emission and plasma illumination of diamond hybrids employing different approaches like doping in the plasma, ion implantation and combination of diamond with other nanocarbon materials. From our studies we reveal that such modifications of properties are related to microstructural alterations. The prominent change observed, and contributing to this enhancement, is the increase in the grain boundaries, with sp^2 graphitic phases residing in them. The effect of *n*- or *p*-type doping into diamond is ruled out. The betterment of the electrical conductivity and field electron emission is attributed to the interconnected sp^2 phases within the grain boundaries, which form itineraries for electrons to traverse through the material.

Influence of Zirconium (Zr) Doping on UV Photodetector Characteristics in Zinc-Oxide (ZnO) Nanostructure

K. Suganthi[a], Sanju Rani[a*]

[a]Department of Physics, SRM Institute of Science and Technology, Ramapuram Campus,Chennai, TN, India

*Corresponding author's email: sanjur@srmist.edu.in

The present study shows effect of Zr- doping on the structural, morphological, optical and UV detector properties of ZnO samples. Three different concentrations of Zr (1wt. %, 3 wt. %, and 5 wt. %) were incorporated to the ZnO by hydrothermal method and effect of Zr were investigated on all four samples. XRD, FE-SEM, HR-TEM, EDX, XPS, UV-Vis spectroscopy, and UV detection measurements provide comprehensive insights into the structural, morphological, and optical characteristics of the samples X-ray diffraction patterns confirms the hexagonal wurtzite structure for all the samples which was again confirmed by High-resolution scanning electron microscopy (HR-SEM). UV detector properties were evaluated by shining UV light on the samples with different intensities and time vs current curve were obtained. The 3 wt. % Zr-doped samples exhibited superior performance as compare to other samples which attributed to the higher concentration of oxygen vacancies present in the sample. The composition analysis of the samples were carried out by XPS and analysed.

.

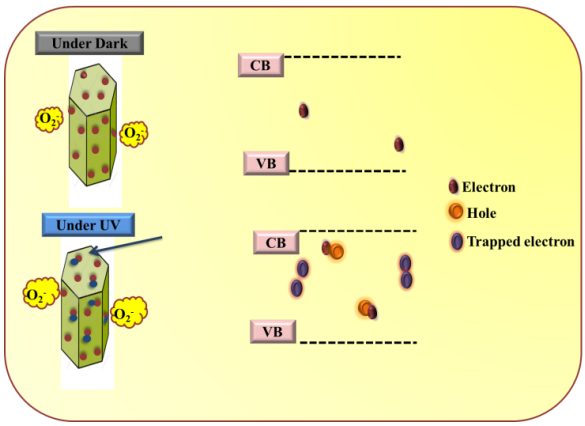


Fig. Schematic representation of photocurrent generation mechanism in ZnO hexagonal shaped nanorod

Optical thin films for Space Applications

Girish M. Gouda

[1]*Laboratory for Electro Optics Systems, ISRO, Peenya Industrial Estate, Bengaluru-560058*

e-mail: girish@leos.gov.in/ girishmg.g@gmail.com

Space borne systems require variety coatings for various applications like thermal control, high absorptance, high reflectance, high transmittance, low scattering, low emissivity, etc. depending on the applications need. The instruments/ payloads which are used for remote sensing, cartography, spacecraft attitude determinations contain variety of optical components which need to coated for intended functioning in the required spectral bands by depositing optical thin films. Mirrors used in telescopes require high reflectance in the broad spectral band comprising of visible and near infrared wavelengths. Lenses used in refractive systems will have anti-reflectance coating (ARC) in narrow and broad spectral bands. Interference filters (IF) used for spectral band selection from visible to infrared wavelengths need to have different band width from few nano-meters to sub micro-meter with specific rejections bands. The mechanical components used in various sensors and baffles require low scatter and high absorber coatings in order to identify feeble sources in the background of solar radiation. The coatings need to withstand various space environmental conditions. The paper gives highlights of various coatings for space applications.

Enhanced erosion resistance of Ti/TiN nanolayered multi-layered coating due to energy absorbing nanoporous Ti layers

Venkataramana Bonu,*[1] Jeevitha M,[1] Praveen Kumar V,[1] Siju,[1] Harish C Barshilia[1]

[1]*Nanomaterials Research Laboratory, Surface Engineering Division, CSIR-National Aerospace Laboratories, Bangalore-560 017, India.*

E-Mail: ramana@nal.res.in

Metal porous layers are usually used in armours and car crash protection due to their energy absorbing capacity. In the present work, their energy absorbing property is smartly used to enhance the solid particle erosion (SPE) resistance of Ti/TiN nanolayered multi-layered coatings. The coatings were deposited on Ti6Al4V substrates using an unbalanced magnetron sputtering system. Two nanoporous Ti layers were sandwiched between three stacks of dense Ti/TiN (3.5/4 nm) bi-layers (Fig. 1). The total thickness of the coating is ~9 µm. The porous layers were created in the magnetron sputtering chamber by following the Thornton model [1]. The optimized coating hardness, elastic modulus, and toughness are 18 GPa, 261 GPa, and 3.2 MPa $m^{1/2}$, respectively. SPE resistance of the coatings was tested according to ASTM-G76 standards @ 400 °C. The optimized coating showed 18 times better erosion resistance compared to the bare Ti6Al4V substrate for 100 m/s erodent speed.

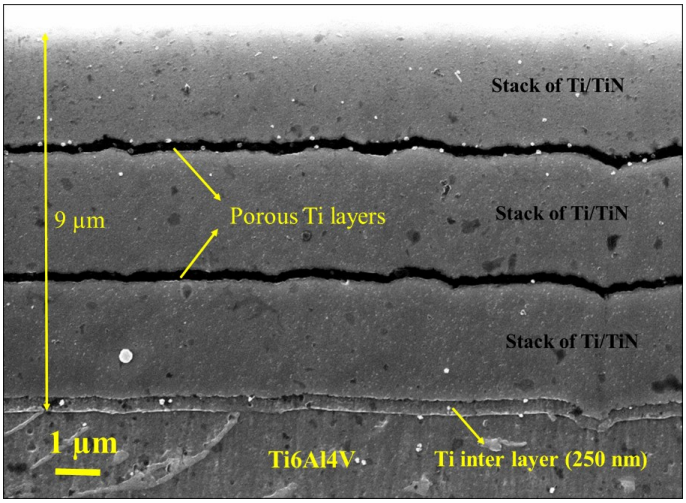


Fig. 1 Cross-sectional FESEM image of Ti/TiN nanolayered multi-layered coating.

Reference:

1. John A. Thornton The microstructure of sputter-deposited coatings J. Vac. Sci. Technol. A 4 (6), 3059-3065, 1986.

Ion beam engineering of nanoscale structures

Debdulal Kabiraj

Inter-University Accelerator Centre, New Delhi
Email: kabiraj@iuac.res.in

While traveling through a material, energetic ions lose energy by nuclear (Sn) and electronic (Se) energy loss. Sn is an elastic energy loss process that is well described by Rutherford scattering cross-section. This stochastic binary collision process produces vacancies and interstitials and their complexes. With increasing energy Se dominates over Sn and peaks at around 1 MeV/nucleon. This inelastic energy process generates energetic electrons through the Coulomb interaction of the nuclear charge of the projectile and the bound and free electrons in the material. These energetic electrons generate thermal spike along the ion path by interacting with the lattice. Beyond a material-dependent threshold, a collective atomic movement is possible leading to an ion track.

Ion beam irradiation can be effectively utilized for the growth of nano-particles and post-growth manipulation of the size and shape of embedded nano-particles. Swift Heavy Ions (SHI) irradiation of metallic nanoparticles supported in SiO_2 matrix is studied. The research interest is to form aligned nano-rods due to the elongation of metallic nanoparticles along ion tracks. The uni-directional ion track (~9 nm), created by melting of the core due to thermal spike, defines the nano-rod template (size, aspect ratio and alignment). In another example, we have utilized SHI to form nano-size open volume in Ge. Subsequent irradiation showed growth in size and change in shape. Preferential elongation of the pores along the ion beam direction is also observed. This leads to swelling and relative swelling is found to increase steadily with increasing ion fluence and then tosaturate at a maximum value of 20% at the highest fluence of 1×10^{14} ions cm^{-2}. An unusually highsputtering of the porous structure is observed when irradiated at an angle. The sputtering opens upthe sub-surface voids to show the surface pattern. The results are explained on the basis of the thermal spike model. Ultra-fast processes during SHI-generated thermal spike (heating and subsequent cooling within 10ps of time) could diverge from the thermodynamically-predicted phase, decorate with new phases, and also introduce defects.

Opportunities and challenges of porous and thin film alumina for ion beam dosimetry

Aloke Kanjilal

Department of Physics, School of Natural Sciences, Shiv Nadar Institution of Eminence, NH-91, Tehsil Dadri, Gautam Buddha Nagar, Uttar Pradesh 201314, India

Email: aloke.kanjilal@snu.edu.in

The application of hadron therapy in cancer treatment requires precise dose monitoring. For this, carbon ions are considered to be more effective than that of protons for the presently used thermoluminescence (TL) phosphors. Among several TL phosphors, carbon-doped alumina is favorable for radiation dosimetry, especially in medical research due to its tissue equivalent atomic number, along with improved radiation absorption, simple glow curve, high sensitivity, and low fading effect. Based on this, a facile approach for achieving a promising TL sensitivity is presented in anodized porous Al_2O_3 (AAO) by doping with carbon ions, especially for ion beam dosimetry. Ion implantation technique has been used here for doping carbon in AAO, where the evolution of a porous structure and carbon distribution up to a depth of ~200 nm have been explored by various characterizing tools. The stimulation of optically active oxygen vacancies with increasing ion fluence has been revealed by photoluminescence and TL analyses, while the chemical nature of these defect centres was monitored by X-ray photoelectron spectroscopy. At the end, the development of thin radiation dosimeter using alumina thin films will also be demonstrated for in-situ dose monitoring.

A Study on the Emerging Characteristics of Leaders Towards Preparedness in a Learning Agility Environment

Dr.N.Asokan
HOD/Physics Department, Faculty of Engineering & Technology,
SRM IST Ramapuram, Chennai
asokann@srmist.edu.in

The world of work has permanently changed, with volatility the new norm. Ways of thinking and working that previously led to success now result in stagnation, or worse, regression. Agile organisations need a new breed of leaders.

Leaders are creating new technologies, doing research and writing, teaching and the like. Leaders' ideas tend to be well thought-through, supported by data and analysis, scientific, practical and logical. Leaders develop structure and frameworks that help others solve problems.

This paper will discuss the most important characteristics, identified by the author and any good leader should possess and able to apply in a variety of highly demanding situations. The author reviewed the studies made by the researchers on trait wise, which are, every leader is expected to prepare themselves to perform, and complied all the outcomes on these traits like Purpose Paradox, Personal Mastery, Fanatic Discipline, Practical Intelligence, Leadership Values, Reading Books, Trusted Relationship, Cultivating Foresights, and Powerful Storytelling.

First Solar in India - solar energy for India's future

Mr Sujoy Ghosh
First Solar India
Email:

Please note that the following will be the focus of my talk at this session

a) CdTe thin-film PV module manufacturing process overview
b) Evolution of CdTe thin-film PV over the past 25 years.
c) Future roadmap of Thin-film PV
d) From lab to fab. what does it take

Development and Commercialization for Advanced Equipment and Process Technology for Industrial Thin Film Coatings

Dr. Milind G. Acharya
Executive Director and Founder
MILMAN THIN FILMS SYSTEMS PVT. LTD., PUNE, INDIA
Email: milind.acharya@milmanthinfilms.com

The journey of conceptual proof of concept to providing a complete industrial business solution goes through the 'Valley of Death' in any commercial technology development.

The paper describes how laboratory R & D level concepts in thin film-based processes and products were converted to true industrial solutions. This journey includes process development and engineering to develop state of the art production of thin film deposition equipment. Various aspects of equipment development include subsystems, integration, and process parameter optimization to deliver consistent thin film-coated products on a large scale, both in terms of large volume as well as large numbers.

The paper walks through the journey of some of the products developed and commercialized as examples to describe the above journey.

Resource Efficiency and Circular Economy in e-waste Management: A new Sustainable Business Model

Ratheesh.R

Centre of Excellence (CoE) on E-waste Management, Centre for Materials for Electronics Technology (C-MET), Ministry of Electronics and Information Technology (MeitY), Government of India, IDA Phase III, HCL (P.O.), Hyderabad, Telangana-500051, India
Email: ratheesh@cmet.gov.in

The steady increase in e-waste generation has become one of the critical environmental issues globally and a major challenge in achieving sustainable development goals. Although substantial quantities of valuable materials are contained in e-waste, available technologies and management strategies are incompetent to handle the complex chemical compositions and hazardous components present in them. Unbeknownst to many e-waste handlers, improper recycling of e-waste will pose serious threat to public health and environment due to toxic substances contained in them such as lead, lithium, mercury, polybrominated flame retardants etc. On the other hand, the over dependence of scares and precious metal resources from primary sources have exacerbates the burden on the already delicate ecosystem and led to the emergence of urban mining to recover critical materials from e-waste. Urban mining not only opens up new sustainable business models but also provide advantages such as higher risk mitigation, resilience etc. With a view to promote resource efficiency and circular economy in e-waste management, C-MET has established a Centre of Excellence (CoE) on e-waste Management, first of its kind in the country, to develop cost effective, scalable and environmentally benign e-waste recycling technologies with Technology Readiness Levels (TRLs) of 5 to 7 and dissemination of the same to prospective industries for commercial exploitation. A host of recycling technologies including printed circuit boards, Li-ion batteries, rare earth permanent magnets, Si- solar cells, CFLs, LED displays etc. have been developed and ameliorated with a view to support the e-waste recycling ecosystem in the country. Turnkey solutions have been conceived and transferred to interested industries to realize swift translation of technology solutions from lab to market. A self-sustainable ecosystem in e-waste management has been evolved through technology transfers, licencing of IPs, consultancy services, Royalty, recycling services, training programmes etc. CoE on E-waste is an innovative model promulgating inventive ideas with immense impact that nurtures prospective start-ups to weave the entrepreneurial fabric with zeal and synergy.

HORIBA Raman microscope for 2D materials applications: Why is it important?

H C Sudeeksha

HORIBA India Scientific, Bangalore – 560102, India

Mail: hc.sudeeksha@horiba.com

Two-dimensional (2D) materials have a wide range of applications in various fields such as semiconductors, photovoltaics, and batteries due to their versatile physical, chemical, and electronic properties. From graphene to transition metal dichalcogenides (TMDCs) and beyond, Raman spectroscopy has emerged as a valuable tool in characterization of 2D materials and visualization of various heterogeneities in the sample that are created intentionally or occur naturally. Raman imaging technique provides the necessary spatial information on key aspects like number of layers, phase identification, strain effects, band structure, interlayer coupling, defects, and doping type, which is imperative in design and fabrication of 2D materials into devices. HORIBA Raman microscopes have been designed with many technically advanced features for Raman imaging. The QScan^{TM}, DuoScan^{TM} and SmartSampling^{TM} algorithm offered by HORIBA Scientific result in very fast imaging with no compromise in the image contrast, detail, and quality. Quite often the structural, electronic, and morphological heterogeneity in 2D materials are on the order of few tens of nanometers or less, which is beyond the spatial resolution of conventional Raman microscopy, in which case the tip enhanced Raman scattering (TERS) and tip enhanced photoluminescence (TPL) can offer better spatial resolution.

In this presentation, we will demonstrate the applications of Raman imaging in phase identification in a silicon chip, stress measurements in nano-indented silicon and determining number of layers in graphene and WS_2. Finally, we will discuss a few results on TERS and TPL imaging of carbon nanotubes and WS_2-WSe_2 heterojunctions.

Keywords: phase; Raman imaging; stress; TERS; TPL

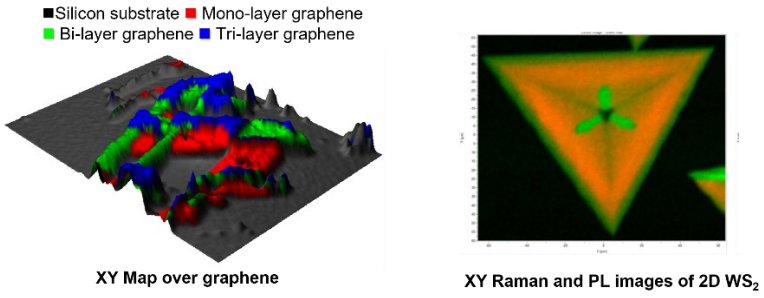


Figure 1: Raman image of graphene and WS_2

3D Printed Microfluidic Bioreactors: Pioneering Advancements in Bio-Photonics

Mr. Ikram Khan

ISMO Biophotonics Private Limited
Email: ikram@ismobiophotonics.com

This talk highlights groundbreaking advancements in bio-photonics facilitated by the development of 3D printed microfluidic bioreactors. Conventional bioreactor systems face challenges such as high costs, complex operation, and limited scalability. However, the 3D printed microfluidic bioreactors presented in this discussion offer a promising solution. Through the integration of microfluidics and photonics, these devices enable precise control, real-time monitoring, and analysis of cellular behavior. This abstract explores the key features, benefits, and applications of these bioreactors, emphasizing their potential to revolutionize various domains including drug discovery, personalized medicine, tissue engineering, and diagnostics. Join us to witness the transformative potential of these bioreactors in shaping the future of bio-photonics.

"Role of PLD from Scientific Lab to Industry"

Jagadesh O.E.
Executive VP, Laser Science Services (I) Pvt. Ltd.
E-mail: jagadesh@laserscience.in

This talk will provide a basic overview to motivate young minds towards the ever growing Photonics field.

The talk will cover the Role of PLD and upscaling in the field of Nanoscience & Photonics for various applications.

Photocatalytic activity of indium doped zinc oxide seed layers and one-dimensional nanorods under solar irradiation

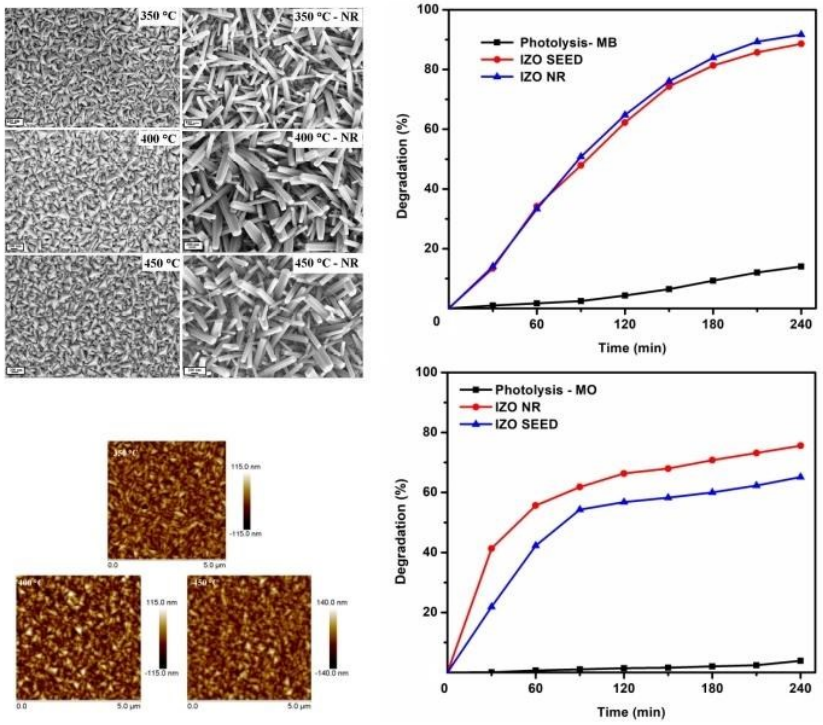
Devika Mahesh, John Paul and **M.C. Santhosh Kumar***

Optoelectronic Materials and Devices Lab, Department of Physics, National Institute of Technology Tiruchirappalli, Tamil Nadu – 620 015

Email: *santhoshmc@nitt.edu*

We report the deposition of indium doped zinc oxide thin films at various substrate temperatures 350 °C, 400 °C and 450 °C by spray pyrolysis technique. In: ZnO 1 D nanorods are grown on these thin film seed layers by aqueous chemical growth process. The scanning electron microscopy and atomic force microscopy indicate that the surfaces of the seed layers are topped by nanopyramids of size in the range 123 nm to 380 nm. The growth of 1 D nanorods is confirmed by SEM. The structural, morphological, optical and electrical properties of the seed layers and nanorods are studied. Enhanced visible luminescence has been observed for the 1 D nanorods grown on the seed layers, though the seed layers showed quenched emission characteristics. Photocatalytic activity of seed layers and nanorods grown at 450 °C are studied. Degradation efficiency of 90% and 70% against methylene blue and methyl orange dyes respectively.

Keywords: Zinc Oxide, 1 D nanorods, Surface morphology, Photoluminescence, Photocatalysis



Recycling light and wastes for sustainable energy generation and storage

Aruna Ivaturi

Smart Materials Research and Device Technology Group, Department of Pure and Applied Chemistry, University of Strathclyde, Glasgow G1 1XL, United Kingdom

Email: aruna.ivaturi@strath.ac.uk

In this talk I will cover two areas of energy research being carried out at my lab; 1. results on harvesting indoor light using perovskite solar cells, 2. upcycling biomass waste for printable electrochemical energy storage supercapacitors.

Perovskite solar cells (PSC) have recently emerged as promising candidates for indoor light harvesting with high power conversion efficiencies (PCE). However, almost all of the reported studies are on indoor white light harvesting. I will present our recent results on exploring for the first time perovskite solar cells for harvesting near-UV indoor blacklight (UV-A). Blacklights are commonly used for decoration e.g. Halloween as well as for enhancing indoor plant growth and for disinfecting hospital settings. The champion UV stable devices delivered enhanced PCE of 26.19% and an astonishing power output of 991.21 $\mu W/cm^2$, under blacklight illumination of 3.76 mW/cm^2. And retained 95.53% of their initial PCE after 24 hours UV exposure. This high power output and enhanced efficiency is due to the high energy of the UV photons as compared to the energy of the visible photons. This work opens up a novel direction for energy harvesting from near-UV indoor light sources for applications in microwatt-powered electronics such as IoT sensors located in UV environments such as healthcare settings, indoor horticulture, and places with blacklight decorations.

Currently, more than 80 % of commercial supercapacitors utilize chemically synthesized expensive carbon nanomaterials that require non-renewable resources for synthesis. Employing renewable, environment friendly and naturally available waste biomass feedstock as precursor for producing carbon materials is a low-cost and sustainable approach for designing the electrodes of supercapacitors. In this talk, I will discuss about the high surface area hierarchical porous multilayered graphene-like carbon that we obtain via room temperature sono-exfoliation of the activated carbon synthesized via simple and environmentally friendly hydrothermal carbonization and potassium bicarbonate activation of waste hazelnut shells as the precursor. The high surface area graphene-like carbon showed excellent electrochemical performance with specific capacitance of 320.9 F g^{-1} at 0.2 A g^{-1} current density and exceptional capacitance retention of 77.8% at 2 A g^{-1} current density after 10000 cycles in 1 M Na_2SO_4 electrolyte. Moreover, flexible supercapacitors fabricated using sono-exfoliated graphene-like activated carbon coated stainless steel mesh electrodes and biopolymer gel electrolyte exhibited an outstanding energy density of 38.7 W h kg-1 and power density of 198.4 W kg-1. These results show that mechanically exfoliated graphene-like activated carbon derived from hazelnut shells exhibit superior electrochemical performance that can compete with other activated carbon materials used in energy storage devices for real time applications.

Energy applications of Antimony Chalcogenide

A. Rohini,and P. Malar

Department of Physics and Nanotechnology
SRM Institute of Science and Technology, Kattankulathur, India
Email: malarp@srmist.edu.in

Antimony Chalcogenide ($Sb_2(S,Se)_3$) is a potential material in various energy applications including photovoltaics, photodiodes, water splitting for H_2 production and batteries due to its suitable characteristics namely earth-abundant constituents, visible region band edge, very high absorption coefficient, stability and ease in controlling of stoichiometry. Sb_2Se_3/CdS heterojunction configured solar cells, n-Si/p-Sb_2Se_3 heterojunction photodiode and TiO_2/Sb_2Se_3 photocathodes are some of the examples.

In this work, the details of growth of Sb_2Se_3 absorber thin films that are oriented along electrically favored [001] direction via selenization of thermally evaporated antimony films and the laboratory scale Sb_2Se_3 solar cells fabricated in substrate configuration Mo/Sb_2Se_3/CdS/ ITO/Ag are presented. Various characterization studies performed on the absorber thin films and the devices showed that the films were polycrystalline, single-phase in nature and near stoichiometric. In addition, the films showed excellent optical absorption coefficient values >$10^6 cm^{-1}$ in the entire visible region with it band edge at ~1.1 eV. The laboratory scale devices showed an encouraging photo conversion efficiency of 4.6% for the solar cell with an active area of 0.33 cm^2 under A.M 1.5 illumination conditions.

Keywords:
Antimony selenide, thin film solar cells

A paradigm shifts in efficiency and stability of air ambient fabrication of Perovskite Solar Cells

Trilok Singh

Department of Energy Science and Engineering, IIT Delhi, Hauz Khas, New Delhi, 110016

Email: triloksingh@iitd.ac.in

Organic-inorganic hybrid perovskite materials have gained a lot of attention as light harvesters in thin film photovoltaic cells (PVCs) due to its low cost precursors and capable of being processed via variety of scalable methods. These materials exhibit outstanding properties such as strong light absorption, long carrier diffusion length, and tailorable optoelectronic properties through compositional engineering of cations and halides. Despite the high efficiency (>25%), and excellent optoelectronic properties the biggest issue of organic-inorganic trihalide perovskite is *stability under* heat and light soaking conditions. The other challenge is to grow uniform and pin-hole free perovskite films on *large area substrates* of various compact layers to fabricate large area perovskite cells under *controlled ambient conditions*.

This presentation will focus on the fabrication of perovskite cells with modified fabrication process on various metal oxide compact layers and their photovoltaic characteristics. Recent finding showed that films fabrication parameters (temperature, humidity, dripping, substrates preconditioning), uniformity, grain growth and post annealing conditions vastly influenced the final device performance. By interfacial engineering using organic additives, dendritic absorber layer was converted to flat uniform layer with large crystalline grains, leading an improvement in photovoltaic performance. Moreover, this talk will also highlight large area cell fabrication and long term stability measurements under ambient conditions.

Turbopumps: Lowest vibration and highest uptime made with laser balancing technology

Mr.Yatin Nakhare

Pfeiffer Vacuum (India) Private Limited, Secunderabad

Email:

There have been numerous optimizations since the invention of the turbo pump in 1958. One aspect that has a particularly large influence on the lifetime and vibration of the turbopump is the balance quality of the rotor.

In practice, every rotating component has a certain unbalance (U), that cannot be completely avoided. This circumstance leads to a rotating radial force (F) and thus generates vibrations (see figure 1). The rotor speed of turbopumps (Ω) is up to 1500 Hz, which can result in tremendous forces. Because it is made of aluminum and very light, the rotor is very sensitive to the smallest mass unbalances.

Reducing the unbalance is an absolute necessity for the safe and reliable operation of a turbopump and does have a positive impact on the very numerous applications in which they are used. It is not only important from an application point of view to keep the vibrations as low as possible. The reduction of the radial forces also has an impact on the lifetime of the bearing that supports the rotor and thus on the time between service intervals.

There are a number of technologies available to measure and reduce unbalances. The compensation of the unbalance can be achieved by adding additional mass, for example by mounting balancing screws, or by removing mass with machining processes. The latest and currently most efficient method is laser balancing. The unbalance compensation is achieved by removing rotor material in the form of segments (see figure 2) with the technique of laser ablation. This technology was developed and patented by Pfeiffer Vacuum - the company in which the turbo pump was invented 63 years ago.

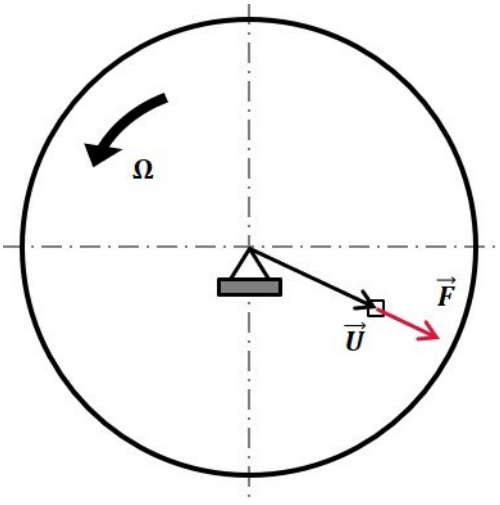


Figure 1

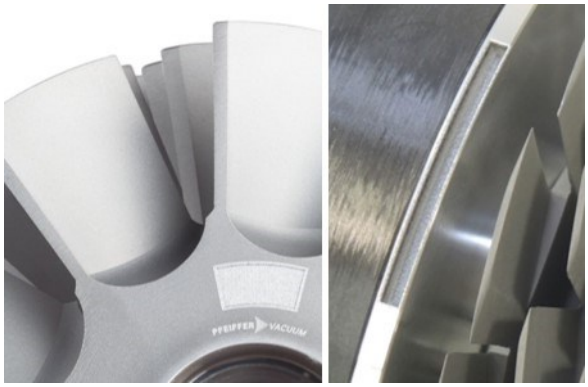


Figure 2

The Road Ahead for Nanothermite-based Energetics: From Materials to Applications

Rajagopalan Thiruvengadathan

Department of Engineering and Technology, Southern Utah University Cedar City, Utah 84720
Email: t_rajagopalan@cb.amrita.edu

Both nanoscience and nanotechnology have undoubtedly contributed significantly to the development of thermite-based nanoenergetic materials with tunable and tailorable combustion performance and their subsequent integration in devices. Specifically, the talk will emphasize on the immense paybacks in designing and fabricating ordered/disordered assembly of energetic materials over multiple length scales (from nano- to milli-scales) in terms of realization of desired reaction rates and sensitivity. Besides presenting a critical review of present advancements made in the synthesis methods as well the synthesis of nanoenergetic materials, the article will touch upon aspects related to various applications that employ nanoenergetic materials. These applications include propulsion and related areas like microthrusters, and microchip-based devices. The talk will conclude with the author's summary on the seemingly insurmountable challenges and the road-ahead towards deployment of nanoenergetic materials in practical applications. The real challenge lies in the ability to preserve the assembly of fuel and the oxidizer nanoparticles in intimate contacts achieved at the nanoscale while synthesizing macroscale energetic formulations using advanced fabrication techniques both in bulk and thin film forms.

Synthesis of Tungsten nanocomposite for future fusion reactors by employing fast sintering method

Ritu Kumai Pilania[1], Pawan Kumar Kulriya[2] and **Charu Lata Dube[1,*]**

[1]*School of Nano Sciences, Central university of Gujarat, Gandhinagar, Sector-30, 382030, India.*

[2]*School of Physical Sciences, Jawaharlal Nehru University (JNU), New Delhi, 110067, India.*

Email: *charulata.dube@cug.ac.in

Tungsten is one of the most promising materials for plasma facing components (PFCs) in future nuclear fusion reactors. We report the synthesis of pure tungsten and tungsten nanocomposites of different composition by using fast sintering method. The β phase of tungsten evolved after fast sintering along with other existing phases of tungsten at temperature of 1500 °C under uniaxial pressure of 40MPa. In order to investigate the effect of radiation damage on structural and microstructural properties of the sintered samples, a surrogate method of ion irradiation is chosen. The sintered pure tungsten and tungsten doped with rare earth oxides were irradiated with gold ions of energy 100 MeV at fluence of ~1.7×10^{14} ions/cm^2. The X-ray diffractograms of irradiated samples indicate an increase in XRD peak intensity of beta phase of tungsten (owing to ion-solid interactions). A detailed analysis will be presented during the conference.

Keyword: Tungsten nanocomposite; Radiation damage; Ion beam irradiation, PFCs.

Thermal induced morphological modification in covellite

Rao Pritty [1&3], Kumar Sanjiv [2], Vinayak Seema [1], Sharma Suresh C.[3*]

[1]*Solid State Physics Laboratory, DRDO, New Delhi-110054, India.*

[2]*National Centre for Compositional Characterisation of Materials, BARC, Hyderabad-500062, India(Retired).*

[3]*Delhi Technological University, New Delhi-110042, India.*

Email: sureshsharma@dtu.ac.in

The copper sulphide system has many stoichiometric and non-stoichiometric polymorphs. Covellite (CuS) is the most Cu deficient and stoichiometric member of this family [1]. Covellite nanoparticles are attractive materials for energy and biological applications. The morphology of the nanoparticles is an important consideration in these applications. The paper presents preliminary investigations on the morphology of CuS powders prepared wet chemically at room temperature and subsequently heat treated in 393-523 K temperature range in an inert atmosphere. The morphology was measured by transmission electron microscopy. Conforming to the hexagonal structure of covellite, the powder treated at 393 K consists of regular and elongated hexagonal crystallites. Powders heat treated at 523 K retain their phase constitution, however, the crystallites tend to acquire spherical morphology. The minimisation of surface energy is probably the driving force behind this transformation. The study shows that wet-chemically prepared covellite nano-crystallites can be shape-tailored on thermal treatment.

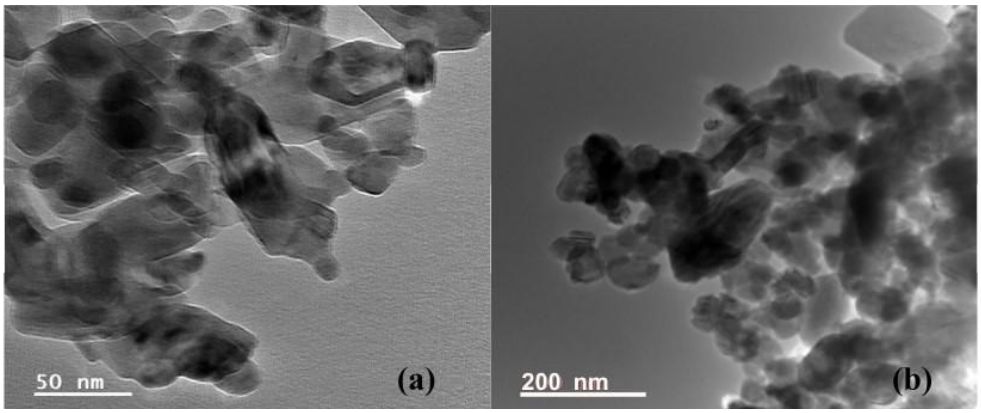


Fig.1: HRTEM images of CuS powder heat treated at a) 393 K and b) 473 K under argon atmosphere.

References:

1. D. J. Chakrabarti and D. E. Laughlin, The Cu-S (copper sulfur) system, Bull. Alloy Phase Diagrams, 4 (1983) 254–271. https://doi.org/ 10.1007/bf02868665N. Barreau, Solar Energy, 83 (2009) 363-31.

Fenton-process adapted Fe-Cu heterostructures and retrievable films for deactivation/removal of emerging categories of persistent organic pollutants

Shubra Singh

Crystal Growth Centre, Anna University, Chennai, India
Centre for Energy Storage and Technologies (CEST) Anna University, Chennai, India
E-mail : shubra6@gmail.com, shubra6@annauniv.edu

Frequent consumption of antibiotics for human, veterinary and agricultural purposes has led to the incessant release of antibiotics to water resources and other similar environments resulting in a widespread invasion of antibiotic resistant bacteria (ARB) and antibiotic resistant gene (ARG) into water streams. There has been an increased threat alert from wastewater treatment plants and pharma hubs due to water contamination primarily due to presence of antibiotics and antibiotic resistance bacteria and genes. We adopt Photo Fenton-process for antibioticremoval using passivation-bypassed Fe-alloy, rate-controlled using photo-activity. We propose to develop a simple but efficient method to design a solardriven, compensated and coupled Fenton-photocatalysis process for the effective inactivation of antimicrobials in contaminated waterbodies. Introduction of such processes are expected to open up new avenues for water treatment. Various Photoactive materials have also been designed for decontaminating water under light simultaneously producing power from wastewater through an efficient Photocatalytic Fuel Cell. Besides this, another approach on chemical immobilization of nano-photocatalysts using polymer matrix membranes for promising multicycle industrial wastewater treatment will also be discussed. A combination of these approaches can produce a number of tunable materials that can be investigated for applications spanning from energy to environmental remediation.

References

[1]. Synergy of photocatalysis and fuel cells: A chronological review on efficient designs, potential materials and emerging applications. John S, Nogala W, Gupta B and Singh S, Front. Chem. (2022) 10:1038221. doi: 10.3389/fchem.2022.1038221

[2]. Enhanced photo-fenton and photoelectrochemical activities in nitrogen doped brownmillerite $KBiFe_2O_5$, Durga Sankar Vavilapalli, Santosh Behara, Raja Gopal Peri, Tiju Thomas, Muthuraaman B, Ramachandra Rao M . S., Shubra Singh Scientific Reports, Nature publications (2022) 12:5111

Production of Biodiesel from Wastes of Animal Husbandry using TiO_2 Nanoparticles

Ranjeeta Chatterjee[1], Lalita Rane[2], Poonam Wani[2], Neena Seth Pajni[3], Ayesha Shaikh[1], Rahul Jadhav[1], Mahima Gamot[2], Sayali Gawade[1]

[1]*Department of Zoology, Prof. Ramkrishna More ACS College, Akurdi, Pune, Maharashtra.*

[2]*Department of Physics, Prof. Ramkrishna More ACS College, Akurdi, Pune, Maharashtra.*

[3]*Principal, Gobindgarh Public College, Alour, Khanna, Ludhiana, Punjab.*

Email: ranjeeta.p.chatterjee@gmail.com

To minimize the greenhouse emission and to prevent depletion of fossil fuels, there is a need of green fuel. Biofuel could be used as an alternative to traditional fossil fuels to be used in various applications including transportation, heating, and electricity generation. The biofuel is a type of fuel derived from renewable biological resources such as plants, crops, algae, or animal fats. Biodiesel is one of the biofuels, which represents a viable solution as it is derived from renewable biological resources such as vegetable oils, animal fats, or recycled cooking oil. The production process of biodiesel involves transesterification of vegetable oils or animal fats, using methanol and a catalyst. In the present work, the biodiesel was produced from the wastes of fish (viscera), poultry (skin and viscera) and slaughterhouse (skin and viscera of goat). In conventional method, vegetable oil or animal fat are used for biodiesel production, which are edible and consumed by human. In this present work, all ingredients used are wastes and are usually thrown, which causes environmental hazards. Instead of methanol, bioethanol was used for transesterification, which has been derived from agricultural wastes. The crude biodiesel produced from the animal wastes were found to be viscous, as goat waste> poultry waste> fish waste. To minimize the viscosity of the biodiesels, TiO_2 nanoparticles were used. The efficacy of the biodiesel shown was poultry> goat> fish. The biodiesel can be used directly as a substitute or blended with petroleum diesel in various proportions, depending on the desired fuel characteristics and local regulations.

Keywords: Biofuel, Biodiesel, fish wastes, poultry wastes, slaughterhouse wastes, TiO_2 nanoparticle, transesterification.

Abstract category : - A (2D system)

A-001

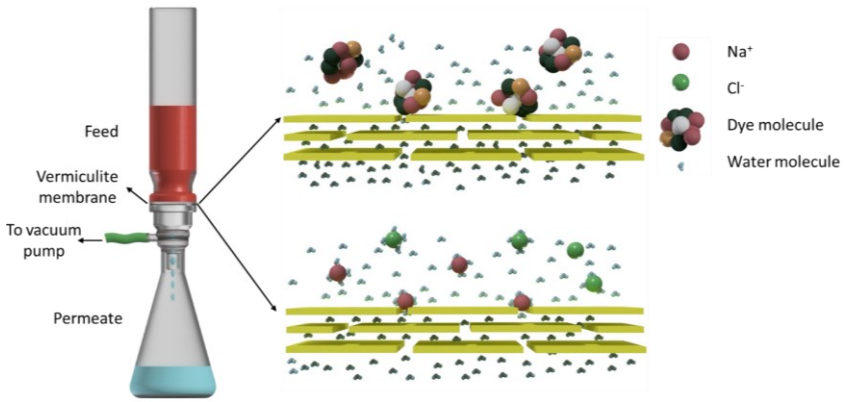
Anomalous transport in angstrom-sized membranes with exceptional water flow rates and dye/salt rejections

Aparna Rathi[1] & Gopinadhan Kalon[1,2]

[1]Discipline of Physics, Indian Institute of Technology Gandhinagar, Gujarat 382355, India

[2]Discipline of Materials Engineering, Indian Institute of Technology Gandhinagar, Gujarat 382355, India

Fluidic channels with physical dimensions approaching molecular sizes are crucial for novel desalination, chemical separation, and sensing technologies. However, fabrication of precisely controlled fluidic channels in angstrom size is extremely challenging. This, along with our limited understanding of nanofluidic transport, hinders practical applications. Here, we fabricated high-quality salt-intercalated vermiculite membranes with channel sizes ~ 3-5 Å. Unlike pristine samples, the salt-intercalated membranes are highly stable in water. We tested several such membranes, of which 0.6 µm thick membranes showed dye rejection efficiencies >98% with exceptionally high water permeance of 5400 L m^{-2} h^{-1} bar^{-1} at differential pressure of 0.9 bar. Interestingly, the same membrane also rejected NaCl ions, with efficiencies of~95%. Our highly confined channels exhibit sub-linear ionic conductance related to hydration sizes, steric exclusion, K^+ mobility enhancement, and conductance saturation at concentrations ≤ 10 mM. This makes highly confined channels interesting for both fundamental science and applications.



A-002

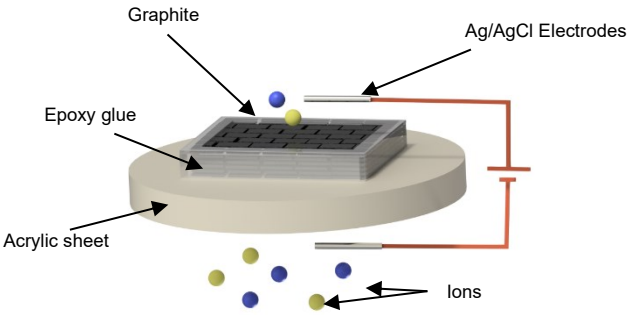
Selective transport of water molecules through interlayer spaces in graphite

Lalita Saini[1], Gopinadhan Kalon[1,]

[1]Discipline of Physics, Indian Institute of Technology Gandhinagar, Gujarat 382355, India

[2]Discipline of Materials Engineering, Indian Institute of Technology Gandhinagar, Gujarat 382355, India

Interlayer space in graphite is impermeable to ions and molecules, including protons. Its controlled expansion would find several applications in desalination, gas purification, etc. Previously, metal intercalation has been used to modify graphitic interlayer spaces; however, resultant intercalation compounds are unstable in water. Here, we successfully expanded graphite interlayer spaces by intercalating aqueous KCl ions electrochemically. Our spectroscopy studies provide clear evidence for cation-π-interactions explaining the stability of the devices, though weak anion-π-interactions were also detectable. The water conductivity shows several orders of enhancement when compared to unintercalated graphite. Water-evaporation experiments further confirm the high permeation-rate. There is weak ion permeation through interlayer spaces, up to the highest chloride concentration of 1 M, an indication of sterically limited transport. In these very few transported ions, we observe hydration energy-dependent selectivity between salt ions. These strongly suggest a soft ball model of steric exclusion, which is rarely reported. These findings improve our understanding of molecular and ionic transport at the atomic scale.



A-003

Ultrafast water permeation through highly confined laminates of graphene oxide-alumina silicate 2D clay membranes

Biswabhusan Dhal[1], Gopinadhan Kalon[1,2] *

[1]*Discipline of Physics, Indian Institute of Technology Gandhinagar, Gujarat 382355, India*

[2]*Discipline of Materials Engineering, Indian Institute of Technology Gandhinagar, Gujarat 382355, India*

*(*E-mail: gopinadhan.kalon@iitgn.ac.in)*

Aquaporin channels of 3 angstrom size transport water molecules selectively while rejecting ions. Even with considerable efforts, mimicking Aquaporin channels with simultaneous ultra-fast transport and ion rejection seems to be a distant goal. Such studies mainly focused on hydrophobic structures of nanometer to sub-nm sizes and low salt concentrations. Structures that are capable to handle sea salt concentrations of 1M. In this study, we fabricated a heterogeneous membrane, with equal proportion of hydrophobic graphene oxide (GO) and hydrophilic alumina silicate 2D clay materials. GO-alumina-silicate clay (1:1) membranes show exceptionally large water permeance > 1000 L/(m^2.h.bar) and salt rejection >80%, at less applied pressures of 150 mbar. Remarkably, the cation selectivity along the in-plane (IP) direction is also substantial, i.e., >0.9. It is observed that the water flux and ion rejection in the IP orientation is much higher than the routinely studied out-of-plane (OP) transport, promising several applications. These membranes were found to be highly water-stable with the intercalation of one of Al^{3+}, Ca^{2+}, or Mg^{2+}. Our detailed COMSOL Multiphysics simulations indicates that electrostatic, steric and hydrophobic interactions control the transport in the IP direction.

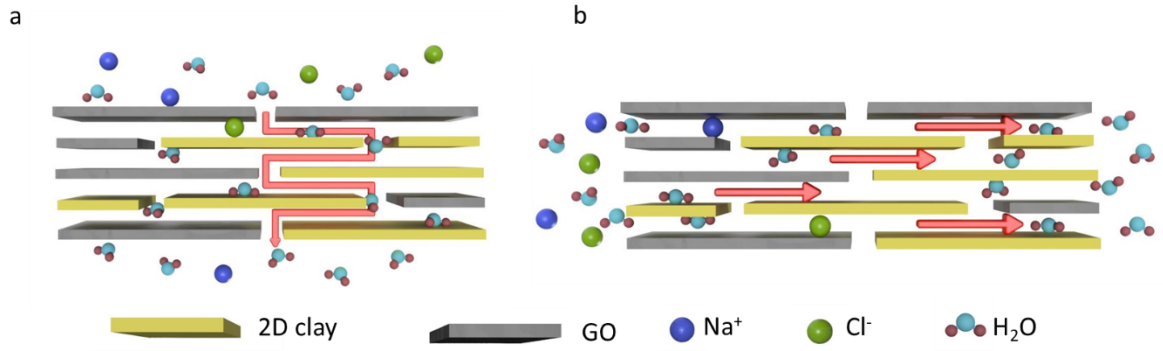


Figure shows the transport pathways in GO-alumina silicate membranes. (a) OP transport of GO-alumina silicate membrane. (b) IP transport of the GO-alumina silicate membrane.

A-004

Synthesis of One Atom Thick 2D Gold Nanostructures- Goldene

Sudhir Sharma and Ramesh Jagannathan

Nano and Biomaterials Laboratory, New York University Abu Dhabi UAE

Emails sks16@nyu.edu (submitting author) and rj31@nyu.edu (corresponding author)

2D materials have demonstrated an immense interest due to their wide range of emerging applications in photovoltaics, optical sensing, drug delivery etc. Gold nanostructures have synthesized by various biological, photochemical and wet chemical routes but the reports on 2D gold are not available. For the first time, we report a technique to synthesize one-atom thick 2D gold crystals (goldene) from thin films of gold after post heat-treatment of 475ºC. HRTEM imaging showed herringbone and honeycomb lattices with a lattice spacing of 2.4Å. SAEDP showed the presence of $(1\bar{1}1)$, (200) and (220) planes of fcc gold. AFM imaging of these crystals confirmed that they are and are 1-2Å i.e. one-atom thick gold crystals. EDS, XPS and STEM confirmed the chemical composition of 2D crystals/films are gold. Goldene exhibited multiple, intense and well-resolved optical absorption peaks across the UV-vis region with optical band gap of 3.59 eV.

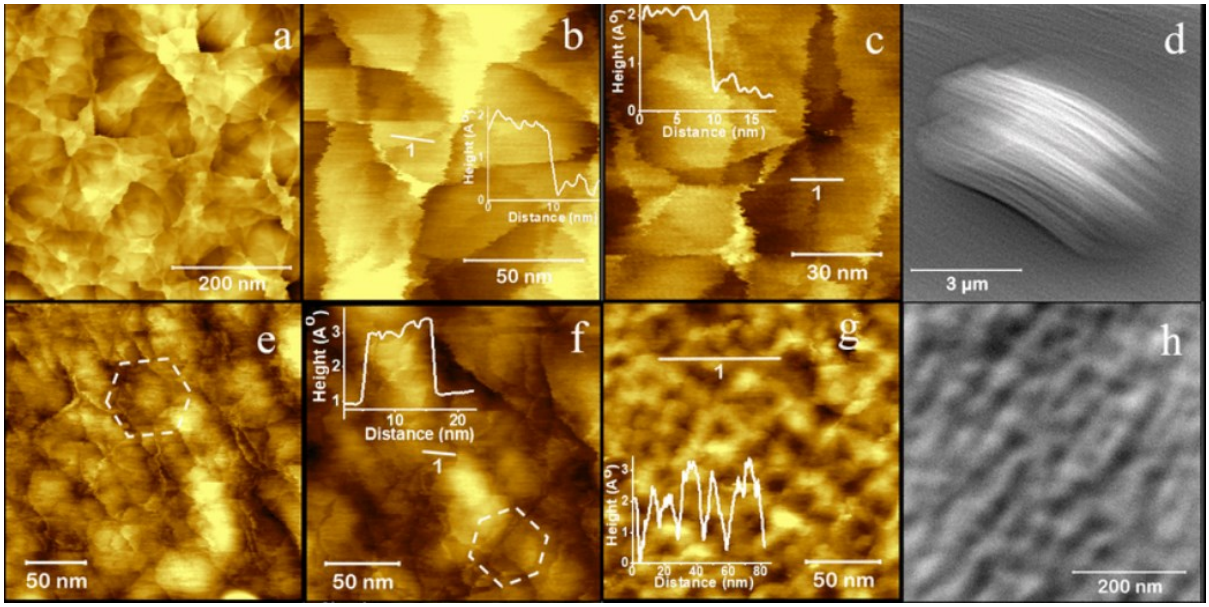


Figure1 Demonstration of goldene (One atom thin gold films) on sapphire and silicon substrates

A-007

Title: Optoelectronic Properties of Graphene interfaced Carbon dots

Carbon exists in numerous allotropic forms like graphite, graphene, and carbon dots. These materials have diverse properties from bulk to nanoscale leading to various applications. Graphene is a hexagonally arranged carbon atom monolayer with extraordinary optical and electronic transport properties making it a favorable material for flexible electrode applications. Likewise, Carbon dots are quasi-0D carbon nanoparticles exhibiting excellent tuneable emission properties. These two materials can be used to make LEDs in which graphene work as an electrode and CDs as an emissive layer.

This work studies the photoluminescence properties of carbon dots deposited on graphene. CVD-grown Monolayer Graphene was transferred on SiO_2/Si by Chemical etching of metal substrate, characterized by Raman Spectroscopy. Luminescent green-emitting CDs were synthesized by the solvothermal method. We noticed Partial quenching of the emission of the CDs. However, good emission film efficiencies make it suitable for optoelectronic applications.

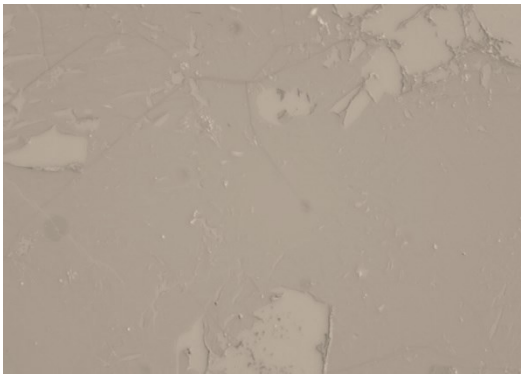


Image of Monolayer Graphene on SiO_2

A-011

High-efficiency photodetector based on CVD-grown continuous monolayer WS2

Dilip K. Singh*, Rakesh K. Prasad

Department of Physics, Birla Institute of Technology Mesra, Ranchi -835215, India

*Email: dilipsinghnano1@gmail.com

Future generation technologies demand high efficiency photodetectors to enable sensing and switching devices for ultrafast communication and machine vision. This requires direct-band gap materials with high photosensitivity, high detectivity and high quantum efficiency. Monolayered two-dimensional (2D)-Semiconductors based photodetectors are the most promising materials for such applications [1,2], although experimental realization has been limited due to unavailability of high quality sample [3]. We plan to present optimized recipe to grow continuous large crystallite monolayered WS_2 using customized CVD and single heating zone. As grown WS_2 based photodetector shows sensitivity of 290 AW^{-1} upon 405 nm excitation and incident power density as low as 0.06 mW/cm^2. The fabricated device shows detectivity of 52×10^{14} with external quantum efficiency of 89×10^3 %. The observed superior photo-response parameters of CVD grown WS_2 based photodetector as compared to Si-detectors establishes it's capability to replace the Si-photodetectors with monolayered ultrathin device having superior performance parameters.

References:

[1] F. Koppens, T. Mueller, P. Avouris, A. Ferrari, M. Vitiello, M. Polini, *Nature nanotechnology* 9(10), 780 (2014).

[2] Q. H. Wang, K. Kalantar-Zadeh, A. Kis, J. N. Coleman, M. S. Strano, *Nature nanotechnology* 7(11), 699 (2012).

[3] R. K. Prasad and D. K. Singh, Continuous Large Area Monolayered Molybdenum Disulfide Growth Using Atmospheric Pressure Chemical Vapor Deposition *ACS Omega* 2023 https://doi.org/10.1021/acsomega.2c07408

A-012

Large crystallite monolayered TMDs growth through controlled nucleation using Atmospheric pressure CVD

Rakesh K Prasad[1], Manisha kumari[1], Dilip K singh*
Birla Institute of Technology Mesra, Ranchi-835215 (India)
*Email: dilipsinghnano1@gmail.com

We demonstrated an effective approach to synthesize large area continuous film of monolayer molybdenum disulphide (MoS_2) and tungsten disulphide (WS_2). In account to control synthesis of number of layers, crystal quality and coverage area, atmospheric pressure chemical vapour deposition (APCVD) techniques is used. In APCVD various parameters like amount of metal or chalcogenide precursors, gas flow rate, growth temperature and time duration plays an important role for continuous monolayers film growth. We observed that the amount of metal precursors (MoO_3 or WO_3) is responsible for creating nucleation sites and excessive vapour phase of MoO_{3-x} or WO_{3-x} leads to formation of multi-nucleation sites **[1]**. Sulfur was found to govern the coverage area and bilayer formation. The optimized parameters for formation of large area continuous monolayer film of MoS_2 would be presented. Figure 1(a) & (b) shows the optical micrograph, Raman spectra and AFM micrograph of as grown MoS_2 monolayers.

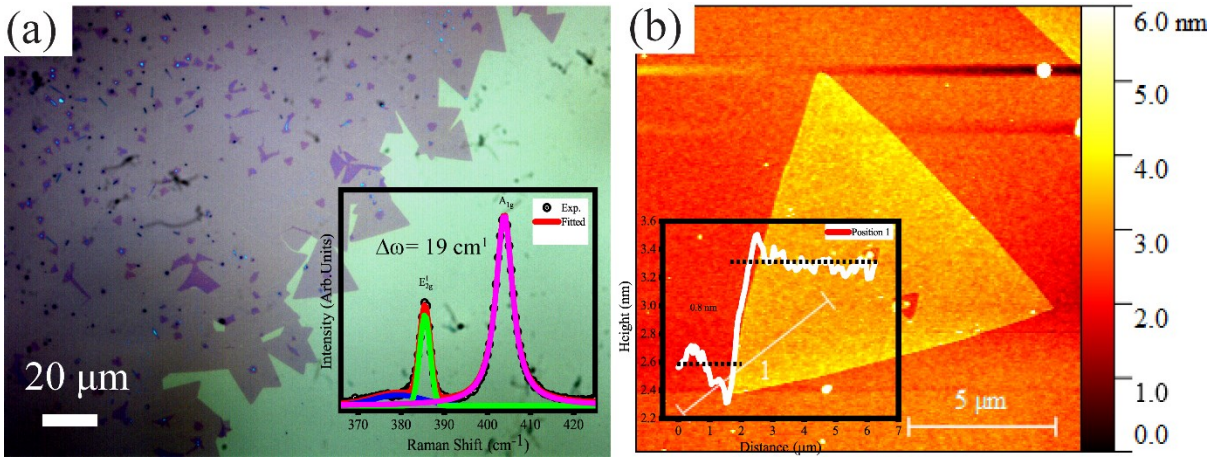


Figure. 1*(a) Shows the optical micrograph of continuous monolayer MoS_2 film with Raman spectra frequency difference ($\Delta\omega = 19cm^{-1}$) (b) Shows the AFM image with thickness of 0.8 nm confirming formation of monolayer.*

Reference:

[1] R. K. Prasad, D. K. Singh, Continuous Large Area Monolayered Molybdenum Disulfide Growth Using Atmospheric Pressure Chemical Vapor Deposition, *ACS omega 8, 10930 (***2023).**

A-013

Intercalated and surface water-mediated Electromechanical Response of 2D Materials on Flexible Substrates.

Lavudya Devendar[1,*], K Lakshmi Ganapathi[2], and Manu Jaiswal[1]

[1]*Department of Physics, Indian Institute of Technology Madras, Chennai-600036, India.*

[2]*Department of Physics, NIT Kurukshetra, Thanesar, Haryana-136119, India*

* E-mail: devendarphysics94@gmail.com

Confined water can be intercalated in the sub-nanometer spaces between layered two-dimensional materials such as graphene oxide by subjecting them to humid environments. Here, we examine the mechanical and electromechanical response of reduced graphene oxide films, prepared with two different oxidative states and coated on polydimethylsiloxane substrate, when these films are subject to different humidity environments, from 5 % to 90 % RH in a custom-designed setup. Applying uniaxial strain resulted in the formation of quasi-periodic wrinkles at low strains and new surfaces or quasi-periodic cracks at high strains (up to 5 % strain). The extent of water intercalation was dependent on the oxidative state of the system as well as the relative humidity exposure. We demonstrate that water intercalation determines the density of cracks induced in the film and thereby also determines the electromechanical response in these electrically conductive films. Our observations are reconciled based on a model that considers the decrease in the in-plane elastic modulus of the system due to confined water, whose microscopic origin lies in the modified network of hydrogen bonding between the graphene oxide layers. [1] However, in films of 2D materials like MoS_2, exposure to humidity results in surface adsorption of water rather than intercalation. This has a significant impact on the crack formation in the system. The potential of reduced graphene oxide and CVD-grown MoS_2 as humidity sensors and strain sensors operating under variable humidity environments will also be discussed.

Reference:

[1] L. Devendar, M R Shijeesh, T. Sakorikar, K L Ganapathi and Manu Jaiswal, J. Phys.: Condens. Matter, 34, 025001, 2022.

A-015

Thermally-driven Multilevel Non-volatile Memory with Monolayer MoS_2 for Neuro-inspired Artificial Learning

Sameer Kumar Mallik,[1,2,*] Roshan Padhan,[1,2] Mousam Charan Sahu,[1,2] Suman Roy,[1,2] Gopal K Pradhan,[3] Prasana Kumar Sahoo,[4] Saroj Prasad Dash,[5] Satyaprakash Sahoo[1,2]

[1]*Laboratory for Low Dimensional Materials, Institute of Physics, Bhubaneswar-751005, India*

[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai, 400094, India*

[3]*Department of Physics, School of Applied Sciences, KIIT Deemed to be University, Bhubaneswar, Odisha 751024, India*

[4]*Materials Science Centre, Quantum Materials and Device Research Laboratory, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India*

[5]*Quantum Device Physics Laboratory, Department of Microtechnology and Nanoscience, Chalmers University of Technology, Göteborg, Sweden*

*Corresponding Author email: skmphy1994@gmail.com

The demands of modern electronic components require advance computing platforms for efficient information processing to realize in-memory operations with a high density of data storage capabilities towards the development of alternatives to von Neumann architectures.[1] Beyond graphene, the multifunctionality of 2D layered semiconductors is persevering incessant technological evolution and has deeply permeated the fabric of low-power electronic applications.[2] Herein, we demonstrate unique functionalities of mem-transistor devices based on monolayer MoS_2 which drive to a high-geared intrinsic transistor at room temperature and also exhibit synaptic multi-level memory operations at high temperature. The memory mechanism is governed by the interfacial physics which solely depends on the gate field modulated ion dynamics and charge transfer at the MoS_2/dielectric interface at high temperatures. For the first time, we have proposed a non-volatile memory application using a single FET device where thermal energy can be ventured to aid the memory functions with multi-level storage capabilities. Furthermore, our devices exhibit linear and symmetric conductance weight updates when subjected to electrical potentiation and depression. This feature has enabled us to attain a high classification accuracy while training and testing the Modified National Institute of Standards and Technology (MNIST) datasets through artificial neural network (ANN) simulation. This work paves the way for new avenues in 2D materials towards vivacious data processing and storage with high packing density arrays for brain-inspired artificial learning.

References

1. Migliato Marega, G. *et al.* Logic-in-memory based on an atomically thin semiconductor. *Nat. 2020 5877832* **587**, 72–77 (2020).
2. Liu, C. *et al.* Two-dimensional materials for next-generation computing technologies. *Nat. Nanotechnol. 2020 157* **15**, 545–557 (2020).

A-016

Raman analysis for the defects in electrochemically exfoliated graphene

Nitin Linge[1], Prabhat Kumar Sharma[2], Ajeet K. Srivastav[1,*]

[1]*Department of Metallurgical and Materials Engineering, Visvesvaraya National Institute of Technology, Nagpur-440010, Maharashtra*

[2]*Department of Electronics and Communication Engineering, Visvesvaraya National Institute of Technology, Nagpur-440010, Maharashtra*

*Corresponding author: srivastav.ajeet.kumar@gmail.com

Graphene is a material that poses extraordinary mechanical, electrical, and thermal properties. Though, obtaining a defect free single-layer graphene is still a challenge. Electrochemical exfoliation, a top-down approach, is a promising route for synthesizing large quantity graphene. However, this synthesis approach introduces defects and degrades the graphene in terms of property from its pristine version. In electrochemical exfoliation the concentration and the type of electrolyte influence the nature of defects as well as defect density. Here, we synthesized graphene oxide (GO) using three different electrolytes, namely Na_2SO_4, NH_4NO_3, and $(NH_4)_2S_2O_8$ with 0.1 M concentration. The obtained graphene oxide was heat treated to get the reduced graphene oxide (rGO). GO and rGO were further characterized using x-ray diffraction and scanning electron microscopy for its phase and morphological evolution. The nature of defect and the defect density were thoroughly analyzed using Raman spectroscopy. The $(NH_4)_2S_2O_8$ electrolyte showed the least defect density in comparison to other two electrolytes.

Keywords: Electrochemical Exfoliation, Defects, Graphite, Graphene Oxide, Raman Spectroscopy

A-017

Vacancies in TiB_2 nanosheets enable N_2 adsorption *via* charge transfer

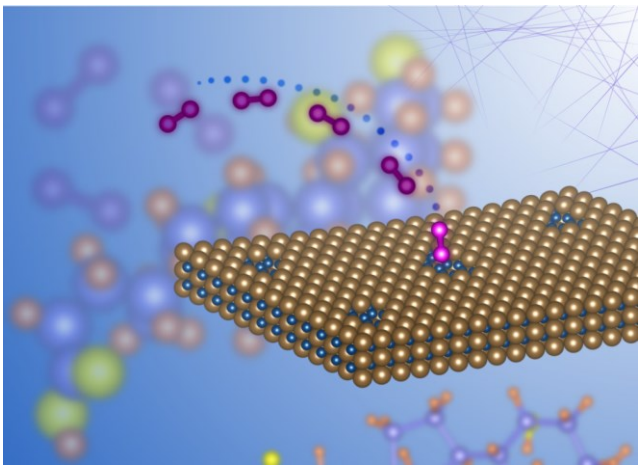
Anshul Rasyotra[a], Anupma Thakur[a], Raviraj Mandalia[b], Raghavan Ranganathan[b] and Kabeer Jasuja[a]*

[a] *Discipline of Chemical Engineering, Indian Institute of Technology, Gandhinagar, Gujarat – 382055, India*

[b] *Discipline of Materials Science, Indian Institute of Technology, Gandhinagar, Gujarat – 382055, India*

Email: rasyotra_anshul@iitgn.ac.in; kabeer@iitgn.ac.in

The quest for finding analogs of graphene has led researchers to explore layered materials that have not been conventionally viewed from the perspective of delamination. Layered metal diborides represent one such class of materials with tremendous potential due to boron honeycomb planes bounded by metal atoms. These materials in bulk form are used for superconductors, armors, etc. Recently, there has been a rising interest on delaminating the layered metal diborides to obtain nanosheets. Delamination, however, introduces functionalization on the nanosheets' surface that restrict us from studying the effect of nano scaling of the material. Here, we present a synthesis method to obtain minimally functionalized nanosheets of metal diborides using surfactants' chemistry. We also show that vacancies generated due to exfoliation endow enhanced catalytic activity to these nanosheets which has been validated *via* DFT studies. These as-synthesized nanosheets will provide a platform to study the layered metal diborides as next-generation catalysts.



A-021

Ball Mill: Paving a Path for Scalable Production of Electrochemically active Titanium Diboride (TiB_2) Based Nanosheets

Bhagyashri Gaykwad, Anupma Thakur, Anuj Buch, and Kabeer Jasuja*

Discipline of Chemical Engineering, Indian Institute of Technology, Gandhinagar

Gandhinagar, Gujarat 382055, India

*Corresponding author: kabeer@iitgn.ac.in

Layered metal diborides have gained a renewed research attention in recent years on account of their ability to yield *XBenes* – their 2D counterparts. While a range of approaches have been developed to exfoliate metal diborides, the ability to obtain *XBenes* in scalable manner is in its incipient stages. In this work, we present a scalable approach that employs high-energy ball milling to exfoliate TiB_2 at gram scale. We firstly show that milling TiB_2 crystals for an optimal duration (6 hours) and at a specific balls-to-powder ratio (20:1) yields multi-layer-thick nanosheets (~5-10 nm). Secondly, we show that the chemical integrity is retained to a large extent upon exfoliation. Finally, we show that upon milling, the native electrochemical activity of TiB_2 enhances by several folds. This ability to obtain TiB_2 nanosheets in a scalable manner using ball mill bridges a critical missing link in the fast-growing science on nano scaling metal diborides.

A-023

MoO_2-MoS_2 Metal-Semiconductor Hetero-Nanowire for multifunctional applications

Renu Yadav, Prahlad Kanti Barman, Ramesh Rajarapu, Saroj Paudyal, Bubun Biswal, Abhishek Misra.

2D Materials Research and Innovation Group, Department of Physics, Indian Institute of Technology Madras, Chennai 600036, India

Email: ph18d046@smail.iitm.ac.in

Transition metal dichalcogenide (TMDC) has shown great interest owing to its enormous properties down to atomic scale. Although TMDC are very unique and well-studied for several application, the combination of TMDC and TMO are rare and need to be explored. We have synthesized a hybrid structure of MoO_2 and MoS_2 using Chemical vapor deposition in a core shell nanowire form. The stable structure having MoO_2 as core and MoS_2 layers wrapped around has shown engrossing properties enabling its use for various applications. Raman spectroscopy revealed the presence of both MoO_2 and MoS_2 hybrid structure. A and B exciton of MoS_2 were observed using PL spectroscopy. Further SEM and TEM analysis confirmed the core shell structure. Memristor device has been realized using the core shell structure. Both volatile and non-volatile resistive switching were observed having application in neuromorphic computing and storage device respectively.

A-025

Synthesis of Large-area, High-quality MoS_2 by Chemical Vapour Deposition Technique

Bhagyalaxmi Pothal,[1,*] Lavudya Devendar,[1] KL Ganapathi[2] and Manu Jaiswal[1]

[1]Department of Physics, IIT Madras, Chennai 600036

[2]Department of Physics, NIT Kurukshethra, Kurukshethra 136119

**presenting author*

Two-dimensional Transition Metal Dichalcogenides (TMDCs) have emerged as promising candidates due to their exceptional electrical, optical, and mechanical properties for novel applications in optoelectronics, sensing, and flexible electronic & photonic devices. Among all synthesis techniques, chemical vapor deposition (CVD) methods provide a promising low-cost route and large-scale, high-quality growth of materials. However, control of properties and reproducibility remain as challenges. Here, we report a facile alkali halide-assisted CVD synthesis of high-quality monolayer MoS_2 flakes on SiO_2/Si & sapphire substrates using powder MoO_3 and sulphur precursor as reactants. Raman spectroscopic, photoluminescence, and X-ray photoelectron spectroscopy analyses were conducted to reveal the structural, optical properties, and crystalline quality of the grown MoS_2 thin films. The study could be utilized for large-scale synthesis of 1L-MoS_2 for high-performance flexible sensors.

A-024

Synthesis of high-quality hexagonal boron nitride films on Si(100) substrate by CVD process using Ammonia Borane precursor

Wahidur Rahman 1† , Rajarapu Ramesh 1, Renu Yadav 1 , Bubunu Biswal 1 , Saroj Poudyal 1 , Prahalad Kanti Barman 1 , Mrinal Deka 1 , Abhishek Misra 1*

1 Department of Physics, 2D Materials Research and Innovation Group, Indian Institute of Technology Madras, Chennai-600036, India

†, *Email: ph21d009@smail.iitm.ac.in; abhishek.misra@iitm.ac.in

Hexagonal boron nitride (h-BN) is the most widely used insulator in the 2D family of materials and it finds various applications, including field-effect transistors, deep UV emitters and detectors, tunneling devices, photoelectric devices, and nanofillers. While there have been several reports on the growth of h-BN by CVD processes on metallic substrates, these substrates are often rough and come with various defects. Moreover, the need for post-growth transfer to substrates for device integration and characterization adds to the complexity and cost of the process. In this study, we aim to synthesize high-quality h-BN films on Si(100) substrates using a CVD process with an Ammonia Borane precursor. The resulting h-BN films will be characterized using Raman spectroscopy, AFM, and XPS to analyze their structural, morphological, and chemical properties. Growing h-BN directly on Si(100) substrates will eliminate the need for post-growth transfer and facilitate direct integration of h-BN films into devices, thus improving their performance and reliability.

Abstract category : - B (Biomedical coatings)

B-001

Synthesis and Characterization of TiO_2-ZnO composite thin films for Biomedical applications

Gimmi Guruprasad Engoor[1], Nilesh J Vasa[2], I. A. Pilani[3], Sujatha N[1]

[1]Department of Applied Mechanics, Indian Institute of Technology Madras, Chennai-600036, India

[2]Department of Engineering Design, Indian Institute of Technology Madras, Chennai-60036, India,

[3]Department of Mechanical Engineering, Indian Institute of Technology Indore, Indore-452020, India

gimmi5055@gmail.com; njvasa@iitm.ac.in; palaniia@iitm.ac.in; nsujatha@iitm.ac.in;

Biocompatibility is modeled as a surface phenomenon. Host-cell adhesion, proliferation, and differentiation on the implant surface guarantee osseointegration, whereas biofilm formation due to bacterial colonization on the implant surface result in its failure. The study aims to investigate the ideal mixing ratio of TiO_2-ZnO as biocompatible thin films by evaluating their antibacterial and cytocompatible capability. TiO_2-ZnO mixed in different proportions are used as Radio-frequency (RF) sputtering targets. Subsequently, TiO_2-ZnO thin films are deposited on Stainless-steel samples of dimension 1cm x 1cm by RF sputtering. Chemical composition is analyzed by Scanning electron microscopy (SEM) and X-ray Diffraction (XRD). Atomic Force Microscopy (AFM) and Goniometer characterize the surface roughness and wettability, respectively. Wettability, roughness, and chemical composition are critical in determining the antibacterial properties and host cell adhesion, proliferation, and differentiation on the implant's surface.

Keywords: Biocompatibility, Thin film composites, Sputtering

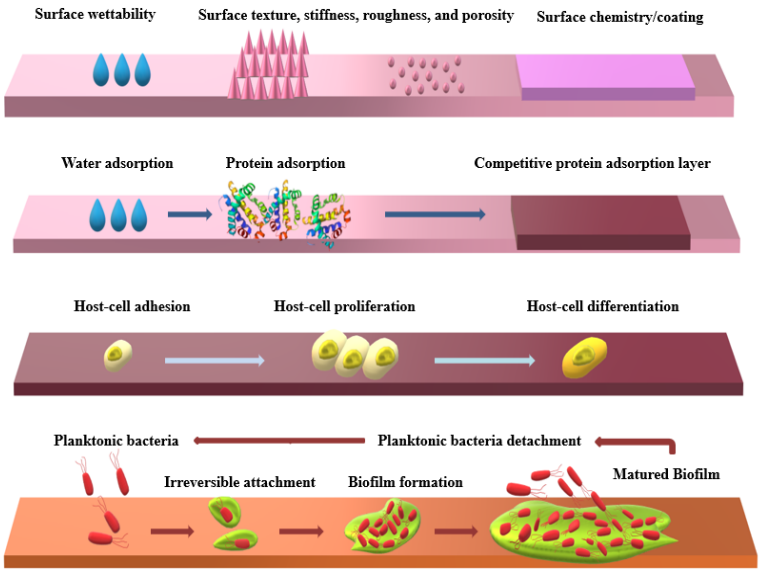


Fig: Biocompatibility modeled as a surface phenomenon

B-002

Effect of morphology on the roughness and hydrophilic properties of TiO_2 nanostructures for suitable hemocompatible applications.

Subhashree Mishra[1,2*], Vignesh Muthuvijayan[2], Somnath C. Roy[1]

[1]*Semiconductiing Oxide Materials Nanostructures and Tailored Heterojunction (SOMNaTH) lab, Department of Physics, Indian Institute of Technology Madras, 600036, India.*

[2]*Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Idian Institute of Technology Madras, 600036, India.*

Email- * ph20d302@smail.iitm.ac.in

Blood has a unique property of hemostasis by virtue of which it ceases to bleed in case of an injury. However, it acts adversely when blood comes in direct contact with any implant or any artificial surface like catheter, stent, or mechanical valve placed in the human body. Blood clots formed on the surface of the implant reduces its lifetime. This makes people undergoing implant surgeries take anticoagulants throughout their life. This work aims to fabricate hemocompatible TiO_2 coatings that will inhibit protein adsorption and platelet adhesion. The scope of this work includes the development of TiO_2 thin film by using RF sputtering technique. The dependence of morphology on the roughness and hydrophilicity was studied by AFM and contact angle measurements. The anticoagulant properties of the coating was studied by aPTT, PT and platelet adhesion tests. The roughness of all the films was found to be less than 5 nm.

Keywords - Hemocompatibility ; Anticoagulant ; Hydrophilicity ; Roughness ; Morphology

B-003

Ecofriendly urea nano-sack: jute grafted silica ring woven fertilizer to control urea release and enhance crop productivity

Bandana Kumari Sahu, Dr.P.S.Vijayakumar

Institute of Nano Science and Technology, Knowledge City, Sector – 81, Mohali, Punjab, India

Email: bandana.ph18223@inst.ac.in

Leaching and volatilization loss of urea is an alarm to environmental and human health. There has been advancement in the preparation of coated urea fertilizer but the problem remains, such as impact of petroleum based polymer to environmental pollution is unavoidable, hydrophilic nature of bio-based polymers. Herein, a biodegradable, hydrophobic coating material for fertilizer has been developed by synthesizing jute grafted silica nano-ring, using egg white as a reinforcing agent, known to give hydrophobicity due to increased β-sheet content on gentle heating. While increasing the silica content for diffusion control, the membrane brittles; hence, for the first time here, jute grafted silica nano-ring has been used, where the jute act as a strong buckle for egg white β-sheet fastener. The flexibility of coating material significantly improves the physical and mechanical strength (resistance to penetration and abrasion) of coated urea fertilizer to make it transport friendly. Jute acts as an auto rate-cutter for spill-way pores in silica that allows threshold amount of nutrient while initial wetting and then controls nutrient loss by swelling. Thus both forms of loss *viz.,* volatile and liquid with humidity and flooding respectively, gets controlled. In addition, the coated urea fertilizer shows ~ 72 % nitrogen release in a 60 days incubation period and the release kinetics shows best fitting effect with Ritger-Peppas model indicating non-Fickian diffusion nutrients due to polymer relaxation. This ecofriendly stable scalable urea coating shows improved photosynthesis and 60 % more yield efficiency in rice production. Furthermore, the coating material is biodegradable, confirmed by soil burial test.

References:

1. Imbrogno, J.; Nayak, A.; Belfort, G. Egg White Varnishes on Ancient Paintings: A Molecular Connection to Amyloid Proteins. *Angew. Chemie* **2014**, *126* (27), 7134–7137.

Abstract category : - C (Computational modelling and simulations)

C-003

Electro-catalytic reduction of CO_2 on 2D novel materials: a DFT based study

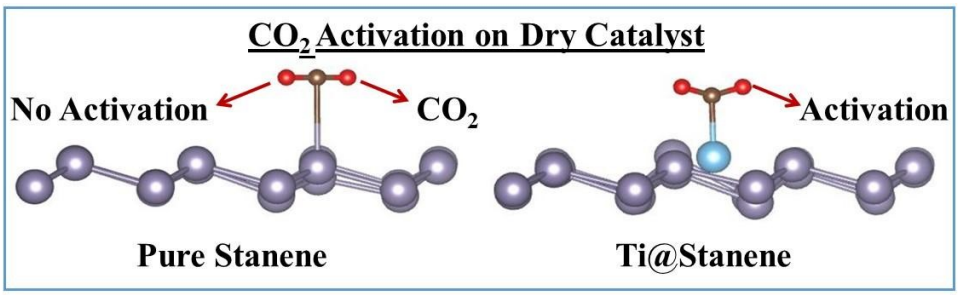
Sudatta Giri and Debolina Misra

Department of Physics, Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram, Chennai, India, 600127.

Email of submitting author: ph21d0003@iiitdm.ac.in

Email of corresponding author: debolinam@iiitdm.ac.in

Electrochemical reduction of CO_2 into valuable fuels such as methane, ethanol, formic acid etc. is a promising way to mitigate the global warming problem and to address the current energy crisis. As the conventional catalysts suffer from poor stability, high cost and low efficiency, in this work we intend to investigate the newly developed 2D materials with hexagonal structure such as Boron doped graphene and stanene, as potential catalysts for CO_2 reduction reaction (CO_2RR). As adsorption and subsequent activation of CO_2 on catalyst surface is a crucial step in CO_2RR, we carried out an in-detail study of CO_2 binding and its activation on 3d transition metal single atoms, anchored on B-doped graphene and stanene, and compared their efficiency on these two different supports. Finally, we interpret our results on the basis of intricate metal-support interaction and charge transfer between the catalyst and the adsorbed molecules.



C-005

Thermoelectric Properties of doped Topological half-Heusler $LuPdBi_{1-x}Z_x$ (Z = P, As, Sb) Compound

Narender Kumar[1,2,a], Nisha Sheoran[1,b], Hardev S. Saini[1,c], Sunita Srivastava[3,d], and Manish K. Kashyap[4,e]

[1]Department of Physics, Guru Jambheshwar University of Science & Technology, Hisar-125001, Haryana (India)

[2]Dayanand College, Hisar-125001, Haryana (India)

[3]Department of Physics & Astrophysics, Central University of Haryana, Mahendergarh-123031 (India)

[4]School of Physical Sciences, Jawaharlal Nehru University, Delhi-110067 (India)

a) narenderdnc@gmail.com
b) nisha.sheoran.18@gmail.com
c) Corresponding author: hardevdft@gmail.com, hardev1984@gjust.org
d) sunita@cuh.ac.in
e) mkkashyap@jnu.ac.in

The electronic and thermoelectric (TE) properties of doped half-Heusler (HH) $LuPdBi_{0.75}Z_{0.25}$ (Z = P, As, Sb) compounds are investigated using first-principles calculations and Boltzmann transport equation under the constant relaxation time approximation. The calculated values of various elastic constants show that the resultant compounds are mechanically stable. The Seebeck coefficient enhances significantly due to doping of P, As, Sb atoms in place of Bi-atom, which further increases the value of power factor to the value ~ 4.69×10^{11} W/m.K^2.sec for $LuPdBi_{0.75}Sb_{0.25}$ compound at 700 K. The dopant Sb reduces the value of lattice thermal conductivity from 4.44 W/m.K to 1.07 W/m.K for LuPdBi and $LuPdBi_{0.75}Sb_{0.25}$ compounds, respectively. The calculated value of figure of merit (ZT) for pure and Sb-doped LuPdBi compound is 0.25 and 0.41, respectively, at 700 K. This work presents the possibility of LuPdBi compound to be used as efficient thermoelectric material with suitable Sb-doping.

C-008

The Co-moving velocity in immiscible two-phase flow in porous media: An extensive computational study in dynamic pore network model

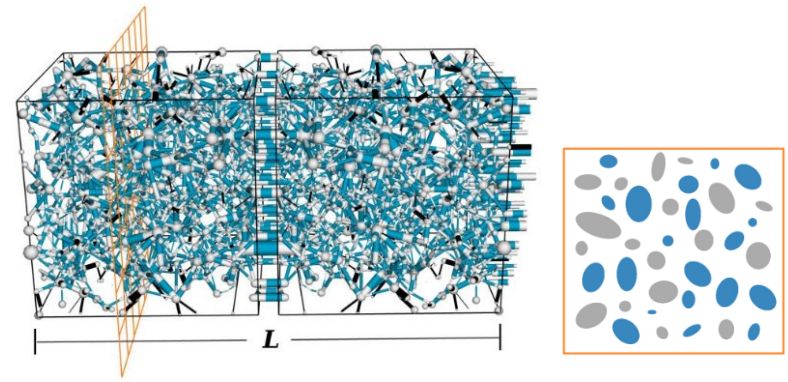
Subhadeep Roy[1], Håkon Pedersen[2], Santanu Sinha[2], Alex Hansen[2]

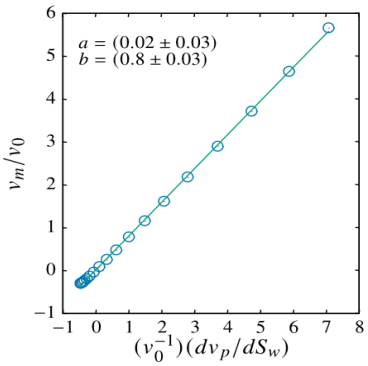
[1]BITS Pilani Hyderabad Campus, Secunderabad, Telangana 500078

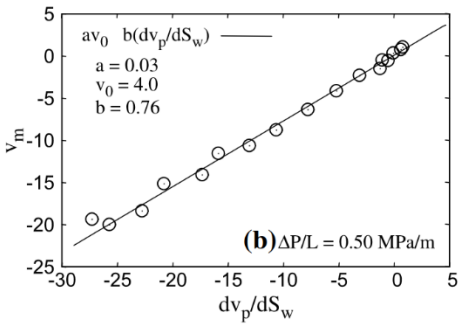
[2]PoreLab, NTNU, 7031 Trondheim, Norway

subhadeep.r@hyderabad.bits-pilani.ac.in

The article presents a continuum description of immiscible two-phase flow in porous media through extensive computational simulation of a dynamic pore network model characterized by two fields: pressure, and saturation. The simulation follows an interface tracking algorithm by solving three coupled linear equations: Young Laplace equation, Washburn equation, and Kirchoff's law. We construct a two-way transformation between the velocity couple consisting of the seepage velocity of each fluid, wetting, and non-wetting, to a velocity couple consisting of the average velocity and a new velocity parameter, the co-moving velocity. The two-way mapping, the mass conservation equation, and the constitutive equations for the average seepage velocity and the co-moving velocity form a closed set of equations that determine the flow. Our numerical simulation is consistent with the relative permeability data from the literature producing a very simple functional form for the constitutive equation over the whole range of parameters.







Upper panel: Dynamic pore network model, reconstructed from a Barea rock. The figure also shows non-wetting and wetting fluid through an imaginary plane through the system.

Lower panel: Comparision of the numerical result and experimental data for a flow of through a water saturated Castlegate rock.

C-013

First-Principles Study of Electronic Transport Properties of Binary Skutterudites by DFT Calculations

Poorva Nayak[1, #], Bharti Gurunani[1], Deepika Jha[1], Shruti Sharma[1], Danish Abdullah[1], Vishal Shivahare[1], Pankaj Srivastav[2] and Dinesh C. Gupta[1, *]

[1]Condensed Matter Theory Group, School of Studies in Physics, Jiwaji University, Gwalior – 474 011

[2]Indian Institute of Information Technology and Management, Gwalior – 474015

E-mail: poorvanayak11@gmail.com[#], sosfizix@gmail.com[*]

In this research, we utilized density functional formalism in the Wien2k code to investigate various characteristics of PtSb3 Skutterudites. The properties we analysed encompassed the compound's structural, electronic, mechanical, and thermoelectric properties. By optimizing the energy versus volume in both ferromagnetic and non-magnetic spin orderings, we identified the ground state parameters, with the ferromagnetic state being determined as the ground state based on the optimization plots. To validate the structural stability, we also assessed the cohesive energy and mechanical stability. The electronic band profile was explored utilizing the generalized gradient approximation (GGA) and a modified version of the Becke-Johnson potential (mBJ), both of which demonstrated that the compound exhibited a metallic nature. The total and atom-resolved density of states were also analysed to determine the responsible states for the metallic nature. Moreover, our findings revealed that PtSb3 Skutterudites exhibited low lattice thermal conductivity and a high Seebeck coefficient of 6.01 μVK at room temperature, suggesting that this alloy holds promise as a material with thermoelectric properties due to its high-power factor and Seebeck coefficient.

Keywords: DFT, Structural Properties, Thermoelectric Properties, Electronic Profile.

C-014

Exploring the Structural, Electro-mechanical and transport properties of IrMnSb half Heusler's alloy by DFT calculation

Bharti Gurunani[1, #], Poorva Nayak[1], Shruti Sharma[1], Deepika Jha[1], Danish Abdullah[1], Vishal Shivhare[1], Sukruti Ghosh[2] and Dinesh C. Gupta[1, *]

[1]Condensed Matter Theory Group, School of Studies in Physics, Jiwaji University, Gwalior – 474011

[2]Govt. Kamla Raja Girls PG (Auto.) College, Gwalior – 474001

E-mail: bgurunani001@gmail.com[#], sosfizix@gmail.com*

In the present study, we investigate the electronic band structure, mechanical and thermoelectric properties of IrMnSb half Heusler alloy by using *ab-initio* calculations. Structural optimization was performed in three stages, viz. Y1, Y2, and Y3. Energetically Y2 phase is the most stable phase. We calculated the exchange and correlation using GGA and mBJ approximations. We find the alloy to be half-metallic with a magnetic moment of 3 μB, in accordance with the Slater-Pauling rule. Using mBJ approximations, IrMnSb alloy shows the half-metallic nature with an indirect band gap of 1.15 eV. The second-order elastic constants are calculated by elast code. The calculated elastic parameters expose the ductile nature of IrMnSb alloy. The thermoelectric property was calculated by semi-classical Boltzmann transport theory, under time relaxation approximation. Seebeck coefficients (S) and figures of merit (ZT) are calculated at three different temperatures (300K and 900K).

Keywords: DFT, mechanical, thermoelectric properties.

C-015

Ab-initio study of Electro-Magnetic, Mechanical and Transport Properties of V_2CrSb Inverse Heusler Alloy.

Shruti Sharma[1], Deepika Jha[1], Bharti Gurunani[1], Poorva Nayak[1], Vishal Shivhare[1], Sukriti Ghosh[2] and D.C Gupta[1]

[1] *Condensed Matter Theory Group, School of Studies in Physics, Jiwaji University, Gwalior – 474011 (India)*

[2] *Department of Physics, Government Kamla Raja Girls Autonomous Post Graduate College, Lashkar, Gwalior – 474001 (India)*

Email: – shrutisharma2695@gmail.com[1], sosfizix@gmail.com

First-principles calculations were used to investigate the electronic structure, magnetic, mechanical, thermoelectric and half-metallic properties of the V_2CrSb alloy. The alloy is optimized in ferromagnetic and non-magnetic state with lattice parameter 6. 22Å.The electronic and magnetic properties are calculated using GGA and mBJ approximations. Using the calculated band structures, we found that the V_2CrSb alloy with Hg_2CuTi structure is half metallic ferromagnet. The total magnetic moment of this alloy is 3μB as it obey the Slater-Pauling rule Mt=Zt-18. The mechanical properties of this alloy are also calculated to determine the dynamic stability of the alloy. Various thermoelectric properties like seebeck coefficient, electrical conductivity, figure of merit etc, are also demonstrated which affirm the possible application of this material in green energy harvesting as well as for spintronics.

Keywords: -Density functional theory, Inverse Heusler alloys, Spintronics, Thermoelectric materials, Slater -Puling Rule

C-016

The Prediction of Structural Stability, Electronic Structure, Magnetism, Mechanical Properties, and Charge Density in $RbTiF_3$ Halide Perovskites from a DFT Perspective Research

Vishal Shivhare[1,#], Shruti Sharma[1], Deepika Jha[1], Poorva Nayak[1], Bharti Gurunani[1], and Dinesh C. Gupta[1],*

[1]*Condensed Matter Theory Group, School of Studies in Physics*, Jiwaji University Gwalior-474011 (INDIA)

vishalllshivhare@gmail.com[#],

Despite the profusion of materials for the mechanism of spintronic advancement, halide perovskites have a significant potential to carry such cutting-edge applications. High throughput simulations on the spin polarisation, structural, electrical, and magnetic properties of $RbTiF_3$ have been performed using density functional theory (DFT). There is good agreement between the optimised lattice constant and the theoretical lattice constant. The unit cell structure is evaluated in both ferromagnetic (FM) and non-ferromagnetic (NM) configurations in order to predict the ground state stability. The lowest energy state total estimations from all magnetic interactions are found to be the ferromagnetic ground state. By increasing band gap with the use of modified Becke Johnson, the half-metallic nature with the forbidden band gap is eliminated (mBJ). The specific half-metallic nature is further determined by examination of state densities. In a nutshell, the material has application promise in spintronics and solid-state devices. Alloys can also be valuable for industrial and other technological sources because of their mechanical stability. Moreover, a high cohesive energy value governs their strong bond connection inside their lattice structures. The combination of these alloys' properties creates a beautiful and dynamic image when used in spintronics and other industrially sophisticated technologies.

Keywords: Structural properties; Electronic structure; Magnetic materials; De-localized d electrons; Elastic and mechanical properties.

C-018

Insight into Structural, Electronic and Mechanical Response of PtScTiAl Quaternary Heusler Alloy for Green Energy Devices

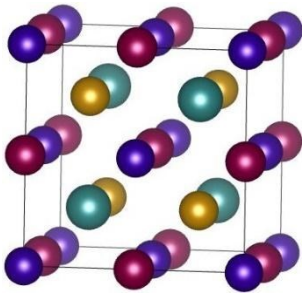
Deepika Jha[1, #], Shruti Sharma[1], Poorva Nayak[1], Bharti Gurunani[1] Vishal Shivhare[1], Danish Abdullah[1], Sukriti Ghosh[2], Dinesh C Gupta[1, *]

[1]Condensed Matter Theory Group, School of Studies in Physics Jiwaji University Gwalior-474011

[2]Department of physics, Kamla Raja Girls Govt. Postgraduate College, Gwalior-474001

Email: deepa33449jha@gmail.com# , sosfizix@gmail.com*

First principle techniques are used to examine the magneto-electronic structure of the PtScTiAl alloy. To calculate the exchange-correlation potential modified becke-jhonson potential and the generalised gradient approximation are incorporated. The alloy takes on a cubic structure due to its ferromagnetic nature, and the structural characteristics found to be accurate match the findings of experiments. The half-metallic nature of the band profile is further supported by the estimated electronic conductivities of up and down spin channels. Here is an example of how pressure affects the structural and electrical profile. By calculating elastic constant PtScTiAl's mechanical stability is established. The ductile behaviour of an alloy with a high melting temperature is specified by the computed elastic parameters. The plausibility of using alloy to create hard spintronic devices or possible thermoelectric materials is suggested by the efficient thermoelectric characteristics with half-metallic and ductile nature.



PtScTiAl cubic crystal Structure

C-020

Perovskite Solar Cell Exceeding 30% Efficinecy With Graded Bandgap Absorber And Inorganic Charge Extraction Layers Using Scaps-1d

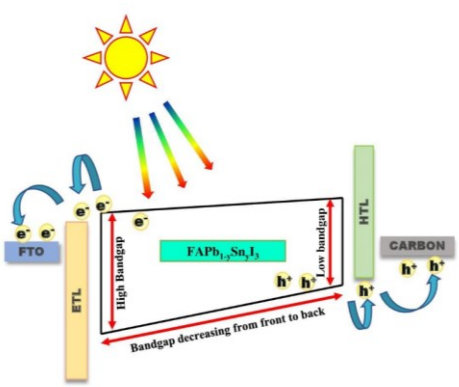
Monisha Nayak,[1] Abu Jahid Akhtar[1] & Sudip K. Saha[1*]

[1]Department of Physics, Diamond Harbour Women's University, Sarisha, Diamond Harbour Road, South 24 Parganas, West Bengal, 743368, India

Submitting author: monisha03nayak@gmail.com

Corresponding author: sudipsahaju@gmail.com

The ever-increasing energy demand of mankind necessitates the development of solar photovoltaics. Perovskite Solar Cells, a promising 3rd generation solar technology recently sets a new benchmark with impressive efficiency record of 25.8% from single junction devices. With a vision for industrial commercialization in near future, researches primarily focussed on different architectural designs, compositional engineering techniques, and, defect passivation strategies have been intensely carried out to enhance the overall performance of PSCs. Here, we propose a graded band-gap profile for the perovskite absorber with the composition $FAPb_{1-y}Sn_yI_3$ to maximize the absorption of the photons. Using front and back grading design strategies for the absorber, together with an optimized device architecture, maximizes the efficiency to above 30%. This simulation study therefore highlights a novel design strategy for PSCs with mixed tin-lead compositions for maximizing the device efficiency without the need of tandem configurations, expensive organic charge transporting layers or electrodes.



C-021

Influence of different metal ion on photovoltaic performance of ZnO based dye-sensitized solar cells using SCAPS-1D

Arpita Dutta[1], Abu Jahid Akhtar[1], Sudip K. Saha[1*]

[1]*Department of Physics, Diamond Harbour Women's University, Sarisha, 743368, West Bengal, India*

*Email of the corresponding author: sudipsahaju@gmail.com

Email of the submitting author: duttaarpita1995@gmail.com

Zinc oxide (ZnO) based photoanodes are one of the most prominent alternatives to TiO_2 employed dye sensitized solar cells (DSSCs). Though it is a promising candidate for photovoltaic application to convert solar radiations to efficient energy but its performance is limited due to lower stability and efficiency than TiO_2 and its large bandgap reduces the spectral response. To improve the light harvesting properties of ZnO nanomaterial, many metal ions are doped into ZnO crystal structure which suppress the recombination of charge carriers and improves the light absorption capacity in the visible region. In this work, we present a comparative numerical simulation analysis of different metal ions into ZnO structure using SCAPS-1D. The simulation results showed that the different factors analyzed are highly influential in improving the efficiency of doped DSSCs proving that impurities added have enhanced the physio-chemical properties of ZnO by achieving highest efficiency around 6%.

Keywords: DSSC, SCAPS-1D, doping, zinc oxide, efficiency.

C-023

N, and P Using Density Functional Theory

S. Gayathri Devi, C. Preferencial Kala *, D. John Thiruvadigal

Department of Physics and Nanotechnology, Centre for Material Science and Nanodevices, SRMIST, Kattankulathur, Tamilnadu, India.

* Corresponding author: preferec@srmist.edu.in

Doped graphene nanoribbon (GNR) nanodevices have shown promising potential as biosensors due to their high sensitivity, high surface-to-volume ratio, and excellent electrical properties. Doping involves the intentional introduction of impurities into a material to modify its electrical properties. Doping GNRs with different types of dopants can enhance their sensitivity toward specific biomolecules. One approach involves creating GNR field-effect transistors (FETs) that can detect biomolecules based on changes in the device's electrical conductance. Doping the GNR with specific dopants can enhance the sensitivity of the FET to specific biomolecules. In this work, we have studied the electron transport properties of hydrogen-passivated zigzag graphene nanoribbon (ZGNR) with different dopants like Boron (B), Nitrogen (N), and Phosphorus (P) in Rev-Z shape. Understanding the electronic properties in terms of band structure, total energy, partial charges, and density of states is of great significance today by first-principle methods. It is established that the geometrical structures and electronic properties of the 5ZGNRs could be considerably varied with the doped systems. The transport properties have been analyzed by transmission spectrum and current-voltage (I-V) characteristics using non-equilibrium Green's function techniques. Our computed results denote that the Rev-Z shape 5ZGNR doped systems behaved as metallic and semiconductor systems based on their dopants concentration. The effect of B, N, or P doping in ZGNR edges gradually raises the current at lower bias voltage.

Keywords: ZGNR, Dopants, Bandstructure, Density of states, Transmission Spectrum, I-V characteristics

References:

1. Johnson, A.P., Sabu, C., Swamy, N.K., Anto, A., Gangadharappa, H.V. and Pramod, K., 2021. Graphene nanoribbon: An emerging and efficient flat molecular platform for advanced biosensing. Biosensors and Bioelectronics, 184, p.113245.
2. Heerema, S.J. and Dekker, C., 2016. Graphene nanodevices for DNA sequencing. Nature nanotechnology, 11(2), pp.127-136.

C-025

Computational Modelling and Simulations

When utilising the Wiedemann-Franz law to calculate lattice thermal conductivity (K_L), electrical conductivity is taken into account, which produces a bias in the actual value of K_L. The Bi_2Se_3 nanocrystals with truncated hexagon plate morphology stabilised in a hexagonal crystal structure were measured without physical contact, and we computed the K_L from the Raman spectra. Bi_2Se_3 hexagonal plates range in thickness from 37 to 55 nm and have lateral diameters of about 550 nm. Three Raman lines are present in these Bi_2Se_3 nanocrystals, and they are consistent with the theoretical predictions of the A_{1g}^1, E_g^2 andA_{1g}^2modes. Despite the fact that the first-order thermal coefficient of Bi_2Se_3 nanocrystals is quite low, the room temperature (K_L=1.72 $Wm^{-1}K^{-1}$) is quite close to the result of a simulation using a three-phonon process. Anharmonicity and acoustic-optical phonon scattering play a key role in lowering the K_L of Bi_2Se_3, as shown by the simulations of phonon lifespan, Gruneisen parameter, and K_L of the mode frequencies. A high figure of merit can be attained by addressing the anharmonic effects in other thermoelectric materials using the non-contact measurements and pertinent thermal property parameters. Here we discuss the phonon lifetime , Gruneisen parameter and K_L of Bi2Se3 from both an experimental and theoretical standpoint. The temperature and laser power dependent Raman spectra of the Bi_2Se_3 nanocrystals are utilised to derive the K_L whereas the K_L, and gruneisen parameter of Bi_2Se_3 were calculated using the PHONO3PY programme.

Figure 7

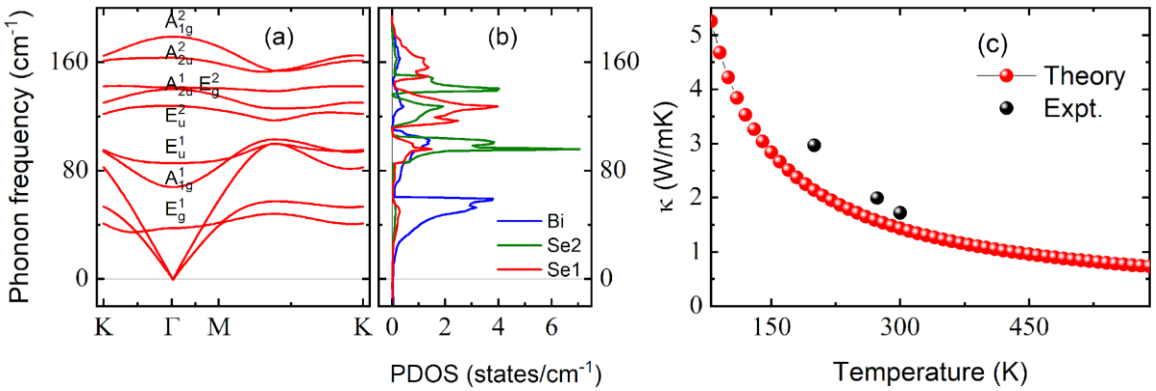


Figure 7 : (a) Phonon band structures (b) phonon density of states and (c) simulated temperature-dependent thermal conductivity of the Bi_2Se_3.

Abstract category : - F (Microelectronics and optoelectronics devices)

F-002

Cu_2ZnSnS_4 (CZTS) Nanoparticles based Resistive Random-Access Memory Device

Ankit K. Yadav[1], Chandra Prakash[1], Ambesh Dixit[1,*]
Advanced Material and Device Laboratory (A-MAD), Indian Institute of Technology, Jodhpur, Rajasthan, India, 342030

* ambesh@iitj.ac.in

ABSTRACT

The inorganic nanoparticles (NPs) based memory devices have attracted a great deal of attentions because of their low fabrication cost, low energy consumption, high storage capacity, and the better flexibility [1]. Herein, we successfully demonstrated the synthesis of CZTS nanoparticles and their integration into resistive random-access memory (RRAM) device, i.e., Cu(top electrode)/CZTS(NPs)/ITO(bottom electrode) configuration. The device exhibits stable bipolar non-volatile analog resistive-switching for 10^3 cycles. The retention characteristics for 2 x 10^3 s, exhibit average R_{HRS}/R_{LRS} ratio ~ 1.6, suggesting the stable non-volatile characteristics also. The field dependent transport of Cu vacancies may act as the current carrier across the active layer [2]. In addition, the Cu electrode ions may also migrate across the device, participating in filament formation, and thus, turning device into low resistance state. The work will cover these characteristics and operating mechanism for the present device in detail.

Keywords: RRAM, CZTS NPs, analog, retention, resistive switching.

REFERENCES:

[1] W. Zhang *et al.*, "Analog-Type Resistive Switching Devices for Neuromorphic Computing," *Phys. Status Solidi - Rapid Res. Lett.*, vol. 13, no. 10, pp. 1–13, 2019, doi: 10.1002/pssr.201900204.

[2] D. Y. Yun, N. S. Arul, D. U. Lee, N. H. Lee, and T. W. Kim, "Memory stabilities and mechanisms of organic bistable devices with giant memory margins based on Cu2ZnSnS4 nanoparticles/PMMA nanocomposites," *Org. Electron.*, vol. 24, pp. 320–324, 2015, doi: 10.1016/j.orgel.2015.05.007.

F-003

Lanthanides Doped Persistent Phosphor for Security Applications

P Vanishree[1*], G Swati[1]

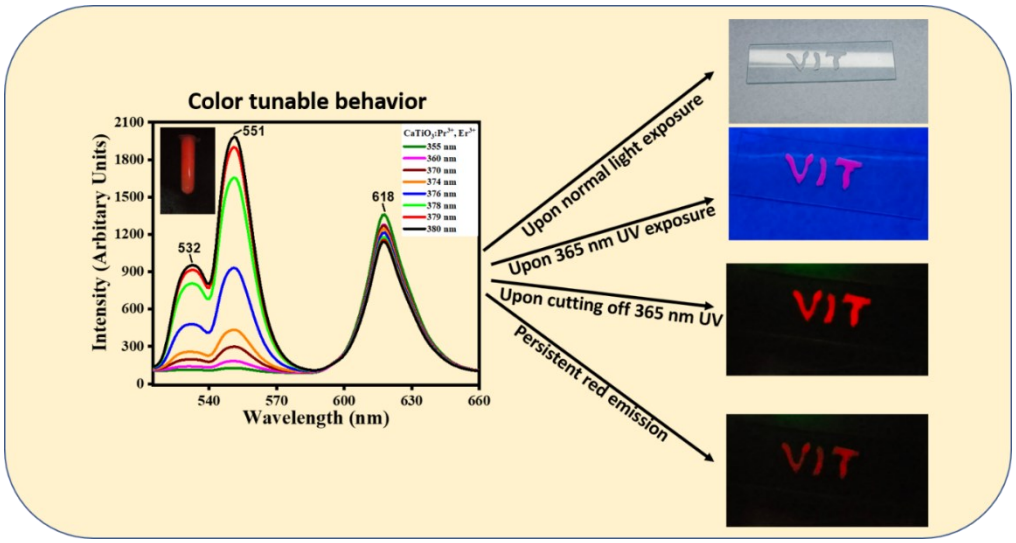
1 Centre for Nanotechnology Research, Vellore Institute of Technology, Vellore –632014, India.

vanishree1807@gmail.com

Counterfeiting is global threat especially in electronics and healthcare sectors resulting in loss of economy and lives. Need of hour is to develop an effective security application. In this work, a novel security ink was formulated, patterned, and tested. For this, lanthanides doped calcium titanate phosphor material was synthesized via high-temperature solid-state method. Increasing dopant concentration shows notable elemental peak shift denoting substitution of dopant ions into vacant sites of the orthorhombic crystal structure of $CaTiO_3$. The photoluminescence analysis of $CaTiO_3:Pr^{3+}Er^{3+}$, exhibited color-tunable emission mechanism for excitation wavelengths falling in UVA region (315nm to 400nm). This phosphor material also exhibits up-conversion phenomenon upon excitation with NIR radiation and the persistent luminescence under 365nm UV. Furthermore, the phosphor ink was formulated and tested on glass substrate showed deep red emission under 365nm UV and under dark. These features of multiple emission and persistence proves phosphor a potential candidate for security application.

Keywords: Dual emissions, persistence phosphor, security ink

Graphical Abstract:



F-004

Copper oxide thin films and nanostructures and their application in solar cells and resistive switching devices

Vishwas D Patel, Ashutosh Mohanty, Dhritiman Gupta*

Department of Physics, School of Advanced Science (SAS), Vellore Institute of Technology (VIT), Vellore-632014, Tamil Nadu, India.

Submitting and Corresponding Author
*Email: dhritiman., Tel: +91-9047509685

Two stable forms of copper oxides namely, CuO and Cu_2O are p-type oxides with bandgap in the range of 1.5 to 2.1 eV. These materials have attracted a great deal of interest for potential application in photovoltaic and photocatalytic devices and also as hole transport buffer layer in organic and perovskite devices. Here we will discuss our recent results on solution processed and electrodeposited thin films of copper oxide and their application in solar cells. Nanostructures of copper oxide was also synthesized via solvothermal route. Capacitively coupled resistive switching behaviour was observed in a planar-geometry two-terminal device based on nanostructures of copper oxide as active material and indium tin oxide (ITO) as electrodes. Creation of excess density of oxygen vacancy near the electrodes in conjunction with trapping and detrapping of electrons from these defect sites is perceived as the prime mechanism for the observed switching behaviour.

F-005

Investigation of structural and dielectric properties of orthorhombic phase of Ta_2O_5 nanosheets

Shivani Sangwan*, Deshraj Meena and Vinod Singh

Department of Applied Physics, Delhi Technological University, Delhi - 110042, India

shivanisangwan0709@gmail.com; deshrajmeena@dtu.ac.in; vinodsingh@dtu.ac.in

Abstract:

The dielectric characteristics of Tantalum pentoxide (Ta_2O_5) nanosheets in its orthorhombic phase, synthesized by hydrothermal process have been investigated in the temperature range of 80 K to 400 K and frequency range of 20 Hz to 2 MHz. The obtained results indicate that both the dielectric constant (ε') and dielectric loss (ε'') values increases with increasing temperature. The value of ε' increased from 10 to 20 on sintering the Ta_2O_5 at 950°C and this enhancement in its dielectric property can be justified by the thermally activated polarization and the decrease in the grain size of the Ta_2O_5 nanosheets at higher temperatures. Furthermore, the frequency dependence of ε' was found to follow the inverse law, which indicates the high effect of the distribution of relaxation times in the Ta_2O_5 nanosheets. Optical bandgap of the material is found to be 3.8 eV by analysing its UV-Visible absorbance spectra. Overall, this study provides a better understanding of Ta_2O_5 electrical behaviour and results suggest that the prepared nanosheets have potential applications as an alternative dielectric material in various electronic and optoelectronic devices.

Keywords: Tantalum pentoxide nanosheets (Ta_2O_5), Hydrothermal process, Dielectric constant, Dielectric loss, Relaxation time.

F-006

Bipolar Resistive switching in $BiFeO_3$ Artificial Synapse Mimicking Pavlov's Associative Learning

Suman Roy[1], Mousam Charan Sahu[1], Anjan Kumar Jena[1], Sameer Kumar Mallik[1], Roshan Padhan[1], Ajit Kr. Sahoo[3], Gopal Kumar Pradhan[2] Satyaprakash Sahoo[1,*]

[1] *LDM Lab, Institute of Physics, Bhubaneswar, India*

[2] *KIIT University, Bhubaneswar, India*

[3] *Nanomagnetism and Microscopy Laboratory, Indian Institute of Technology Hyderabad*

Email: suman.roy@iopb.res.in. *Corresponding author: sahoo@iopb.res.in

In the era of super computer and artificial intelligence, Neuromorphic Computing (NC) has emerged as a promising paradigm for processing large amount of data in an efficient and brain-inspired manner unlike von Neumann computing which relies on a CPU and separate memory unit. Owing to its extraordinary features and dynamical device property, Resistive Switching (RS) devices is emerging as a fundamental circuit element for NC. Bismuth ferrite (BFO) is a promising material for RS-based NC due to its multiferroic properties, which enable the coupling of electrical and magnetic responses. It is well established that, oxygen vacancies (V_o) play pivotal role in RS behaviour. In this work, to enhance the effect of V_o, ion irradiated Sol-gel grown Ag/BFO/FTO memristor device has been fabricated. Interestingly, the device exhibit both digital and analog resistive switching behaviour in a single device which is rarely reported. A possible mechanism for digital and analog resistive switching in our device is proposed. In order to support the bioinspired synaptic behaviour essential synaptic function such as Pair-Pulse Facilitation (PPF), Long Term Potentiation (LTP) and Long-Term Depression (LTD) are successfully realized. It is known that, to demonstrate more complex synaptic behaviour such as spike-time-dependent plasticity and Pavlov's classical conditional learning both Short Term Memory (STM) and Long-Term Memory (LTM) retention are required to be present simultaneously in a device. For the first time in BFO, we successfully demonstrated Pavlov's classical conditioning learning using electrical stimuli, which provides the salient features of learning and forgetting. This works enhanced the utility of BFO based resistive random-access memory, which provides information about the simultaneous existence of digital and analog behaviour, thereby facilitating the further implementation of memristor in low-power NC.

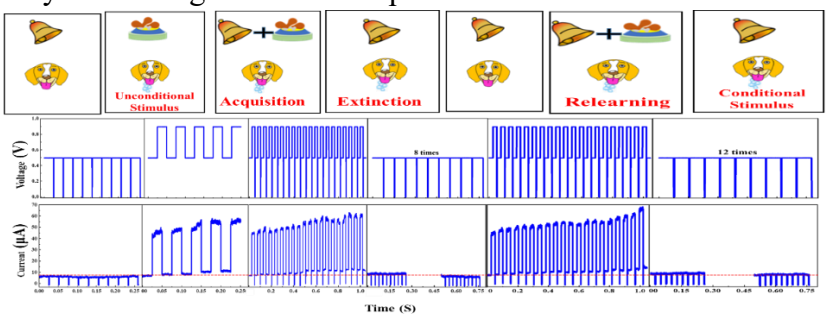


Figure 1: Experimental emulation of Pavlov's dog experiment explaining the classical conditioning obtained from memristor.

F-009

Transient electroluminescence studies of TADF thin-film blue emitter

Dinesh Kumar S[1], Dhruvajyoti Barah[2], Debdutta ray[2] and Jayeeta Bhattacharyya[1,*]

[1]*Department of Physics, IIT Madras, Chennai – 600036*

[2]*Department of Electrical engineering, IIT Madras, Chennai – 600036*

[*]Corresponding author: jayeeta@iitm.ac.in, submitting author: ph18d027@smail.iitm.ac.in

The efficiency of Organic Light Emitting Diodes (OLEDs) has been significantly enhanced by employing Thermally Activated Delayed Fluorescence (TADF) as an emitter, which allows efficient inter-system crossing of dark triplet excitons to fluorescent singlets without the use of heavy metal ions, resulting in a 100% internal quantum efficiency[1]. However, external losses, such as exciton polaron annihilation and exciton-exciton annihilation[2], can diminish the quantum efficiency of OLEDs. Such quenching mechanisms can be suppressed by embedding the TADF molecules in a host matrix. In this study, the transient photoluminescence (PL) and transient electroluminescence (EL) measurements were done on OLEDs having varying doping percentages of TADF emitter in the emissive layer (EML). In our work, we used a blue TADF material DMACDPS doped into a wide bandgap host, DPEPO. The results indicated that the EL decay rate after the bias was turned off dominated by the optical lifetimes of the transition while the rise times when the bias was turned on, depended on the carrier mobility, film thickness, etc. Transient PL and transient EL data were measured for different biases, which gives insight into the various mechanisms involved in the generation of emitted photons.

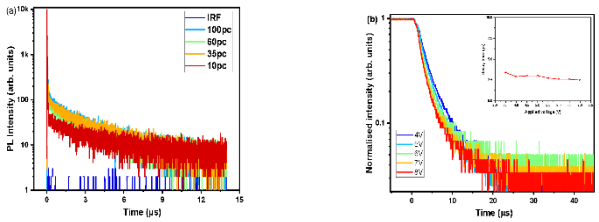


Figure: (a) Transient Photoluminescence of Different doping concentrations of DMACDPS with DPEPO, (b) Transient electroluminescence decay of 60% doping of DMACDPS in DPEPO for different bias, inset graph shows the decay time at different voltages.

References:

1. Nakanotani, H.; Tsuchiya, Y.; Adachi, C. Thermally-activated Delayed Fluorescence for Light-emitting Devices. *Chem. Lett.* **2021**, *50*, 938–948, doi:10.1246/cl.200915.

2. Hasan, M.; Shukla, A.; Ahmad, V.; Sobus, J.; Bencheikh, F.; M McGregor, S.K.; Mamada, M.; Adachi, C.; Lo, S.-C.; Namdas, E.B.; et al. Exciton–Exciton Annihilation in Thermally Activated Delayed Fluorescence Emitter. *Adv. Funct. Mater.* **2020**, *30*, 2000580, doi:10.1002/ADFM.202000580.

F-012

Highly Stable and Controllable Quantum Conductance States up to 100 G_0 in TiO_2 Memristor

Mousam Charan Sahu, [1,2] Sameer Kumar Mallik, [1,2] Pankaj Misra,[3,2] and Satyaprakash Sahoo[1,2]

[1] *Laboratory for Low Dimensional Materials, Institute of Physics, Bhubaneswar-751005, India*

[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai-400094, India*

[3]*Oxide Nano Electronics Lab, Laser Material Processing Division, Raja Ramanna Centre for Advanced Technology, Indore, 452013, India*

Email: mousams977@gmail.com

Memristors are simple two terminal devices in which an insulating layer is sandwiched between top and bottom metal electrodes. Under applied bias, the reversible formation and dissolution of conducting filament (CF) inside the insulator results in switching of the device resistance.[1,2] When the diameter of the CF is narrowed down to one atomic radius the electron moves ballistically inside the memristors. As a result, instead of a sharp jump, the device conductance evolves through plateaus of quantum of conductance ($G_0 = 2e^2/h$). However, with the increase in diameter of the CF several phenomena evolves such as joule heating, oxidative corrosion effect, mechanical stress, Gibbs-Thomson effect that results in unstable Quantum Conductance (QC) states.[3] In this regard, an oxygen vacancy engineered $Ag/TiO_2/Pt/Ti/SiO_2/Si$ memristor is fabricated that could able to exhibit stable and controllable QC states up to 100 G_0, for the first time. Under DC cyclic voltage measurements, the device exhibit compliance current (CC) controlled volatile (VS) and non-volatile (NVS) resistive switching behaviour. The VS switching of the device signifies that, the CF in our memristors are due to Ag atoms. During the NVS, following the CF formation, when a negative voltage is applied to the memristor instead of a sharp jump the device exhibit several transitions at fraction or integer multiples of G_0. Interestingly, during the CF formation when a CC of 1mA is applied, the device exhibits QC states ranging from 1-8 G_0. However, when the CC is increased to 2mA, and 3mA the exhibits higher integer multiple of QC states ranging from 2-20 G_0 and 5- 37 G_0, respectively. Statistical data from more than thousands of resistive switching cycles showing QC is collected over 50 devices. Such CC control of QC states in memristors may be attributed to the oxygen vacancy stoichiometry inside the TiO_2 layer. A possible CF formation/dissolution model is proposed to explain the experimental results. More importantly, not only in DC mode the higher order QC states can also be achieved in ultrafast pulse voltage operation mode, which is very important for practical read-write memory operations. Highly stable, readily controllable QC states up to 100 G_0 can be achieved in our memristor in pulse operation mode by manipulating the pulse amplitude, width, number etc. This demonstration of CC controlled QC states with higher integer values up to 100 G_0 could instigate a new horizon in the multi-bit high density memory storage devices.

References:

1. Jena, A. K. *et al.* Bipolar Resistive Switching in TiO2 Artificial Synapse Mimicking Pavlov's Associative Learning. *ACS Appl. Mater. Interfaces* **15**, 3574–3585 (2023).
2. Sahu, M. C. *et al.* Effect of Charge Injection on the Conducting Filament of Valence Change Anatase TiO2 Resistive Random Access Memory Device. *J. Phys. Chem. Lett.* **12**, 1876–1884 (2021).
3. Milano, G. *et al.* Quantum Conductance in Memristive Devices: Fundamentals, Developments, and Applications. *Advanced Materials* **34**, 2201248 (2022).

F-015

Exploring the switching mechanism in V_2O_5 memristor

Manu Shaji[1], Antony Sharon[1,2], K. J. Saji[3], Aldrin Antony[1,2], M.K. Jayaraj[4]

[1]Nanophotonic and Optoelectronic Devices Laboratory, Department of Physics, Cochin University of Science and Technology, Kochi, Kerala, India – 682022
[2]Centre of Excellence in Advanced Materials, Cochin University of Science and Technology, Kochi, Kerala, India – 682022
[3]International School of Photonics, Cochin University of Science and Technology, Kochi, Kerala, India – 682022
[4]University of Calicut, Thenhipalam, Malappuram, Kerala, India - 673635
Email: manushaji@cusat.ac.in

Abstract

Memristors are a new class of devices that can be used for the realization of ultrafast in-memory computational chips. Metal oxides are one of the major candidate in the fabrication of memristors due to their stability and ease of fabrication [1,2]. Here we report the fabrication of a memristor with thermally evaporated vanadium pentoxide (V_2O_5 – 70 nm) thin film with ITO and Ag as bottom and top electrodes respectively. The endurance of the device was checked by operating it up to 100 cycles and the device shows good retention. Understanding the switching mechanism is crucial to develop memristor based artificial synapse. Raman spectroscopy was employed to thoroughly understand the switching mechanism, and for that, we fabricated a device in a lateral configuration with thermal evaporated silver electrodes having a separation of 120 µm. Raman scattering studies suggests that the conduction is primarily mediated by the formation and rupturing of filaments composed of non-stoichiometric metallic Magnéli and Wadsley phase of V_2O_5.

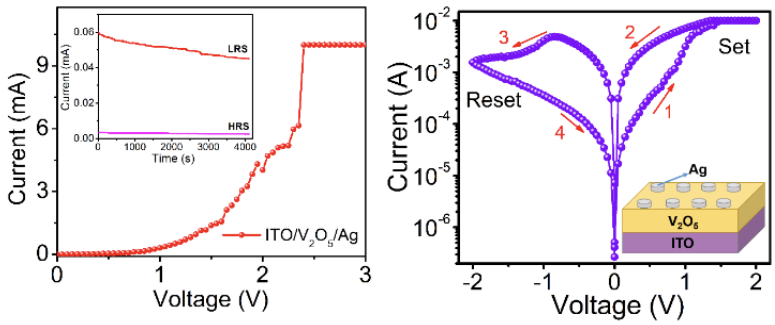


Figure 1: a) I-V characteristics showing the forming process. Inset shows the retention of the device on high resistance state (HRS) and low resistance state (LRS). b) Switching behaviour of the fabricated device. Inset shows the schematic of fabricated device.

References

1. A. R. Patil, T. D. Dongale, R. K. Kamat, and K. Y. Rajpure, Mater. Today Commun. **34**, 105356 (2023).
2. D. Zhu, Y. Li, W. Shen, Z. Zhou, L. Liu, and X. Zhang, J. Semicond. **38**, 071002 (2017).

F-016

Efficient UV-Photodetector based on CVD-grown ZnO Nanowires

Manisha Kumari[1], Rakesh K. Prasad[2], Dilip K. Singh[3*]

Department of Physics, Birla Institute of Technology Mesra, Ranchi-835215 (India)

**Email: dilipsinghnano1@gmail.com*

Due to high sensitivity, excellent signal-to-noise ratio nanowire-based detectors can operate at high speeds and with high gains. Zinc Oxide (ZnO) nanowires (NWs) are considered a capacity contender in optoelectronic devices due to their direct wide band gap (3.23 eV), high excitonic binding energy at room temperature (60 meV) and high surface-to-volume ratio [1]. In this work, we present the recipe for the growth of ZnO NWs using CVD and the performance parameters of the fabricated UV photodetector. ZnO-based photodetector with a 365 nm excitation shows high on/off ratio (0.910^2) with charging and discharging time of 1.06 sec and 0.84 sec and sensitivity of 12.19 AW^{-1} at incident power density of 0.01 mw/cm^2. The fabricated detector exhibits external quantum efficiency of 2.3×10^3 % and detectivity of 4.81×10^{11} jones. Here we have shown the possibility of fabrication of Si/ZnO NWs-based efficient photodetectors for Optoelectronic applications fabricated through the CVD process.

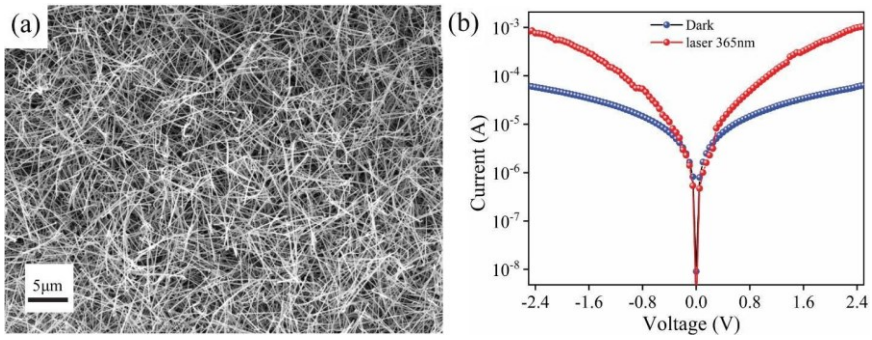


Fig. 1(a) FESEM image of ZnO nanowires grown through CVD on Si substrate (b) Current-voltage characteristics of the as-grown ZnO nanowire-based Photodetector.

Reference:

[1] C. Soci, A. Zhang, B. Xiang, S. A. Dayeh, D. P. R. Aplin, J. Park, X. Y. Bao, Y. H. Lo, and D. Wang, ZnO Nanowire UV Photodetectors with High Internal Gain, *Nano Letters*, 7(4), 1003-1009, 2007.

F-018

Symmetric bipolar resistive switching in Copper Oxide nanostructure/ITO lateral device induced by exposure to atmospheric Oxygen

Ashutosh Mohanty, Dhritiman Gupta*

Department of Physics, School of Advanced Science (SAS), Vellore Institute of Technology (VIT), Vellore-632014, Tamil Nadu, India.

Email: mohantyashutosh23@gmail.com, dm.gupta@gmail.com *

Abstract:

Metal oxide semiconductors MOS of both p/n types are adaptable in a wide number of technology due to their versatile nature. Capacitively coupled bipolar resistive switching behaviour is observed in the lateral geometry two-terminal device with copper (II) oxide nanostructure as a solid electrolyte and indium tin oxide (ITO) as electrodes. Capacitive effect was apparent in low voltage regime due to the presence of offset current and voltage at zero bias. Trapping and de-trapping of electrons near electrodes due to the local density of oxygen vacancies is perceived as the prime mechanism for the observed switching behaviour. The device has ON/OFF ratio, $ION/IOFF$~0.6 which was found to be stable over at least 100 continuous cycles. Analysis of ultraviolet photoelectron spectroscopy (UPS) shows the Fermi energy level of copper oxide ~4.69 eV, which is in close match with the work function of ITO-electrode and X-ray photoelectron spectroscopy analysis confirms the presence of native oxygen vacancies.

F-019

Semimetallic electrode to achieve Schottky-Bardeen Limit

Bubunu Biswal [1,2†], Rajarapu Ramesh[1], Renu Yadav[1], Saroj Poudyal[1], Prahalad Kanti Barman[1], Mrinal Deka[1], Wahidur Rahman[1], B.R.K. Nanda[2*], Abhishek Misra[1*]

[1]*Center for 2D material Research and Innovations and Department of Physics, IIT Madras, Chennai, India, 600036*

[2]*Condensed Matter Theory and Computational Lab, Department of Physics, IIT Madras, Chennai, India, 600036*

†, *Email: biswalbubun444@gmail.com, abhishek.misra@iitm.ac.in

Abstract- The Silicon based MOSFET technology has been reached its scalable limit while Germanium have gain enough attention due to its high electron and hole carrier mobility and its narrow bandgap and high saturation velocity.[1–3] To achieve high quality devices performances in Ge based devices, the formation of Ohmic contact to the Ge is highly desirable. In case of Ge, the charge neutrality level lies near to the valence band edge resisting the modulation of barrier height by pinning the Fermi level near to valence band edge. In this work, we have proposed to use the layered semimetals as electrode to de-pin the Fermi level owing to the finite van der Waals gap at interface and the low carrier density. The evaluated SBH at Ge/semimetal interface reveal the de-pinning of the Fermi level. This is due to the fact that the finite van der Waal gap at the interface opposing the tailing of the metal wave functions into the semiconductor gap state causing the reduction of metal induced gap states. These findings are significant for the development of future high carrier mobility Ge based devices.

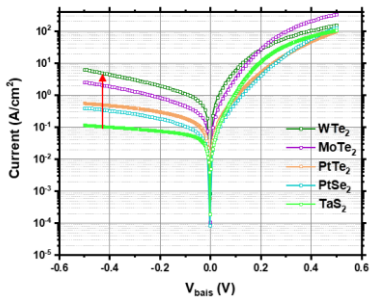


Figure 1 - The IV characteristics of Ge/Semimetal diode showing the modulation of barrier height.

References

[1] *P. Bhatt, P. Swarnkar, F. Basheer, C. Hatem, A. Nainani, and S. Lodha, IEEE Electron Device Lett.* ***35****, 717 (2014).*

[2] *J. Bin Wei, X.W. Chi, C. Lu, C. Wang, G.Y. Lin, H. Da Wu, W. Huang, C. Li, S.Y. Chen, and C.L. Liu, Chinese Phys. B* ***24****, (2015).*

[3] *P. Bhatt, K. Chaudhuri, S. Kothari, A. Nainani, and S. Lodha, Appl. Phys. Lett.* ***103****, (2013).*

F-021

Opto-electrical properties of solution-processed $CuFe_2O_4/TiO_2$ heterojunction thin films

Parul Garg[a], Quadeer Rehman[b], Ashok Bera[c]*

Department of Physics, Indian Institute of Technology Jammu, Jammu and Kashmir, 181221 India

Email[a]:-2019rph0009@iitjammu.ac.in , Email[b]:-2019umt0170@iitjammu.ac.in and Corresponding Author Email[c]:- ashok.bera@iitjammu.ac.in

Abstract: Spinel-structured p-type $CuFe_2O_4$ (CFO) is known for its superparamagnetic properties. Being a narrow-band oxide, it has also been used for photocatalytic activity, and photo-electrochemical water splitting. Here, we report the structural, morphological and optical properties of solution-processed CFO film on fluorine-doped tin oxide (FTO) substrate. It shows a single-phase spinel cubic crystal structure with an optical band gap of 2.2 eV (direct) and 1.2 eV (indirect). A 1.5 times increase in the photocurrent values over the dark current at a bias of 15 V and a steady rise under illumination in the transient photocurrent response confirm that the CFO films are sensitive to light. Finally, we prepared a solution-processed CFO/TiO_2 based p-n heterojunction, which shows typical diode-like characteristics. The designed heterojunction exhibited an enhanced photocurrent of 0.12 μA cm^{-2} under 1 SUN illumination. Hence the studied optoelectronic properties of CFO thin films indicate the unique multifunctional properties of CFO material.

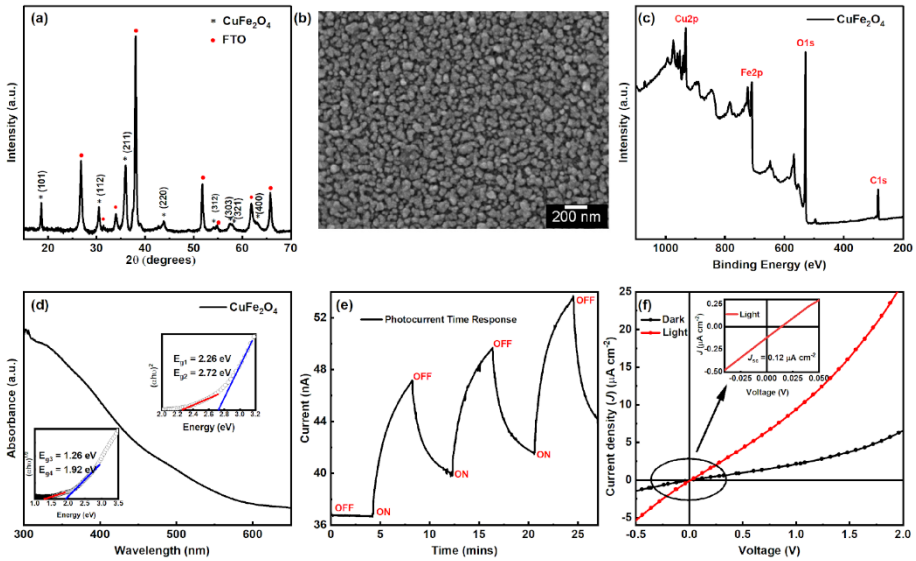


Fig. (a) X-ray diffraction pattern of CFO thin-film. (b) Top view FESEM image of solution-grown CFO thin film on a FTO substrate. (c) XPS survey scan spectra of CFO thin-film. (d) Optical absorption spectra of the CFO thin film and the inset shows direct & indirect tauc plots of CFO thin film. (e) The photocurrent time response of TiO_2/CFO films at 15 V as a function of illumination. (f) Current density (J) vs Voltage (V) characteristics of TiO_2/CFO heterojunction under 1 SUN illumination condition.

F-022

Impact of tailoring of the defect states and the band gap towards extreme photocatalytic performance and photo-induced conductivity in cobalt doped ZnO QD

Karabi Chatterjee[1], Arpita Dutta[1], Shubhankar Mishra[2], Sudip K. Saha[1], Abu Jahid Akhtar[1]

[1]*Department of Physics, Diamond Harbour Women's University, West Bengal- 743368, India;*
[2]*Department of Physics, Jadavpur University, Kolkata, 700032, India*

Abstract

Due to the advantages of tuning the electronic structure and reducing charge carrier recombination, metal doping into semiconductor metal oxides has been considered as an efficient method for enhancing photocatalytic activity and photo-induced conductivity. In this work, we focus on the effect of cobalt doping on the photocatalytic performance and photo-induced conductivity of ZnO QD. It was found that after Co doping, the photocatalytic activity of ZnO QD was remarkably higher than that of undoped ZnO QD when measured with methylene blue (MB) dye. The study showed that the complete degradation of the dye using 5 mol% cobalt doped ZnO QD occurred in just 6 minutes, which is 4 times faster than that of undoped ZnO QD. Furthermore, the photoconductivity and photosensitivity of 5 mol% doped Co doped ZnO QD were increased by 20 and 7 times, respectively, over that of undoped ZnO QD. The outstanding boost in photocatalytic activity and photoconductivity is caused by the tunable band gap mediated photo response, which increases light harvesting and thus the generation of a large number of electron hole pairs. Another possible explanation is that sub-energy levels formed between the conduction and valance bands act as a trap for electrons and holes, promoting charge separation by limiting photogenerated charge carrier recombination.

Keywords: ZnO, quantum dot, photocatalytic activity, photo-induced conductivity, defect states, band gap.

F-023

Giant excitons emission in MoS_2/PbI_2 heterostructures

Saroj Poudyal[1] ,Prahalad Kanti Barman[1], Bubunu Biswal, Renu Yadav[1], Mrinal Deka[1], Wahidur Rahman[1], Rajarapu Ramesh[1], Abhishek Misra[1*]

[1]Center for 2D material Research and Innovations and Department of Physics, IIT Madras, Chennai, India, 600036

Abstract:

Enhancing the light coupling efficiency of Trasition Metal Dichalcogonides (TMDs) is one of the coveted goal for its successful application for optoelectronics and photonic devices. Here we report large (~22 times) increase in exciton emission intensity of MoS_2 by fabricating MoS_2 /PbI_2 heterostructure using dry transfer method. Using micro PL and DFT studies we infer that such enhancement is due to the formatation of type I band alignment between MoS_2 and PbI_2. This inference is futher elucidated by two photon absorbtion spectroscopy.

F-024

High Responsivity in Monolayer MoS_2 Photodetector via Controlled Interfacial Carrier Trapping

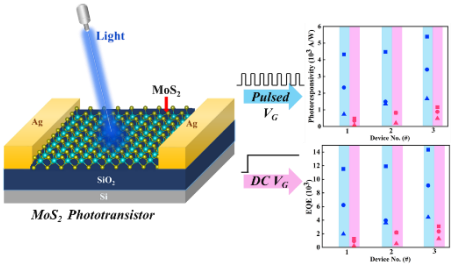
Sandhyarani Sahoo,[1,2] Mousam Charan Sahu,[1,2] Sameer Kumar Mallik,[1,2] and Satyaprakash Sahoo[1,2]

[1] *Laboratory for Low Dimensional Materials, Institute of Physics, Bhubaneswar-751005, India*

[2] *Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai-400094, India*

Email: Sandhya.tiki1995@gmail.com

Two-dimensional transition metal dichalcogenides have garnered extensive attention in potential advances in optoelectronic devices because of the enhanced photoresponsivity and tunable band gap for broadband photodetection. Photodetection predominantly depends on the photoconductive effect and photogating effect. The photogating effect is responsible for high responsivity and photo gain,[1] which inherently includes the electrical bias stress contributing to the charge carrier trapping and degrades the device performance. A facile and effective approach is required to control carrier trapping resulting in a high-responsive low-power photodetection. In this regard, monolayer MoS_2 is considered as the photoactive material and the pulsed gate bias is implemented to control the photogating and photoconductive effects, which could provide an opportunity for obtaining high responsivity in optoelectronic devices. In consequence, this approach results in a large photoresponsivity of ~4.2 × 103 A/W and a high photo gain of ~11.3 × 103 with the positive gate bias stress even in the low power illumination. Additionally, the photo responsivity and photo gain of ~ 0.7×103 A/W and ~1.92×103 with the negative gate bias stress demonstrates the gate tunable photoresponse. Our findings bear the potential for future development of highly responsive low-power photodetector.[2]



References:

[1] Kufer, D.; Konstantatos, G. Highly Sensitive, Encapsulated MoS2 Photodetector with Gate Controllable Gain and Speed. *Nano Lett* **2015**, *15* (11), 7307–7313.

[2] Sahoo, S.; Sahu, M. C.; Mallik, S. K.; Jena, A. K.; Pradhan, G. K.; Sahoo, S. High Responsivity in Monolayer MoS2 Photodetector via Controlled Interfacial Carrier Trapping. *ACS Appl Electron Mater* **2023**, *5* (2), 1077–1087.

F-025

Improvement of UV-C LEDs with p-$Al_{0.60}Ga_{0.40}N/Al_{0.50}Ga_{0.50}N$ Superlattice cladding region between Electron Blocking Layer and p-GaN layer

Harshita Aagiwal[1], Indrani Mazumder[1,2], Kashish Sapra[1,2], Ashok chauhan[1], Kuldip Singh[1,2] and Manish Mathew[1,2]

[1]CSIR-Central Electronics Engineering Research Institute, Pilani, Rajasthan.
[2]AcSIR-Academy of Scientific and Industrial Research, Ghaziabad, Uttar Pradesh-201002, India
Email: manish@ceeri.res.in

III-nitride alloy based superlattice $Al_{0.60}Ga_{0.40}N/Al_{0.50}Ga_{0.50}N$ intermediated lattice aligned cladding region has been proposed between EBL and p-GaN layer in this article. It is observed that the superlattice configuration in hole injection layer leads to enhanced performance in terms of reduced leakage current, IQE droop, polarization charges at hetero-interface between active region and hole-injection layer, increased Hole injection, better carrier distribution etc. The design of the original and modified UV LED structure referred as LED A and LED B have also been studied and compared as shown in Fig. 1. The highest IQE is increased from 39% to 50% in proposed device structure compared to the reference. The proposed to improve hole transportation and electron distribution in the active region by reducing the piezoelectric polarization induced due to lattice mismatch. The IQE droop is reduced from 36.2% to 22.4% in proposed structure as shown in Fig.2. The electron barrier height has also upsized from 280 meV to 330 meV, while the hole potential height has downsized from 410 meV to 340 meV at 150 mA.

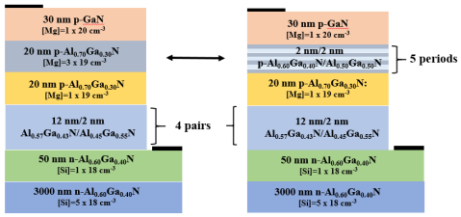


Fig.1 Schematic diagram of UV-C LED, reference and modified structures .

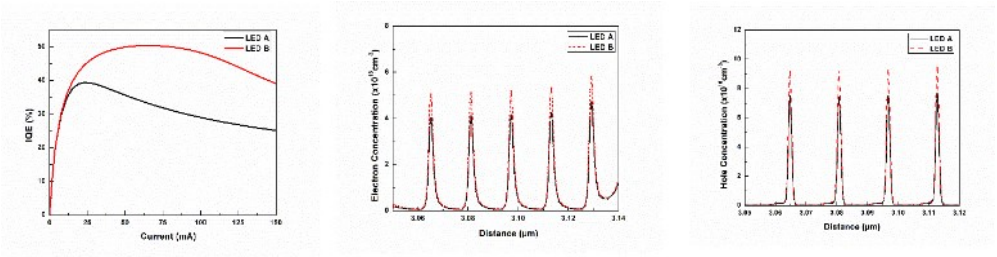


Fig.2 Internal Quantum Efficiency performance, Electron and Hole concentration near the active region of the UV-C LED structures.

References:

[1] Warnock et. al. IEEE TED, pp. 3131, 2017.
[2] M.Meneghini et. al. APL, pp. 33505(1), 2012.

F-026

Wide bandgap Semiconductor Metalohydrogel for non-volatile memory design

Arpita Roy[1], Subhendu Dhibar[2], Shantanu Majumder[1], Bidyut Saha[2], Soumya Jyoti Ray[1]

[1]*Department of Physics, Indian Institute of Technology Patna, Bihar-801106, India*

[2]*Colloid Chemistry Laboratory, Department of Chemistry, The University of Burdwan, Golapbag, Burdwan-713104, West Bengal, India*

Abstract: Non-volatile memory (NVM) elements are essential parts of most of the modern-day microelectronic devices and integrated circuits due to their superior data storage capacity, fast operational speed and cheap cost of fabrication. Resistive random-access memory (RRAM) is such a basic industry-compatible structure in a MIM (Metal/Insulator/Metal) geometry, which can offer advanced performance as required by the International Technology Roadmap for Semiconductors (ITRS) guideline for NVM technology. In this work, we have designed novel flexible RRAM devices using semiconducting metalohydrogels, which exhibits bipolar resistive switching behaviour at room temperature. We explored the switching mechanism through the formation (rupture) of conductive filaments between the metal electrodes between the SET and RESET processes, while the conducting follows space charge limited conduction mechanism. These devices offer robust endurance behaviour, sustainable over 10,000 consecutive switching cycles, offering a high ON/OFF ratio (~100), which can be useful for non-volatile memory design, neuromorphic computing etc.

References:

1. Instantaneous gelation of a self-healable Wide Bandgap Semiconducting SupramolecularMg(II)-metallohydrogel: An Efficient non-volatile memory design with supreme endurance, ACS Applied Electronic Materials, 2023 (accepted)
2. A wide bandgap semiconducting magnesium hydrogel: moisture harvest, iodine sequestration, and resistive switching, Langmuir 38 (34), 10601-10610, 2022

F-027

Flexible organic ferroelectric diisopropyl ammonium bromide (DIPAB) film for optoelectronic applications

K. Shanmuga Priya[1], and P. Murugavel

[1]*Pervoskites Material's Laboratory, Functional Oxide Research Group (FORG),*

Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India

Presenting author E.mail: shanmugak03@gmail.com

Ferroelectric (FE) materials have shown great potential as a promising alternative for green energy harvesting, especially in photovoltaic (PV) and photodetector applications. Anomalous open-circuit voltage with photocurrent response is the main advantage of FE- PV effect than the conventional *p-n* junction solar cell. In this regard, the PV response in organic FE materials upsurge attention over the inorganic FE due to their recently observed high spontaneous polarization and better stability factor. Among that, diisopropyl ammonium bromide (DIPAB) is a promising material with superior FE response. However, making a continuous film of DIPAB restricts its application potential in optoelectronic devices. In the present work, DIPAB continuous film is successfully fabricated on Si(100) and ITO/PET substrates by the thermal evaporation method. The electrical current measurements under UV-Vis light illumination on the DIPAB film displayed a remarkable photocurrent response. Importantly, it is demonstrated that the DIPAB film exhibits notable self-powered photodetector characteristics with a responsivity of 0.6 mA/W and detectivity of 2.2 10^{9} Jones at 11.4 mW cm^{-2} light intensity. The fabricated DIPAB film reported in this work can widen its application potential in other optoelectronic devices.

F-028

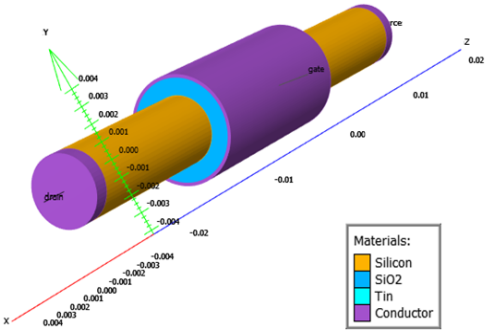
GEOMETRIC AND DIELECTRIC ENGINEERED HIGH PERFORMANCE GATE ALL AROUND FIELD EFFECT TRANSISTOR

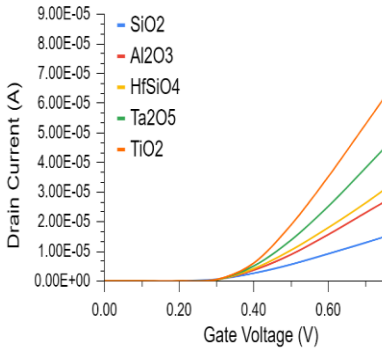
Harsh Raju[1],Vinod Kumar[1]

[1]National Institute of Technology ,Hamirpur

*corresponding author :vinodsharma@nith.ac.in

Abstract: Continuous technological progressions lead to sub nanometre technological nodes. Scaled devices below 5nm technology nodes involves critical challenges and are obvious tailbacks in maintaining the performance metrics of fin FETs. Therefore, FinFETs are now replaced with an alternate device geometry GAAFETs (Gate all around FETs), covering channel from every direction to have better gate control. In this paper, to enhance the performance of GAAFETs at 2nm node, geometric and dielectric engineering is investigated. Simulating rectangular, triangle and cylindrical GAAFETs, it is observed that cylindrical structure is the most suitable attributing to higher I_{ON}/I_{OFF} ratio, lower DIBL and better electrostatic control. Introduction of high-K gate dielectrics like Al_2O_3, $HfSiO_4$, HfO_2 Ta_2O_5, TiO2 in cylindrical GAAFETs doubles the drive current and reduces leakage current significantly. The improved drive current and I_{ON}/I_{OFF} ratio makes it a natural choice for digital as well as analog applications.





Abstract category: - G (Others)

G-004

Synthesis of Tungsten nanocomposite for future fusion reactors by employing fast sintering method

Ritu Kumai Pilania[1], Pawan Kumar Kulriya[2] and Charu Lata Dube[1,*]

[1]*School of Nano Sciences, Central university of Gujarat, Gandhinagar, Sector-30, 382030, India.*

[2]*School of Physical Sciences, Jawaharlal Nehru University (JNU), New Delhi, 110067, India.*

Presenting/Corresponding Author: *charulata.dube@cug.ac.in

Tungsten is one of the most promising materials for plasma facing components (PFCs) in future nuclear fusion reactors. We report the synthesis of pure tungsten and tungsten nanocomposites of different composition by using fast sintering method. A phase transformation is seen after fast sintering in Gleeble machine (available at Institute for Plasma Research, Gandhinagar) at temperature of 1500 °C under uniaxial pressure of 40MPa. In order to investigate the effect of radiation damage on structural and microstructural properties of the sintered samples, a surrogate method of ion irradiation is chosen. The sintered pure tungsten and tungsten doped with rare earth oxides were irradiated with gold ions of energy 100 MeV at fluence of ~1.7×10^{14} ions/cm^2. The X-ray diffractograms of irradiated samples reveal presence of beta phase of tungsten along with other existing phases, owing to ion-solid interactions. A detailed analysis will be presented during the conference.

Keyword: Tungsten nanocomposite; Radiation damage; Ion beam irradiation, PFCs.

G-005

Synthesis and Study of Structure and Optical Properties of RE^{3+}(RE= Sm and Tb) Activated $Ca_8NaBi(PO_4)_6F_2$ Green and Red Emitting Phosphors Prepared by Modified Pechini Method

Bharti Bawanthade[1*], Ahok Mistry[1], Nilesh Ugemuge[1]

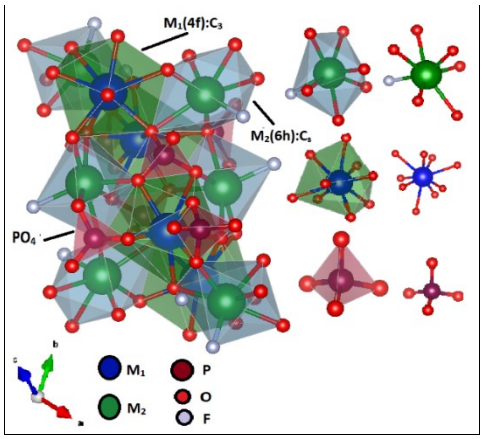
[1]*Anand Niketan College, Anandwan Warora Dist. Chandrapur, India 442914*

[*]*Corresponding author: e-mail address - bhartibawanthade@gmail.com*

Abstract:

In this paper we report $Ca_8NaBi(PO_4)_6F_2$ fluorapatites doped with RE^{3+}(RE= Sm and Tb) ion synthesised by modified Pechini method are promising candidate for red and green emitting materials for optical applications. Characterisation of this synthesized sample was done, XRD and Rietveld refinement analysis confirm that it crystallized into hexagonal structure with the space group P63/m matched with the JCPDS file no.# 96-900-1879. PL analysis performed by HITACHI F-7100 Spectrofluorophotometer, it shows that $Ca_8NaBi(PO_4)_6F_2$: Tb^{3+},Sm^{3+} show highly intense peaks at 544 nm ($5D_4$ to $7F_5$) and 600 nm ($4G_{5/2}$ to $6H_{5/2}$) under the excitation of 350nm and 402 nm respectively. Due to lack of divalent (RE^{2+}) species, it has good thermal stability and environmentally friendly synthesis technique by the modified Pechini method at low temperatures (at 900◦c). The analysis of optical characteristics of the $Ca_8NaBi(PO_4)_6F_2$:Sm^{3+},Tb^{3+} phosphors indicating that these materials are promising candidate for applications as red and green emitting phosphors with the combination of blue phosphor for warm white light emitting diodes applications.

Key words: Red and Green emitting phosphor, Fluorapatite, Pechini Method, Tb^{3+}, Sm^3



+

G-006

EXTRACTION OF BIODIESEL FROM WASTES OF FISH, POULTRY AND SLAUGHTERHOUSE

Ranjeeta P. Chatterjee[1], Ayesha S. Shaikh[1*], Lalita V. Rane[2]
[1]Department of Zoology, Prof. Ramkrishna More ACS College, Akurdi, Pune, India.
[2]Department of Physics, Prof. Ramkrishna More ACS College, Akurdi, Pune, India.
Corresponding Author Email: shaikhayeshaa28@gmail.com

ABSTRACT

Biodiesel is a renewable and sustainable fuel, prepared from natural sources such as vegetable oils and animal fats. It could be used in diesel engine without modification and produces fewer harmful emissions compared to traditional diesel. Biodiesel is conventionally produced through transesterification of fat in presence of a catalyst to form fatty acid esters. The wastes from poultry, slaughterhouse and fish market are unaesthetic and hazards for the environment as they are not hygienic and may contain pathogens, hence waste management is required for them. In the current study, these wastes have been collected, processed and through transesterification, biodiesel have been extracted. In this work, biodiesel is produced from wastes of fish, poultry and slaughterhouse, instead of edible vegetable oils, as used in conventional method. Highest amount of Biodiesel was obtained from slaughterhouse waste followed by poultry waste. The minimal amount was obtained from fish oil.

Keywords*:* Biodiesel, fish oil, poultry waste, slaughterhouse waste, transesterification, waste management.

G-007

TiO_2-NP Toxicity Induced Alterations in Haematological and Biochemical Parameters of Blood of Some Teleosts from Rivers of Pune District, India

[1]Ranjeeta P. Chatterjee, [2]Poonam N. Wani and [1]Rahul G. Jadhav*

[1]Department of Zoology, Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune, Maharashtra, India

[2]Department of Physics, Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune, Maharashtra, India

Email: rahulgjadhav500@gmail.com; Mobile: 8600941971

ABSTRACT

This study aims to investigate the potential toxic impact of Titanium Dioxide Nanoparticles on blood biochemistry and haematological parameters of some teleosts from Pune District, India. The study was conducted by exposing fish batches to different concentrations of TiO_2 Nanoparticles for specific period, followed by assessment of certain blood parameters and liver enzymes. The results revealed significant changes in total blood count, haemoglobin and haematocrit value in a dose-dependent manner. Similarly, the biochemical parameters including alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transferase, acid phosphatase and alkaline phosphatase were found to be significantly altered in exposed fishes. These findings suggest that chronic TiO_2 Nanoparticle exposure could induce hepatotoxicity and physiopathological effects on the test organisms, which could have implications for aquatic ecosystem and human health. Further studies are needed to understand long-term effects of TiO_2 Nanoparticle exposure on different organs and to develop strategies to mitigate its potential adverse effects.

Keywords: TiO_2 Nanoparticle, blood biochemistry, hepatotoxicity, physiopathological effects, teleosts.

G-008

Enhanced Visible light photoelectrochemical performance of C_3N_4 coupled with SnO_2 and CNT towards photoelectrochemical water splitting

Gagan Sharma[1], Deshraj Meena[2,*]

Department of applied physics, Delhi Technological university, Shahabad Bawana road , Delhi, India

*Corresponding Author E-mail: deshrajmeena@dtu.ac.in

ABSTRACT

In this present work, using a hydrothermal[1] approach, we develop and create an organic/inorganic SnO_2/C_3N_4/CNT photoanode. SnO_2/C_3N_4/CNT photoanode characterised by X ray diffraction, scanning electron microscope and transmission electron microscope. SnO_2/C_3N_4/CNT photoanode[2] that has significantly improved photoelectrochemical characteristics. The synthesized SnO_2/C_3N_4/CNT photoanode exhibits a photocurrent density of 2.8 mA/cm^2 , which is ~4 fold higher than untreated graphitic carbon nitride at an applied bias potential of 0.6 V vs. Ag/AgCl. The strong transition of photo-induced electrons from C_3N_4 to SnO_2 and their close interface contact with CNT at the SnO_2/C_3N_4 interface contribute to the superior photoelectrochemical performance. According to results from Kelvin probe force microscopy, the interface barrier height between SnO_2 and C_3N_4 is lower (10 meV), indicating that electron transport over these interfaces is more favourable in ternary photoanodes. In comparison to untreated C_3N_4, the SnO_2/C_3N_4/CNT photoanode showed an onset potential of 0.25 V vs. Ag/AgCl. The improved electron injection across the interface in a ternary photoanode was further validated by the electrochemical impedance spectroscopy data. These findings show a viable path towards creating a highly effective, visible light-active photoanode with exceptional stability for applications in renewable energy.

Keywords: hydrothermal1; photoanode2;.

G-009

Production of Biodiesel from Wastes of Animal Husbandry using TiO_2 Nanoparticles

Ranjeeta Chatterjee[1], Lalita Rane[2], Poonam Wani[2], Neena Seth Pajni[3], Ayesha Shaikh[1], Rahul Jadhav[1], Mahima Gamot[2], Sayali Gawade[1]

[1]Department of Zoology, Prof. Ramkrishna More ACS College, Akurdi, Pune, Maharashtra.
[2]Department of Physics, Prof. Ramkrishna More ACS College, Akurdi, Pune, Maharashtra.
[3]Principal, Gobindgarh Public College, Alour, Khanna, Ludhiana, Punjab.

ABSTRACT

To minimize the greenhouse emission and to prevent depletion of fossil fuels, there is a need of green fuel. Biofuel could be used as an alternative to traditional fossil fuels to be used in various applications including transportation, heating, and electricity generation. The biofuel is a type of fuel derived from renewable biological resources such as plants, crops, algae, or animal fats. Biodiesel is one of the biofuels, which represents a viable solution as it is derived from renewable biological resources such as vegetable oils, animal fats, or recycled cooking oil. The production process of biodiesel involves transesterification of vegetable oils or animal fats, using methanol and a catalyst. In the present work, the biodiesel was produced from the wastes of fish (viscera), poultry (skin and viscera) and slaughterhouse (skin and viscera of goat). In conventional method, vegetable oil or animal fat are used for biodiesel production, which are edible and consumed by human. In this present work, all ingredients used are wastes and are usually thrown, which causes environmental hazards. Instead of methanol, bioethanol was used for transesterification, which has been derived from agricultural wastes. The crude biodiesel produced from the animal wastes were found to be viscous, as goat waste> poultry waste> fish waste. To minimize the viscosity of the biodiesels, TiO_2 nanoparticles were used. The efficacy of the biodiesel shown was poultry> goat> fish. The biodiesel can be used directly as a substitute or blended with petroleum diesel in various proportions, depending on the desired fuel characteristics and local regulations.

Keywords: Biofuel, Biodiesel, fish wastes, poultry wastes, slaughterhouse wastes, TiO_2 nanoparticle, transesterification.

G-014

Investigation on transport properties of nano ferromagnetic M-type Sr-Hexaferrite

Deep N. Chandrani* and Ashish R. Tanna

Department of Physics, School of Science, RK University, Rajkot-360020, Gujarat, India

**Corresponding author: deepchandrani1796@gmail.com*

Abstract

The strontium hexaferrite nanoparticles are synthesized by the solution combustion route. The X-ray spectrum and Rietveld refinement confirms M-type $SrFe_{12}O_{19}$ having a space group of P63/mmc with a secondary phase of α-Fe_2O_3. FE-SEM displays the regular hexagonal platelet formation. Transmission electron microscopy of the sample shows good crystallinity as the grain size calculation assists with XRD and FE-SEM results. UV-Vis DRS gives the optical energy band gap of nano-hexaferrite. TGA demonstrates the thermal analysis and weight loss of the calcined and as-prepared sample. FT-IR is used for calculating force constant, bond length, stiffness constant, elastic moduli, and functional group present whereas Raman spectra confirm that all the peaks in the prepared material correspond to vibration modes and M-type structure formation. The magnetic properties are investigated by VSM and ESR at room temperature enabling less coercivity and high saturation magnetization that agree with the measurement of g-value. The electric transport, impedance, and dielectric studies are done as a function of frequency. The dielectric constant, tangent loss, and dielectric loss decrease with frequency although conductivity upsurges. The imaginary electric modulus spectra fitting of the peak gives a stretching exponential factor (β) calculated using Kohlrausch–Williams–Watts function for the first time making it a suitable material for high-frequency microwave absorption devices.

Keywords: *M-type hexaferrite, solution combustion, Kohlrausch–Williams–Watts function, stiffness constant, Raman spectra, ferromagnetic nanoparticle*

G-015

Terahertz Time-Domain Spectroscopy of Mixed-Phase TiO_2 Thin Film

Guruvandra Singh[1,2], Subhash Nimanpure[3], Preetam Singh[1,2], Shovon Pal[4], Mukesh Jewariya*[1,2]

[1]*CSIR-National Physical Laboratory, Dr. K.S. Krishnan Marg, New Delhi-110012, India.*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India.*
[3]*USAR, GGSIP University, East Campus, Surajmal Vihar Delhi-110092.*
[4]*School of Physical Sciences, NISER, Bhubaneshwar, Odisha-752050, India*
Email: guruvandramrt@gmail.com, jewariya.mukesh@nplindia.org

Metal oxide nanomaterials have great importance for developing next-generation devices in terahertz frequency regimes because nanomaterials have a large volume to the surface area and are used for efficient charge carrier transfer. Terahertz time-domain spectroscopy has been used to investigate the frequency-dependent absorption coefficient of mixed-phase TiO_2 thin film fabricated using an in-house developed magnetron sputtering method on a P-type Si substrate. The developed thin film was examined using TDS in transmission mode at room temperature in the range of 0.1 to 3.0 terahertz frequency band and we have observed lower (<1THz) and higher frequency (>1THz) side absorption coefficient values. Our result demonstrated that the mixed-phase TiO_2 thin film is sensitive to the THz frequency regime and can be used for developing optoelectronic devices for THz applications.

Keywords: TiO_2 thin film, THz Absorption, TDS Spectroscopy.

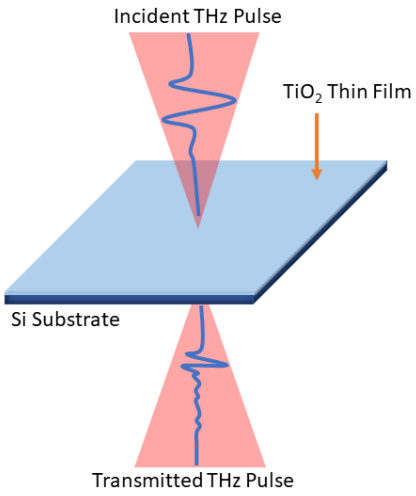


Fig.1. Schematic diagram of TiO_2 thin film on Si substrate and interaction of terahertz radiation with material, some radiation absorbed by thin film, and then THz radiation transmitted through the sample.

G-023

New generation multifunctional bio-polymer based ZnO/CuO nanostructured coating for the control of deterioration of cultural heritage

Sanhita Mandal[1], Karabi Das[1], Siddhartha Das[1]

[1]*Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur*

Sanhita12nov@gmail.com; Karabi.kgp@gmail.com; Sdas.iitkgp@gmail.com

Abstract

Environmental deterioration of historic heritage buildings and works of art has always been a major concern. An increase in natural weathering and anthropogenic activities are the major reasons for the deterioration of cultural heritage buildings and sculptures. In this context, our research will address the issue through the development of innovative and eco-friendly coatings. The proposed solution is to create hydrogel based coating by incorporating ZnO/CuO nanoparticles (NPs) into a chitosan hydrogel network. These ZnO/CuO nanoparticles establish a p-n junction that has excellent antibacterial and advanced photocatalytic properties for degrading inorganic and organic pollutants. The as-prepared NPs formulated via wet chemical precipitation route are characterized by X-ray Diffraction (XRD), Fourier Transform Infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Ultraviolet-Visible spectroscopy (UV-Vis) and Photoluminescence (PL). The photocatalytic property of the synthesized coating is tested by degrading two azo dyes. Additionally, the antibacterial property against gram negative and gram positive bacteria is established through the agar disc diffusion assay by estimating the size of zone of inhibition. The chitosan-based hydrogels are potential engineering scaffolds with advanced anti-microbial and biodegradable properties. The coating having gel-like consistency is ideal to apply on substrates using sprayer without leaving any residue. This hydrogel coating is prepared easily in lab and involves the mechanism of Schiff base condensation. The prepared nanoparticles-adorned hydrogel coating is finally applied on different substrates like granite, marble, and wood. Further, the durability of the coated substrates is carried out through prolonged sunlight exposure, submerging into rainwater and saltwater, photocatalytic dye degradation and antibacterial studies.

Keywords: Antibacterial, Chitosan-based hydrogel, Eco-friendly coating, Nanocomposite, Photocatalytic, Zone of Inhibition

G-025

CeO_2 -Reduced Graphene Oxide Nanocomposite for Display Application

H. J. Amith Yadav [1,*] , B. Eraiah [2] , M. N. Kalasad[1],Vijay Kumar R[1]

[1] *Department of Studies in Physics, Davangere University, Davangere 577007, India.*
[2] *Department of Physics, Bangalore University, Bangalore 560056, India.*
*Corresponding Author: amithyadavhj@gmail.com

Abstract

The hydrothermal method was used to prepare the CeO 2 -rGO composites. The prepared CeO2/rGO composites were subjected to powder X-ray diffraction (PXRD), Scanning Electron Microscopy (SEM), Field Emission Scanning Electron Microscopy (FESEM) , UV-Visible spectroscopic analysis, Photoluminescence study(PL). The observed. CIE results were consistent with an intense blue color (0.272947, 0.275369).

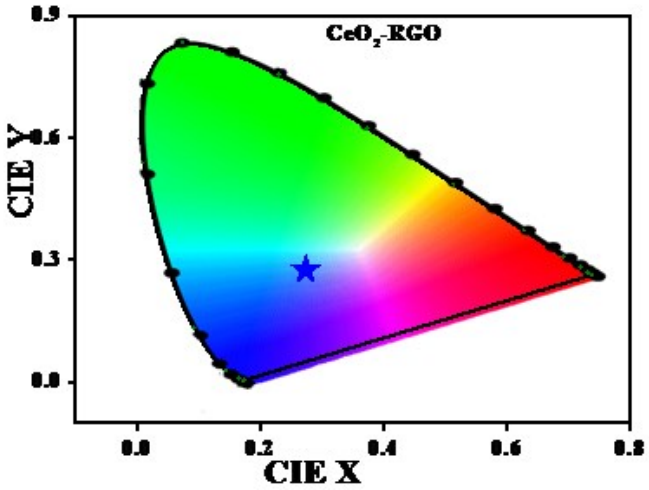


Fig : CIE diagrams of CeO_2-RGO NPs.

Abstract category : - H (Quantum materials and correlated systems)

H-001

Magnetic field induced interband emission energy in a group II-VI semimagnetic semiconductor quantum dot

P.Nalini[1] and A.John Peter[2*]

[1]*Dept.of Physics, Yadava College Govindarajan Campus,Thiruppalai, Madurai-625014.India*

[2]*Dept. of Physics, Govt.Arts and Science College, Melur-625 106. Madurai. India*

nalinimdu@yahoo.co.in and corresponding author* :a.john.peter@gmail.com

Among II-VI materials, the diluted magnetic semiconductor such as CdMnTe heterostructure has attracted much attention due to its potential application in electronic devices. Larger excitonic binding energy (around 10 meV), compared to that of GaAs material (5 meV), plays a vital role in opto-electronic devices to accomplish an efficient room temperature operation. Another interest in this system lies in the concept of incorporating the exchange phenomena among the magnetic ions. The study of sp^3-d interaction of electrons and holes with Mn ions in CdMnTe heterostructures is imperative as the addition of magnetic impurities alters the magneto-optical properties. With different small concentration of Mn ions in CdMnTe heterostructures, making one semiconductor on the surface of the other one, this diluted magnetic system is considered to be an ideal system due to small lattice mismatch [1]. In the present work, magnetic field induced exciton is investigated in a $Cd_{1-x_{in}}Mn_{x_{in}}Te/Cd_{1-x_{out}}Mn_{x_{out}}Te$ quantum dot with the inclusion of sp-d exchange interaction. The barrier height due to conduction band and valence band for various compositions of Mn ions with the application of magnetic field is studied. The barrier offset is determined due to the experimentally available critical magnetic fields. The binding energies of exciton with and without the application of magnetic field taking into account the geometrical confinement. Spin polaronic shift as a function of dot radius is estimated using the mean field approximation for different Mn ions. The interband emission energy as a function of dot radius is investigated in the presence of magnetic field. It is found that the exciton binding energy and the related interband emission energy are influenced much more with the geometrical size and the external magnetic field [2]. It is hoped that the obtained results will be useful for some potential applications in device fabrications such as magneto-optical and photonic devices and the spin manipulation will be concentrated in the spin induced heterostructures for spin based quantum information processing in near future.

References

1. Mnasri et al., J.Nanosci. Nanotech. 12/11 (2012) 8791.
2. Terletskii, et al.. Phys.Stat.Solidi C, 14 (2017) 1700124.

H-002

Bottom-up "meets" Top-down: Observation of the Dual Process in the Synthesis of MoS_2 Quantum Dots through Colloidal Route

Geetika Sahu[1*], Chanchal Chakraborty[2], Subhadeep Roy[1] and Souri Banerjee[1]
[1] *Dept of Physics, BITS Pilani Hyderabad Campus, Secunderabad, Telangana 500078, India.*
[2] *Dept of Chemistry, BITS Pilani Hyderabad Campus, Secunderabad, Telangana 500078, India.*
Email: *p20210061@hyderabad.bits-pilani.ac.in

The article aims to study a systematic evolution of quantum dots (QD) to address the long-standing issue of size uniformity. We have reported a noble trend that shows both growth (at a small-time scale, < 14hr) and reduction (at a large time scale, > 14hr) of Molybdenum disulfide QD-size by considering 'reaction time' as our controlling parameter during the hydrothermal reaction. We hypothesize that QDs in this study are evolving both by bottom-up and top-down approaches where the former shows seeding, nucleation, growth, and sheet formation (through aggregation) while the latter leads to sheet fragmentation. Our hypothesis is supported by STEM images of QDs and sheets, fluorescence spectra, and bandgap calculation (Tauc plot). The sheet formation, at a small-time scale, shows a compact nature which later (10hr) turns to a fractal behavior producing a lower fractal dimension that finally saturates around 1.82 at a larger time (> 18hr).

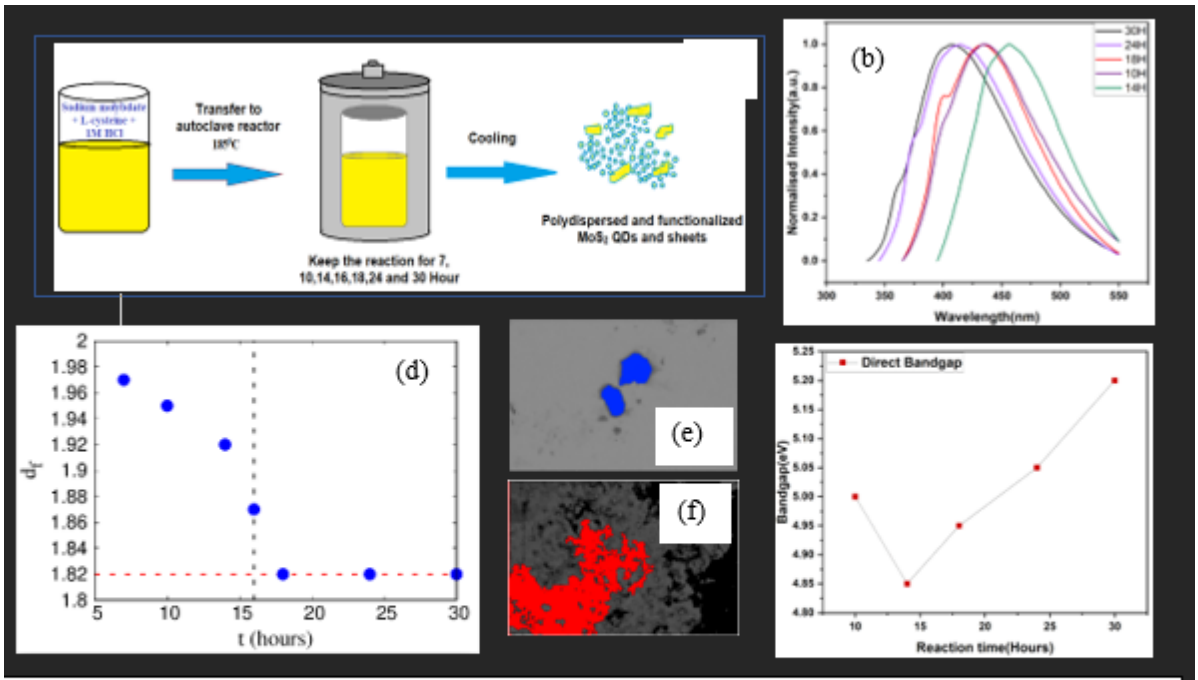


Figure 1: ***(a)*** *Schematics for the reaction set-up.* ***(b)*** *Peak shift in the PL Spectra: red shift until 14hr when the size of the dots increases and blue shift afterward.* ***(c)*** *Bandgap variation with different reaction time: lower the band gap larger the size of the QDs.* ***(d)*** *Decrease in fractal dimension with increasing time. Vertical dotted line shows the initiation of sheet fragmentation.* ***(e)-(f)*** *Structure of a typical QD sheet at 7hr and 30hr respectively.*

H-003

A study of Exchange Bias effect in Fe_3O_4@MnO Core shell Hetero nanostructures

Subodh Khamari and Niharika Mohapatra
School of Basic Sciences,
Indian Institute of Technology Bhubaneswar- 752050, Odisha, India
*Email:*sk75@iitbbs.ac.in, niharika@iitbbs.ac.in

Abstract:
The core shell hetero nanostructures involving spinel ferrites have drawn significant attention in various applications including the development of gas sensors, memory devices, bio medicine, photo catalyst and electrodes. In this study, we have adopted a straight forward one step hydrothermal technique to synthesize Fe_3O_4@MnO core shell hetero nanostructures. The structure and morphology of the heterostructures were characterized by X ray Diffraction (XRD), X-Ray photo electron spectroscopy (XPS) and field emission scanning electron microscope (FESEM). The results of bulk magnetic measurements of the prepared core shell structures indicate the ferrimagnetic behavior at low temperature. The interfacial coupling of synthesized heterostructures was evaluated by the observation of the exchange bias effect under FC protocols, which was demonstrated by a large shifting in magnetization in favor of positive/negative applied field-axis relative to ZFC magnetization curve.
Key words: Hydrothermal method, Core shell hetero structure, interfacial coupling, and Exchange Bias effect.

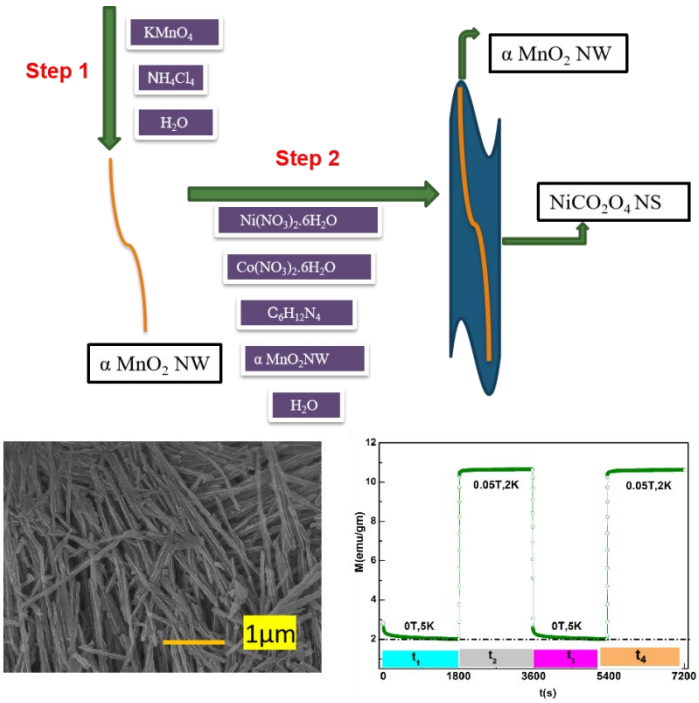
H-004

A study of Magnetism and Memory effect on α-MnO_2@$NiCo_2O_4$ Core-shell system

Laxmipriya Sahoo and Niharika Mohapatra
Department of Physics, school of Basic Science , Indian Institute of Technology Bhubaneswar, India
Email id: ls14@iitbbs.ac.in, niharika@iitbbs.ac.in

Abstract:
Nanomaterials have been the subject of intense research due to their wide applications in various fields, such as catalysis, electrochemical super-capacitors, electronics, biomedical, nanotechnology and photonics. Here we present the physical properties of hierarchical α-MnO_2@$NiCo_2O_4$ core-shell nanostructures, synthesized by a two-step hydrothermal process. This core-shell structure is composed of one-dimensional α-MnO_2 nanowires with uniformly covered by $NiCo_2O_4$ nanosheets. While the XRD patterns is concomitant with the presence of the two phases, and the morphology of the structure is confirmed by SEM/EDX study. FTIR measurement results give an idea about the vibration and bond formation of the samples. Also, optical properties of the samples are examined using UV-visible spectroscopy. Herein, we report for the first time, the magnetic study of these core-shell nanostructures. The results of our magnetic measurements suggest super-paramagnetic type behaviour. We also find the samples do exhibit memory effects at low temperature; while the strength of the memory effect is interpreted in terms of the depth of the memory dip.

Keywords:
Core-shell, Hydrothermal method, Memory effect, Super-paramagnetic, Memory dip



H-005

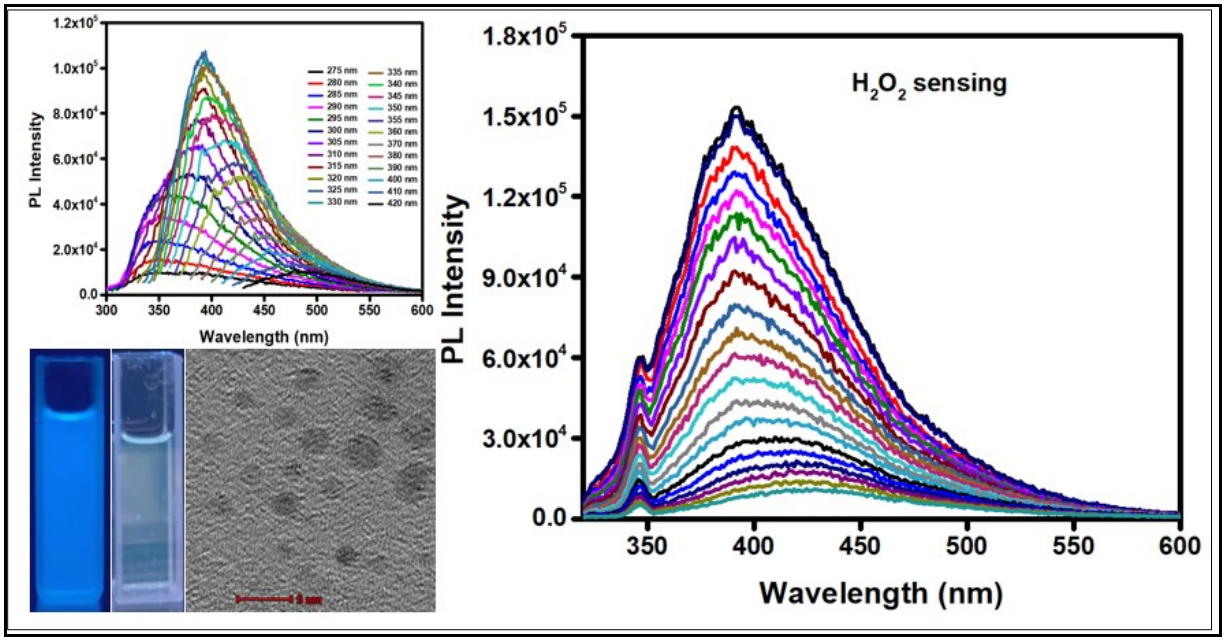
Optical and Structural studies of WSe_2 Quantum Dots synthesised via hydrothermal route for sensing of H_2O_2

Aryan, Mohan Singh Mehata*

Laser-Spectroscopy Laboratory, Department of Applied Physics, Delhi Technological University, Bawana Road, Delhi 110042, India

E-mail address: aaryanchoudhary1610@gmail.com, msmehata@gmail.com

WSe_2 has a two-dimensional lattice structure which provides better optical and electrical properties. In this work WSe_2 quantum dots were synthesised using a hydrothermal process without the use of any capping agent. The TEM images show the presence of WSe_2 quantum dots and under a UV- lamp of wavelength 365 nm blue emission was observed. The absorption peaks lie at 350 nm and 270 nm and the corresponding photoluminescence (PL) spectra were observed for an excitation wavelength range of 275 nm to 420 nm. The Pl intensity first increases with an excitation wavelength and then decreases. The shift in emission peak was observed which is due to the polydispersity of QDs. The synthesised QDs were used for H_2O_2 sensing in water, and the quenching of PL intensity was observed with increasing concentration. Thus, the fluorescent WSe_2 QDs having significant emission quantum yield can detect H_2O_2 in an aqueous environment, which will be further used for biological applications.



H-011

Green synthesised Carbon Quantum Dots for Fluorescent Hydrogen peroxide sensor

Videsh Kumar[a], A.S Rao[a]

[a]*Department of Applied Physics, Delhi Technological University, New Delhi -110042*

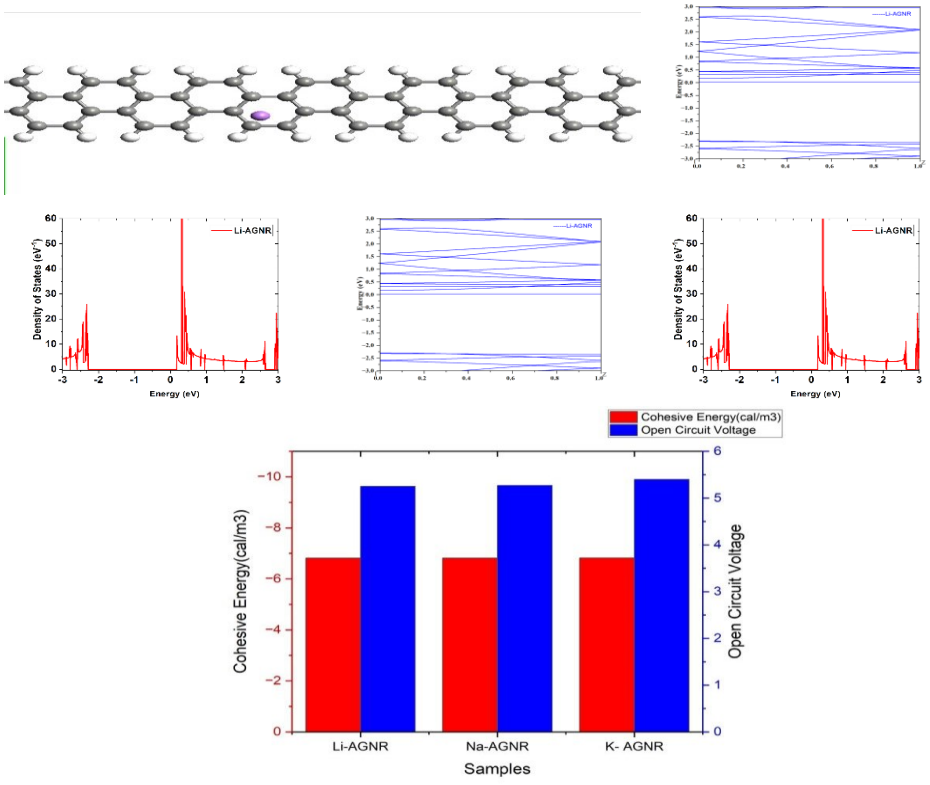
Abstract: Carbon quantum dots (CQDs) were synthesised using fresh leaves of *Wadilia* plant leaves. The pH of the synthesis was controlled at 6 pH for uniform morphology and ligand QDs surface interaction, and the reaction was controlled at 200 degrees for 8 hours. The uniform CQDs were confirmed using HRTEM images of CQDs with an average particle size of 3 nm. UV/VIS absorption spectra have peaks at 281 nm and one hump at 328 nm. This peak signifies the π-π* transition of the C=C bond. From absorption, the broad absorption suggests the Photoluminescence (PL) will be in the range of 290 nm to 400 nm. The PL spectra were recorded in the range with a step size of 10 nm and it was observed that with increasing excitation wavelength the emission intensity increases and the maximum emission was observed at 465 nm for the excitation wavelength of 370 nm. This behaviour of CQDs is due to the polydispersity of QDs. The CQDs were used for MB dye degradation, and almost 92% of the dye was degraded in 1 hour with the help of $NaBH_4$. The CQDs exhibit good emission properties, high stability, and excitation-independent emission behaviour. This study reduces the use of hazardous chemicals for CQDs synthesis and will be helpful for wastewater treatment and the removal of dye in an aqueous medium.

H-012

Mono Alkali(Li, Na, K) Ion Adsorption On Armchair Graphene Nanoribbion For Batteries

Himanshu Pundir[1], Sukhbir Singh[1] and Preetika Sharma [1*]
[1] UIET, Panjab University, Chandigarh
*Corresponding author :preetika.uiet@gmail.com

Graphite, a very common anode material in batteries paved way to high energy density and safety. However, due to new materials, battery size became a dominant feature. Hence, in this paper, AGNR as an anode material with alkali metal (Li, Na and K) ion adsorption is investigated. The high cost and flammable nature of lithium suggests the use of other alkali metals such as Na and K. It is found that Na and K could replace the lithium in batteries. Using DFT, band gap opening, cohesive energy, binding energy of each single ion, type of reaction produced, open circuit voltage and theoretical capacity are calculated. The results suggests that Na ion adsorption can provide affordability and fast charging to the battery whereas the K ion adsorption on AGNR improves the safety and enhance ion transport. Further, modifications in electrodes are also discussed to open up new avenues for battery applications.



Abstract category : - I (Sensors and actuators)

I-001

Bulk Acoustic Wave (BAW) Resonator Based MEMS Magnetic Field Sensor

Vinita[a,b], Jitendra Singh[a,b*]

[a] *Semiconductor Sensors and Microsystems Group, CSIR-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani 333031, India*

[b] *Academy for Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India*

Abstract— This paper experimentally demonstrates a MEMS magnetic field sensor which is working at ~ 0.873 GHz resonant frequency. The Bulk Acoustic Wave (BAW) resonators are most suitable for high frequency (GHz) operation and therefore appropriate for high sensitivity magnetic field sensors. The sensor has a multilayer stack of ($Si/SiO_2/Pt/ZnO/Fe_{65}Co_{35}$) thin films with $Fe_{65}Co_{35}$ as a magnetic field sensing layer and zinc oxide (ZnO) as piezoelectric actuation layer. The influence of an external applied magnetic field up to 1847 Oe has been investigated in terms resonance frequency shift due to ΔE-effect. The magnetic sensor shows sensitivity (S) of 4.26 kHz/Oe with outstanding performance at high frequency and large magnetic field range (0 ~ 2000) Oe. The realized MEMS magnetic field sensors is miniaturized, highly sensitive and can find applications is automobiles, military, robotics, medical devices, space equipment's, geophysics and industrial measurements.

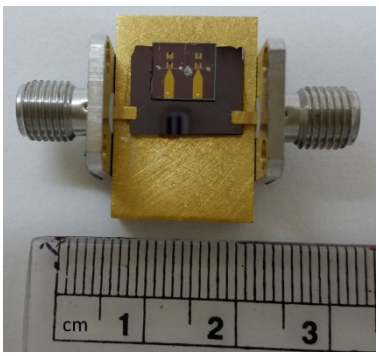


Figure. 1: Fabricated BAW based magnetic field sensor

I-002

Solidly Mounted BAW Resonator as Ozone Sensor

Abstract— In this paper a highly sensitive Solidly Acoustic Resonator (SMR) based on ZnO piezoelectric material and operating at a frequency of 4.02838 GHz is used as ozone gas sensor. Ozone gas selective material; Indium Tin Oxide (ITO) is used as ozone sensing material on the top electrode of resonator. Proposed SMR encapsulates (Mo/ZnO/MO/Bragg Mirror/SiO_2/Si) responds under mass loading effect as change in resonant frequency caused by the increased density of ITO due to ozone gas absorption of varying percentage. The proposed sensor device obtains maximum sensitivity of 200Hz/ppb on 50 ppb ozone gas adsorption. The simulated device with 1500 as quality factor and 6.49% coupling factor holds great promise for ozone gas detection in high sensitivity at room temperature. The behaviour of sensor is analysed using Finite Element Modeling. In addition to it optimisation of Bragg couples is also done in terms of reflectivity and transmissivity.

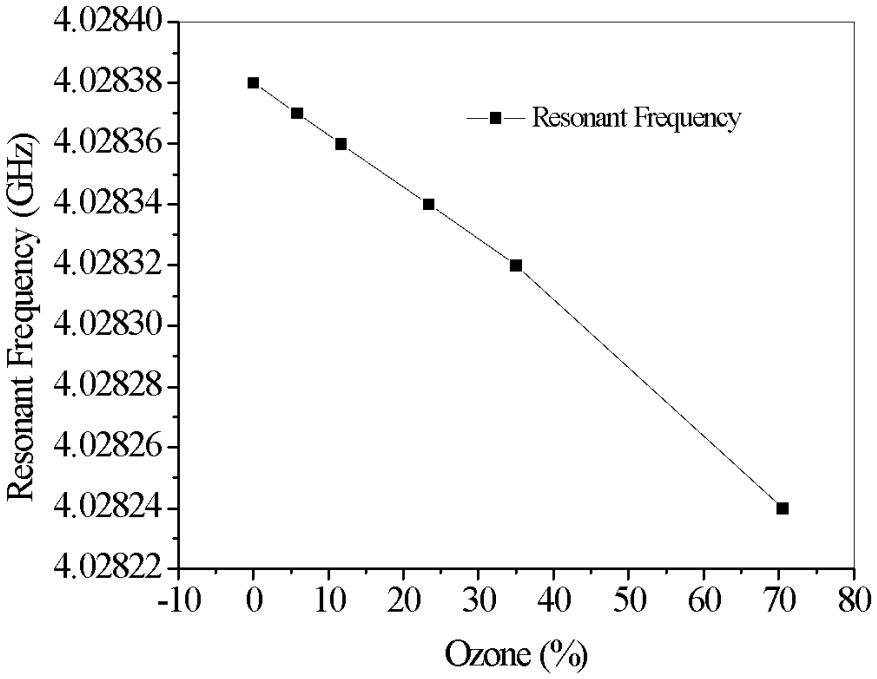


Fig. 1. Resonator response with varying ozone concentration

I-003

Tactile Sensor based on 3D-Graphene Aerogels

Prabhat Kumar*, Martin Šilhavík, Zahid Ali Zafar, and Jiří Červenka
Department of Thin Films and Nanostructures, FZU Institute of Physics of the Czech Academy of Sciences, Prague 16200, Czech Republic
*kumarp@fzu.cz

Abstract

A wide range and fast response tactile sensor using a conductive and flexible 3D graphene aerogel is demonstrated. The sensor can detect small pressures/strains and various biological signals from the movement of human skin. The sensor's active element comprises a 3D graphene nanoporous framework made of graphene sheets separated with air-filled pores. The 3D graphene aerogel is synthesized using a simple hydrothermal technique followed by freeze-drying and high-temperature thermal annealing. The resulting graphene aerogel is highly elastic. It is found that the contact resistance between the 3D graphene and metal electrode is highly sensitive to applied stimuli, enabling the detection of small changes of the sample size down to a few micrometers. Furthermore, the responsivity of the samples allows detecting fast events down to a few milliseconds and independent from temperature. We show that the sensors can be used as wearable electronics for human-machine interfaces and soft robotics applications.

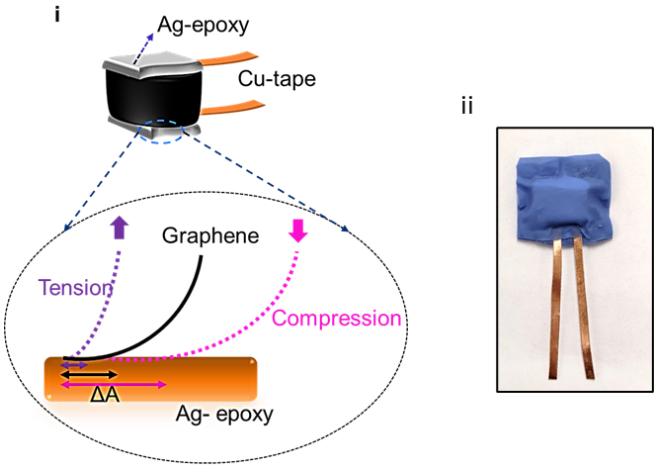


Figure: (i) Schematic illustrations of the GA-based sensor depicting a change in the contact area (ΔA) between elastic graphene walls and silver epoxy contacts caused by compressive and tensile stress. (ii) Actual photograph of a tactile sensor.

I-004

Illuminating Disease Detection with 2D Photonic Crystals

Ramya Anbumuthu[1], Sangeetha. R. G[2*]
[1]*School of Advanced Sciences, VIT Chennai*
[2] *Division of Electronics and Communication Engineering, SENSE, VIT Chennai*
*Corresponding Author Email: sangeetha.rg@vit.ac.in

In bio-sensing, photonic sensing technology is an emerging technology that provides accurate measurements. This paper furnishes a 2D photonic crystal biosensor for detecting dengue disease through the unique refractive index of blood. It is designed to operate at a wavelength between 1.5-1.6µm and utilizes the finite-difference time-domain (FDTD) method for simulation. Also, band gap calculation is performed using the plane wave expansion method. The biosensor's quality factor, transmission efficiency, and sensitivity are observed. The results of the simulation show that the biosensor is highly sensitive and can detect the presence of dengue virus in the blood sample with high accuracy. This research signifies the potential of photonic crystals for developing highly sensitive and accurate biosensors for disease detection.

Key Words: Biosensor, Dengue, Photonic crystal, Refractive index, FDTD

I-007

Mixed Phase of V_xO_y for Sensing Applications

Anchal Rana, Abhimanyu Singh Rana*

Centre for Advanced Materials and Devices, School of Engineering and Technology, BML Munjal University, Sidhrawali, Gurugram-122413, Haryana, India

Email address: anchal.rana.20pd@bmu.edu.in, abhimanyu.rana@bmu.edu.in

Vanadium-based oxide shows tremendous properties due to its multiple oxidation states (+2 to +5). It typically occurs in the Magneil and Wadsley phases. The material's optical and electronic properties undergo a fascinating transformation in these phases. In addition, many vanadium-based oxides exhibit a metal-insulating transition (MIT). In this study, we reported amorphous mixed phases of vanadium oxide (V_7O_{16}+ V_2O_5) deposited using the cathodic arc deposition technique and through a post-annealing process, a pure phase of V_2O_5 was achieved. X-ray diffraction and Raman spectroscopy confirmed the presence of these phases in the samples. The electrical properties of the samples were studied and show the metallic characteristics of the mixed phase, and the insulting behaviour of the pure phase of V_2O_5. We investigated the sensitivity of pure-phase and mixed-phase of V_xO_y thin films for sensing applications. We will present and discuss the above result.

I-008

Beneficial effect of tailoring of cupper valence states towards trace H_2S sensing using Li -Cu codoped ZnO

Subhajit Mojumder, Tanushri Das, Debdulal Saha, Mrinal Pal*
CSIR Central Glass and Ceramic Research Institute, 196, Raja S. C. Mullick Road, Jadavpur, Kolkata, 700032,
E-mail address (Corresponding author): palm@cgcri.res.in (M. Pal).

Hydrogen sulphide (H_2S) is a smelly hazardous gas, exposer to even low concentration for quite some time can creates several health problems and lead to death while concentration is higher. So, need of the moment is to fabricate a highly selective stable hand-held hydrogen sulphide (H_2S) gas sensor for the safety of our health. In the present study, multi-functional lithium and cupper codoped zinc oxide nanorods based chemiresistive sensor was fabricated which could selectively detect H_2S up to 1 ppm concentration with high sensitivity. Fabricated sensor also delineates good selectivity and long term stability (upto 10 months). Phase purity, crystallinity, morphology optical band gap, specific surface area and chemical composition of the synthesized material were characterized using XRD, Raman spectroscopy, FESEM, TEM, UV-Vis spectroscopy, BET, EDS and XPS. Tailoring of bivalency states in copper is creating elevated oxygen defects which can be attributed to enhancement of H_2S sensing.

I-010

Anodic ZnO Nanorods for Non-enzymatic Glucose Sensing

Niharika M.P, B. Manmadha Rao*

Department of Physics, VIT-AP University, Amaravati, A.P, India-522237

Submitting Author Email:niharika.21phd7003@vitap.ac.in ;Corresponding Author Email: rao.manmadha@vitap.ac.in or bmrphysics@gmail.com

A B S T R A C T

Diabetes is a prevalent yet serious illness that is becoming worse globally every year. To monitor glucose levels in blood, ZnO nanorods (ZNRs) as a bio-marker are fabricated using an electrochemical anodization technique. The fabricated ZNRs exhibited rough surface and are having length and diameters ~350 nm-4.1 μm and ~100-400 nm respectively. The sharp peak of XRD confirmed the high crystallinity of ZNRs with wurtzite structure. UV-visible absorption spectrum showed an absorption band at 375 nm. Electrochemical analyser is used to detect glucose. The fabricated ZNRs responded to glucose significantly for up to several mM and the limit of detection is found to be around 10 μM. We believe that this simple and low-cost fabrication technique enables large scale fabrication of ZnO nanorods based bio-markers for glucose sensing.

Keywords: ZnO nanorods, Glucose sensor, Bio-marker.

I-014

Simulation of Surface Acoustic Resonator with ZnO Sensing layer using COMSOL Multiphysics for gas sensor applications

Saurabh Kumar Gupta [1,*] and Jitendra Singh[1,2]

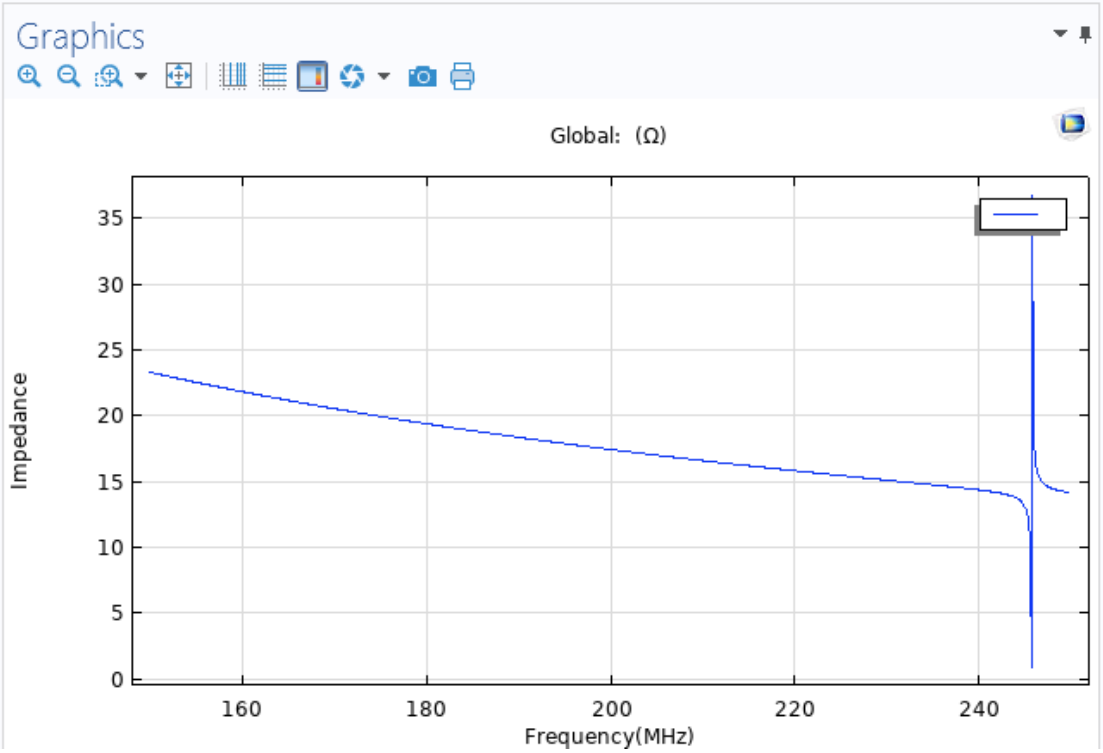
[1]*CSIR-Central Electronics Engineering Research Institute, Pilani, India*

[2]*Academy of Scientific and Innovative Research (Acsir), Ghaziabad, India*

*Corresponding and submitting author: saurabhgupta2197@gmail.com

ABSTRACT:

This work presents a SAW gas sensor working at different resonance frequencies. In this sensor, an interdigitated transducer is integrated on a piezoelectric substrate by etching process. The sensor has a thin sensing film embedded on it. There is a variation in the film mass due to the selective adsorption of a chemical substance present in air. As the film mass increases a resonance shift is observed to a slight lower frequency, giving information about the species amount in air. We have used COMSOL Multiphysics for the modelling and FEM simulation of SAW resonator. ZnO is the sensing layer and Quartz is used as piezoelectric layer. Impedance and Phase characteristics have been studied and plotted with frequency variation. This device finds its use in gas sensor applications.



I-017

Facile synthesis of photosensitive iron oxide nanorods and their application as UV photodetectors

Vrushali E. Kalokhe[a], Abha Mahajan[a], Sanju Rani[b], Rupali Nagar[a#]

[a]*Nanomaterials for Energy Applications Lab, Applied Science Department, Symbiosis Institute of Technology, Pune Campus, Symbiosis International (Deemed University), Lavale, Pune-412115, Maharashtra, India*

[b]*Department of Physics, SRM Institute of Science and Technology, Ramapuram Campus, Chennai 600089, Tamil Nadu, India*

Author email ID: vrushali.kalokhe.phd2021@sitpune.edu.in,

[#]Corresponding author email ID: rupali.nagar@sitpune.edu.in

Abstract:

Iron oxide nanorods (NRs) possess excellent optoelectronic properties leading to potential UV photodetector and other sensing applications. Here, a wet-chemical synthesis method was carried out with altered reaction conditions to investigate the physical and chemical properties of NRs. Remarkably, the nanorods exhibit distinct structural and morphological properties by altering reaction conditions. Transmission Electron Microscopic (TEM) analysis shows significant reduction in the NRs dimensions, ranging from approximately 43±6 nm to 15±4 nm by altering the synthesis steps. Magnetic Force Microscopic (MFM) studies confirm the magnetic nature of the samples with a magnetization degree of ~775°. A thin film of the as-synthesized samples was cast on the screen-printed electrodes for measuring the photocurrent in dark and UV illumination at 365 nm wavelength. The NRs exhibited a quick UV photo response of ~7 s and recovery of ~8 s at the minimal applied bias of 0.2V. As compared to the existing literature reports, this is the first time when undoped iron oxide has been used for photodetection applications. A facile synthesis method resulted in a material with impressive response and recovery times that can be improved further by material engineering. Stability tests are underway to check the robustness of the UV photodetector.

Results:

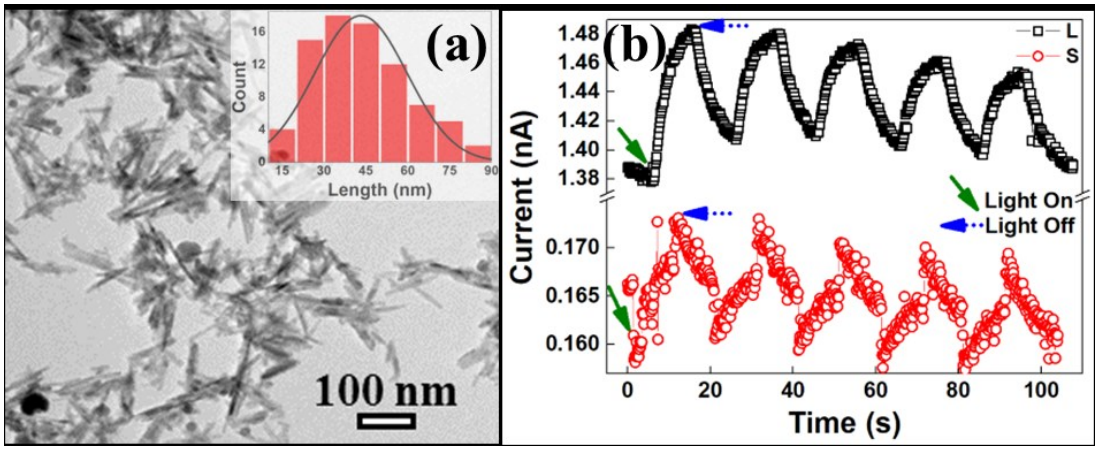


Fig.1. (a) TEM image with particle distribution, and (b) UV photodetector response of large length (L) and small length(S) Iron oxide NRs.

I-018

Enhanced Ammonia Sensing Performance of Zn Doped $BaFe_{12}O_{19}$ Nanoparticles-Based Sensor for Noninvasive Detection of Ammonia in Exhaled Breath of Patients with Renal Diseases

Tanushri Das, Subhajit Mojumder, Mrinal Pal*
CSIR- Central Glass and Ceramics Research Institute
Emails tanushridasphysics@gmail.com , palm@cgcri.res.in *

Chemiresistive gas sensor is the current area of interest of researchers as it offers most cost-effective and low-maintenance way for detection of various gases. Ammonia in human exhaled breath is a biomarker for renal diseases viz. kidney disorder, stomach infection caused by helicobacter pylori bacteria. Herein, Zn-doped barium hexaferrite nanoparticles based stable, ultrasensitive chemiresistive ammonia sensor has been fabricated for breath analysis. The highly selective sensor exhibited superior response (R_{gas}/R_{air}) of 15 to 5ppm ammonia at 250°C. The sensor exhibited rapid response/recovery time of 3s/40s and lower detection limit of 500ppb. The sensor was stable after long-term use for 90 days. Further study revealed that the enhanced ammonia sensing is attributed to promoted charge separation and increased oxygen defect on the surface. Moreover, simulated exhaled breath test showed plausible result by detecting sub-ppm level ammonia. The observations suggest that Zn-$BaFe_{12}O_{19}$ is a promising candidate for practical application as breath analyzer.

I-020

Development of non-enzymatic electrochemical glucose biosensor based on WO3 nanomaterial deposited on TiO2 nanotubes

Bittu Kumar[1], Sudip Kumar Sinha*[1]

[1] *Department of Metallurgical and Materials Engineering, National Institute of Technology, Raipur 492010, India*

*Corresponding author E-mail address: sksinha.mme@nitrr.ac.in

This study employed tungsten trioxide (WO3) nanomaterials (NMs) that were coated on TiO2 nanotubes (TNTs) to fabricate a non-enzymatic glucose biosensor that operates on the amperometric principle. TiO2 nanotubes were successfully synthesized on a Ti6Al4V alloy plate using the anodization technique. TiO2 nanotubes (TNTs) were decorated with WO3 nanomaterials (NMs) using the electrochemical deposition (ECD) technique. The nanohybrid composite (WO3@TNTs) was characterized by its structure and physical features using numerous methods, such as field emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), and energy-dispersive X-ray spectroscopy (EDS). The electrochemical and electrocatalytic properties of the samples were investigated with techniques including electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), and amperometry. The incorporation of WO3 nanoparticles into TNTs results in an electrode interface that exhibits heightened electrical conductivity, consequently providing it biocompatible and having a high degree of electrochemical activity. The hybrid electrode also demonstrated a rapid reaction time of 3 s, a low detection limit of (0.02-0.5mM), and high sensitivity of (1500-6000.41 A/mM/cm2). Excellent reproducibility, repeatability, and stability were shown by the sensors. With its impressive electrochemical capabilities, the non-enzymatic glucose biosensor has great promise for use in continuous glucose monitoring in the biomedical and healthcare sectors, among others.

Keywords: glucose, nanomaterials, electrochemical biosensors, non-enzymatic.

I-021

Investigation on Diamond Morphologies for the Enhancement of Gas Sensing Behavior of ZnO Nanorods

S. K. Ghadei[1,2,*], **K. J. Sankaran**[1,2], **R. Sakthivel**[1,2]
[1]*CSIR-Institute of Minerals and Materials Technology, Bhubaneswar-751003, India*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India*
Email: suryakanta.21@immt.res.in

Among all the gas-sensing semiconducting metal oxides, ZnO has attracted great attention due to its high sensitivity, chemical, and physical stability, nontoxicity, and abundance in raw materials. In order to achieve high sensitivity, quick response, and recovery time different ZnO nanostructures including nanorods, nanowires, and nanoflakes-based sensors are fabricated [1]. However, the assembly and integration of 1D nanomaterials into three-dimensional arrays or hierarchical structures of mechanically strong substrates are desirable for microelectronic devices. Diamond is an interesting substrate material with superior mechanical, thermal, and chemical stabilities [2]. Moreover, among various carbon allotropes, diamond-based materials are less explored for gas sensing.

In this work, we have fabricated ZnO hierarchical structures on diamond thin films of different morphologies and nanostructures, and their behavior toward gas sensing Diamond thin films were synthesized using microwave plasma chemical vapor deposition technique using optimizing conditions to achieve different morphologies and ZnO nanorods are grown hydrothermally. Different morphologies of diamond thin film result in a change in the size of grain boundaries. Moreover, the size of grain boundaries leads to changes in sp^3 and sp^2 content which is responsible for gas-sensing behavior.

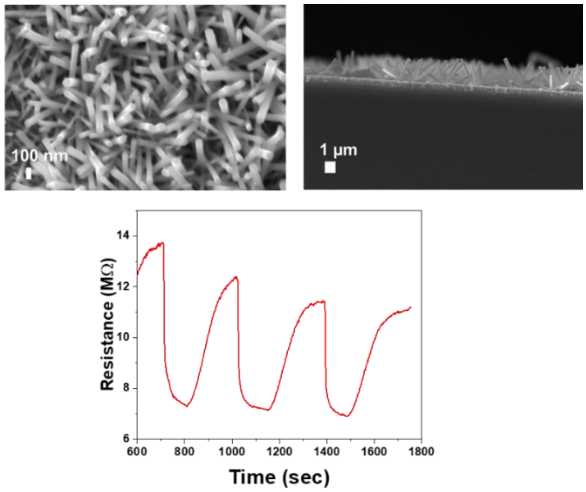


Figure 1. ZnO nanostructured diamond thin film and gas-sensing behavio

[1] Ma, S., Li, R., Lv, C., Xu, W., & Gou, X. (2011). Facile synthesis of ZnO nanorod arrays and hierarchical nanostructures for photocatalysis and gas sensor applications. Journal of hazardous materials, 192(2), 730-740.
[2] Araujo, D., Suzuki, M., Lloret, F., Alba, G., & Villar, P. (2021). Diamond for electronics: Materials, processing and devices. Materials, 14(22), 7081.

I-023

Electrochemical detection of biomarkers at a nanomaterial modified electrode surface

Charlin S, Arunkumar S, Kathiresan M and Subbiah A*
CSIR-Central Electrochemical Research Institute, Karaikudi-630 003, Tamil Nadu, India
*Corresponding Author: alwarappan@cecri.res.in

2D nanomaterials are extensively explored for applications in membranes, energy production/storage, tissue engineering, sensing, and in catalysis. 2D nanomaterials presents key advantages such as high anisotropy, effective surface area, mechanical strength, plasmonic, electron confinement, and optical properties. Further, 2D nanomaterials can be tuned to superconductors, semiconductors to insulators. Herein, we propose a novel electrochemical sensor based on 2D nanomaterials modified with metal-organic-framework based electrochemical platform for the rapid, selective and sensitive detection of the stress-markers epinephrine and nor-epinephrine. Epinephrine and Nor-epinephrine are considered as important catecholamine biomarkers that play a key role in the central nervous system of mammals. Abnormal levels of both these neurotransmitters is an indication of several stress related issues in mammals. Not only that, the surge or fall in the level of these neurotransmitters can lead to a variety of disorders such as cardiac pathologies, schizophrenia and Huntington's and Parkinson's diseases. Therefore, monitoring the level of these neurotransmitters remains vital. The proposed electrochemical method of detection is expected to outperform the existing methodologies such as capillary electrophoresis, flow injection analysis and photo kinetics in terms of cost effectiveness, speed, limit of detection and sensitivity.

I-024

Electrochemical and Optical biosensors based on Sulphur Doped Graphitic Carbon Nitride

Arunkumar Sakthivel and Subbiah Alwarappan *

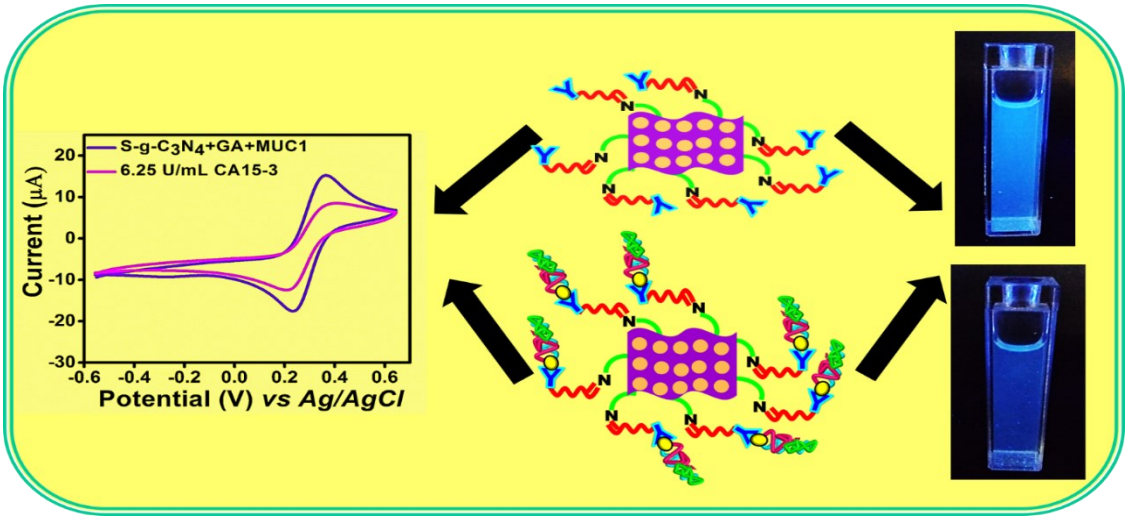
CSIR-Central Electrochemical Research Institute, Karaikudi,Tamilnadu.

Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201 002, India

Abstract

A dual biosensing platform operating through electrochemical and fluorescence mode for the cancer biomarker, CA15–3 detection is realized. Initially, sulphur doped graphitic carbon nitride nanosheets (S-g-C3N4) was obtained by a one step process. The presence of heteroatom (sulphur) in the molecular structure improved the optoelectronic properties and the surface functional group (–NH2) facilitated the covalent binding of antibodies. As a result, the selectivity was improved during the analysis. The proposed biosensing platform detected low concentration of the cancer biomarker, CA15–3 (2.9 U mL^{-1}) in human serum samples. Results evidenced the usefulness of this platform for clinical analysis and early disease diagnosis.

Keywords:S-g-C3N4, CA-153, electrochemical and fluorescence.



I-025

Nanocatalytic Interface to Decode the Phytovolatile Language for Latent Crop Diagnosis in Future Farms

Mahima Chandel, Vijayakumar Shanmugam*

The detection of volatiles released by plants during infection proves to be significant for early diagnosis of disease. The volatile viz., β-ionone, a cyclic antimicrobial compound, is released in multiple folds by CCD 1 expression, and non-enzymatic cleavage of carotene. This is triggered at the latent stage of biotic stress like bacterial leaf spot disease, caused by *Pseudomonas syringae*. Very recently metal oxide based chemoresistive sensors are found to substitute the conventional methods like GC-MS, PTR-MS, chemiluminescence for detection of volatiles. Here, SnO_2 based chemoresistive gas sensor for early diagnose of *P. syringae* infection has been attempted.[1] To our knowledge for the first time, volatile with multiple oxidation sites *i.e.* ionone (4 oxidation site) has been attempted for sensing to get maximum signal at minimum concentration. Further, platinum doped SnO_2 on interdigitated electrode enhances the sensitivity by favorable space charge layer and surface island formation for reactive interface site.

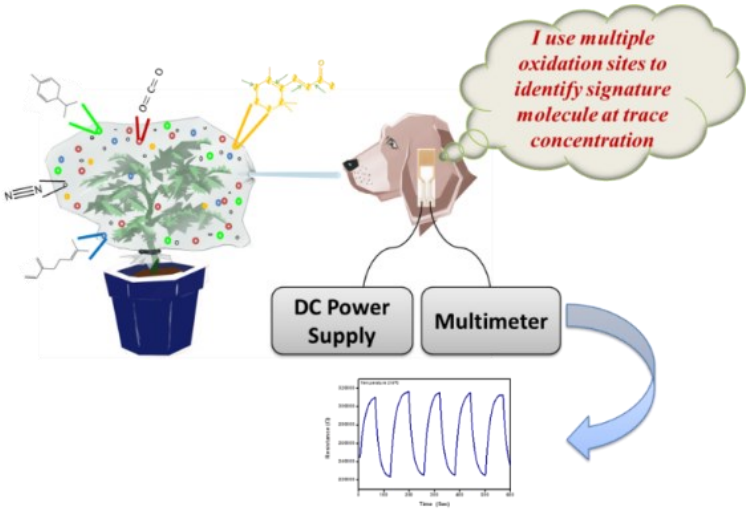


Figure 1. Sensing of plant volatiles through chemoresistive sensor

Reference

1. Chandel M. *et al.*, *Analytical Chemistry,* 94, **2022**, 11081–11088.

I-026

Onco-nanosensor for liquid biopsy-based cancer detection – Exosomes in circulation as biomarkers

Ashok Kumar Dhinakaran
Toronto Metropolitan University

Abstract:
The early and accurate diagnosis of cancer is crucial for effective treatment and improved patient outcomes. In recent years, exosomes have emerged as promising biomarkers for cancer detection. This research focuses on the development of Onco-nanosensor, a SERS-based nanosensor for cancer diagnosis utilizing peripheral exosomes as biomarkers. First, we have developed in-house fabrication methodology to manufacture onco-nanosensor by adopting a ultrashort pulsed laser ablation technique. The sensors offer high signal enhancement and diagnostic sensitivity. Second, we have developed a diagnostic algorithm using patient derived peripheral exosomes as training data to accurately detect and capture the cancer signatures in patient blood. We were able to successfully differentiate between 3 types of cancers and primary and metastatic cancer samples using the onco-nanosensor with high sensitivity and specificity.
Keywords: Nanosensor; Cancer diagnosis; machine learning; Exosomes; SERS

J-004

Interface study of Molybdenum Oxide thin films on n- and p-type crystalline silicon surface

Abhishek Kumar[1, 2], Vandana[2, 3], S K Srivastava[1,2] and Prathap Pathi[1,2, *]

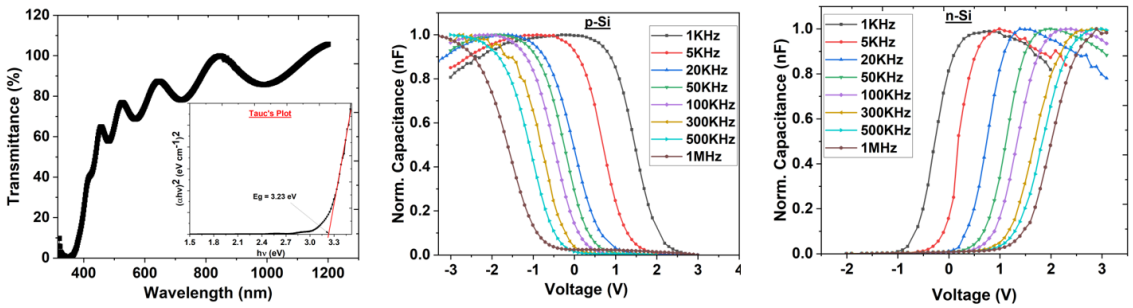
[1] PV Metrology Section, Advanced Materials and Devices Metrology Division, CSIR-National Physical Laboratory, New Delhi-12, India

[2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, UP- 201002, India

[3]Industrial Waste Utilization Nano & Biomaterials Division, CSIR-Advanced Materials and Processes Research Institute, Bhopal-462026

Corresponding author: prathap@nplindia.org Submitting author: abhishek.npl19a@acsir.res.in

In this study we are presenting the interface modulation of n- and p-type crystalline silicon with application of molybdenum oxide thin film for carrier selective layer. Sub-stoichiometric molybdenum oxide (MoO_X) thin films were grown on glass and n-Si and p-Si substrates by DC reactive sputtering with molybdenum target in pure $Ar+O_2$ gas ambient at room temperature for 20 minutes at 62W DC power. The optical properties were studied using UV-Vis-NIR spectroscopy. The optical transmittance more than 70% was observed in the visible spectrum and the band gap was found to be 3.23 eV for the MoOx thin film. The interface study was done using the capacitance voltage measurement of Al/MoOx/Si/Al structure at different frequency. Density of interface traps was found to be 6.30 x 10^{12} and 9.34 x 10^{11} cm^{-3} for n- and p-Si respectively. Barrier height of approx. 0.66 eV and 0.126 eV was calculated from $1/C^2$ vs V curve at 100kHz for n- and p-Si respectively. The current-voltage and capacitance-voltage results demonstrate a good rectifying characteristic such as enhanced barrier heights for its application as interfacial layers in silicon solar cells.



(a) (b) (c)

*Figure SEQ Figure * ARABIC 1. (a). Transmittance of MoOx thin film and the inset shows the band gap calculated from Tauc's plot, (b) C-V characteristics of MoOx/p-Si and (c) C-V characteristics of MoOx/n-Si at different frequencies.*

References:

[1] M. Gülnahar, H. Nasser, A. Salimi, and R. Turan, "On the electrical and charge conduction properties of thermally evaporated MoOx on n- and p-type crystalline silicon," *J. Mater. Sci. Mater. Electron.*, vol. 32, no. 1, pp. 1092–1104, 2021, doi: 10.1007/s10854-020-04884-5.

J-011

Efficient Perovskite Photodetectors based on Thiocyanate- Assisted Film Formation

Sneha Rana, Prachi Diwakar, Dr. Aditi Upadhyaya*

Department of Physical Sciences, Banasthali Vidyapith, Rajasthan-304022, India

Email: sneharana9897@gmail.com, prachi.diwakar100@gmail.com

*Email: upadhyaya.aditi@gmail.com

Abstract.

Metal halide perovskite nanoparticles have unique optical and electrical properties, which make them highly attractive for use in photodetectors. In this report, a solution process method was employed to fabricate perovskite thin films, and the addition of lead(II) thiocyanate was found to enhance photovoltaic performance. Specifically, lead(II) thiocyanate was found to promote the formation of perovskite thin films with larger crystalline grains and fewer defects. The surface morphology of the resulting perovskite thin films exhibited complete surface coverage with negligible pin-holes, indicating that the films were of high quality and free from agglomeration.

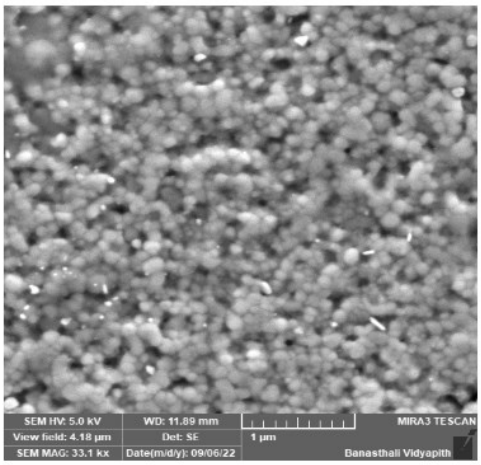


Figure 1. FESEM image of pure $CH_3NH_3PbI_3$ and $CH_3NH_3PbI_3$+Pb (SCN) $_2$ film

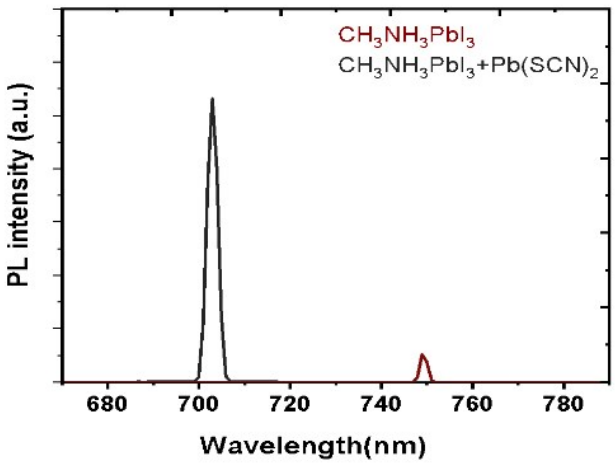


Figure 2. PL spectra of pure $CH_3NH_3PbI_3$ and $CH_3NH_3PbI_3$+Pb(SCN)$_2$ film

J-013

Unravelling the effect of soxhlet extracted *Pisolithus arrhizus fungi* in bio-sensitized solar cells in response to diverse polar solvents

Amutha Soosairaj[1], Ahalya Gunasekaran[2], Sambandam Anandan[2], Durga Prasad Pabba[3], Leo Rajesh Asirvatham[1,*]

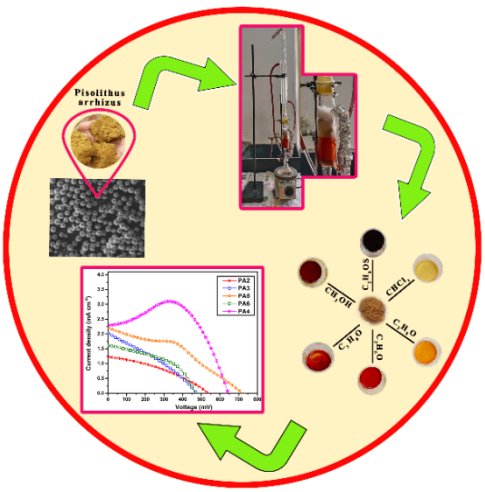
[1] *Department of Physics, St. Joseph's College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, 620002, India.*
[2] *Nanomaterials and Solar Energy Conversion Lab, Department of Chemistry, National Institute of Technology, Tiruchirappalli, 620 015, India.*
[3]*Departamento de Ingenieria Mecanica, Universidad Technologica Metropolitana, Santiago, Chile.*

Submitting author Email ID : amuthasoosaiscc@gmail.com
Corresponding author Email ID: aleorajesh@gmail.com

Abstract

The potential use of *Pisolithus arrhizus fungi* as an effective sensitizer in bio-sensitized solar cells is the first of its kind to investigate the photovoltaic capabilities of BSSCs. The soxhlet extraction method was employed to extract *Pisolithus arrhizus* dye molecules in different polar solvents including chloroform, 2-propanol, acetone, ethanol, methanol and DMSO, and coded as PA1, PA2, PA3, PA4, PA5 and PA6 respectively, to fabricate BSSCs. The structural, optical and morphological properties of the extracted dyes and dye-anchored TiO_2 films were analyzed through FTIR, UV-Vis spectroscopy, Fluorescence spectroscopy, SEM, EDAX and AFM analysis. The optical absorption spectra revealed the presence of flavonoid compounds in the chosen fungi. The current-voltage characteristics and electrochemical impedance spectroscopic analysis showed that PA4 (ethanolic-extracted) based BSSC exhibited a remarkable power conversion efficiency of 1.29% when compared to other solvent-based BSSCs in the descending order of PA5>PA3>PA6>PA2>PA1 with 0.70>0.405>0.32>0.27>0.0019% conversion efficiencies.

Diagrammatic representation



J-015

Graphene Oxide as an Effective Interface Passivation Layer for Organic Semiconductor-Silicon Hybrid Solar Cells

Ruchi K. Sharma[1,2], Avritti Srivastava[1,2] Anjali Saini[1,2], J.S. Tawale[3], Pathi Prathap[1,2], Sanjay K. Srivastava[1,2]*)*

[1]*Photovoltaic Metrology Section, Advanced Materials and Device Metrology Division, CSIR-National Physical Laboratory, New Delhi, 110012, India*

[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India*

[3]*Indian Reference Materials Division, CSIR-National Physical Laboratory, New Delhi 110012, India*

dwivedi.ruchi4312@gmail.com *srivassk@nplindia.org

Conjugated organic polymer-silicon (Si) hybrid solar cells (HSCs) using PEDOT:PSS as hole transport layer is quite promising owing to its low cost approach and potential for high efficiency. PEDOT:PSS/n-Si interface plays a vital role in the junction properties and it is essential to minimize the defects (recombination of charge carriers) at the interface for an efficient HSC. Here, graphene oxide (GO) synthesized by modified Hummer's method has been utilized as interface passivation layer between n-Si and PEDOT:PSS to address the recombination losses. The GO thin film was deposited via simple spin coating technique with an optimized spin speed of 4000 rpm followed by post-heat treatment at ~110 ℃ for 4 min. The minority carrier lifetime of n-Si was improved ~7 folds after applying thin GO layer (GO/n-Si/GO) (see fig.1). The HSC employing GO interlayer (see device structure in the inset of fig.1) could achieve the PCE as high as 11.03% with an absolute enhancement of 3.11% as compared to the device without GO interlayer (PCE; 7.92%). The enhancement in the device performance can be attributed to improved passivation due to GO interlayer having various oxygen functional groups. Thus, GO could be an effective interface passivation layer for future high-performance HSCs.

J-017

As-Deposited V_2O_x Thin Films by Thermal Evaporation: A Promising Carrier-Selective Layer for Silicon Heterojunction Solar Cells

Rajesh Kanakala[#], Narendra Bandaru[#,*], Rajesh Maurya, Jatindra Kumar Rath*

Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu - 600036, India

[#] - Equal contribution; * Corresponding authors: jkr@iitm.ac.in ; narendra.bandaru05@gmail.com

Abstract

This study investigates the use of as-deposited vanadium sub-oxide (V_2O_x) thin films as a carrier-selective layer in silicon heterojunction (SHJ) solar cells. V_2O_x thin films were deposited onto n-type crystalline silicon wafers and characterized for thickness variation, composition, carrier-selective properties, metal-semiconductor contacts, and surface topography. The smooth surface morphology of the as-deposited V_2O_x thin films (RMS roughness: 0.5 nm to 2.5 nm) is indeed advantageous for fabricating polycrystalline TCO films in SHJ solar cells. The results indicate that, even below 10 nm, we have achieved 302 µsec, which could be attributed to the low-charged defect density that leads to the low activation energies (i.e., 0.50 eV to 0.46 eV). This ensures field-effective passivation caused by a sub-stoichiometric SiO_x interlayer that forms when silicon bonds with oxygen. The findings of the lifetime mapping demonstrate that lifetimes are homogeneous, however locally low lifetime spots due to defects are encountered. Our data demonstrate that as-deposited V_2O_x thin films, even without further treatment, can be a replacement to the conventional carrier-selective layers in SHJ solar cells.

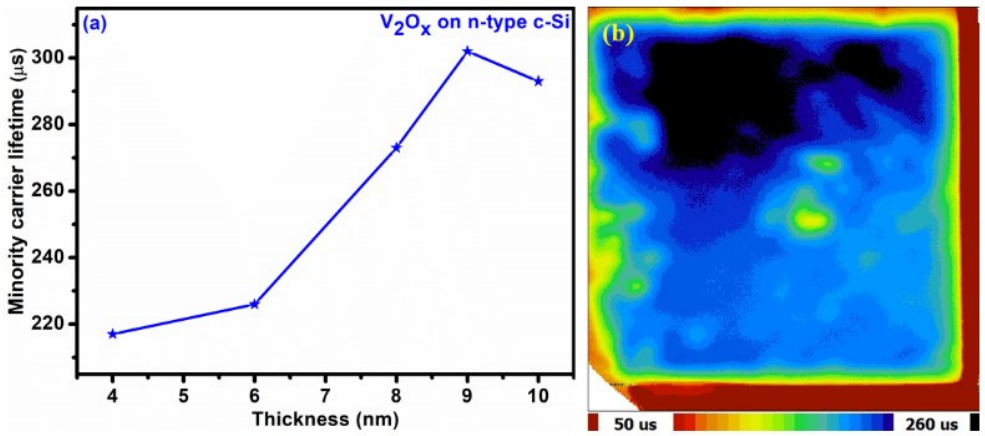


Figure 1. (a) Effective lifetimes (τ_{eff}) of the V_2O_x thin films deposited on n-type c-Si wafer substrates by varying the thickness from 4 nm to 10 nm and (b) Lifetime mapping of a 9 nm thick V_2O_x film.

J-019

Fabrication of efficient organic-silicon hybrid solar cell via tailoring the silicon surface properties and polymer layer thickness

Urvashi Punia[a,b] , Premshila Kumari[a,b], Ruchi K. Sharma[a,b], Subha Laxmi[a,b], Ritu Srivastava[a,b], Sanjay K. Srivastava[a,b)*]

[a]*Advanced Materials and Device Metrology Division, CSIR-National Physical Laboratory, New Delhi-110012, India*

[b]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India*

punia.urvashi11@gmail.com and *srivassk@nplindia.org

Organic-silicon (Si) hybrid solar cells (HSCs) have shown tremendous potential as an alternative low-cost technology. However, as-cut solar grade wafers, mostly used in photovoltaic industry, contain lot of saw-damages thus limiting their direct applications. Tailoring of Si surface properties and organic (PEDOT:PSS) layer thickness to find their inter-relationship for the efficient PEDOT:PSS/n-Si HSCs is very important. Therefore, the present study aims at carrying out effective surface conditioning of Si via acidic-etching to obtain damage free surface, with an optimal thicknesses of Si wafer and PEDOT:PSS layer for efficient PEDOT:PSS/n-Si HSCs. It was found that surface defects were minimized significantly for 4 min etching (Si thickness ~130 µm). Further, the thickness of the polymer layer was tailored as function of spin speed. The polymer thickness of 150±24 nm (corresponding to 800 rpm) resulted in the best power conversion efficiency of 8.79% for the HSCs primarily due to enhanced photocurrent density (as shown in Fig. 1). Also, surface reflectance and minority carrier lifetime (MCLT) results revealed the thickness dependent anti-reflection and passivation property of the polymer layer. The maximum MCLT of 23.55 µs was obtained for 400 rpm based polymer layer (thickness 250±30 nm) (inset of Fig. 1). Thus, the optimized conditions of Si surface conditioning and polymer layer thickness established in the present study may be useful for the development of efficient hybrid solar cells.

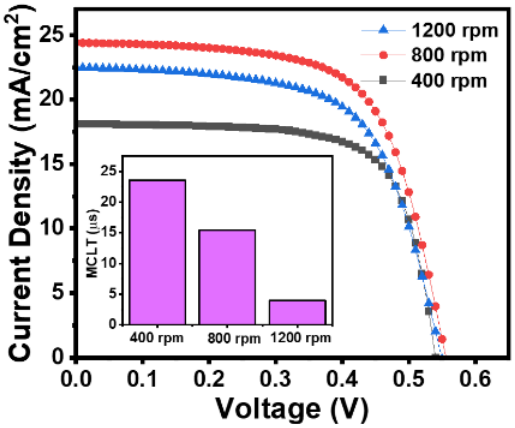


Figure 1. Illuminated J-V characteristics of the HSCs for different spin speed; MCLT results of the corresponding samples are shown in the inset.

J-020

Impact of minor modifications and its large effect on the morphology of lead free $AgBiI_x$ (x=4, 5, 7) perovskite thin films

Muthu Gomathy M. Pandian,[ab] Shanthi Subashchandran,*[b] Dhruba B. Khadka,[a] Yasuhiro Shirai,[a]

[a] *Photovoltaic Materials Group, Center for GREEN Research on Energy and Environmental Materials, National Institute for Materials Science (NIMS), 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan.*

[b] *Crystal Growth Centre, Anna University, Chennai-600025, Tamil Nadu, India.*

*sshanthi@annauniv.edu
*KHADKA.B.Dhruba@nims.go.jp

Abstract:
The methylammonium lead halide perovskites have become the leading photoactive semiconductors for solar cell applications, however, issues like chemical instability due to the organic materials and the lead toxicity still remains. Recently, silver bismuth iodide, $AgBiI_x$ perovskites replaced the former which makes the halide perovskite layer becomes stable non-toxic. We demonstrate the various concentration of $AgBiI_x$(x=4, 5, 7) in terms of understanding the comparison between those. This work reports the slight variations on the negligible things which shows big impact on the complete inorganic lead free AgBiI(4,5,7) perovskites. The photovoltaic conversion efficiency of the fabricated perovskite solar cells using $AgBiI_4$ showed improved results when compared to the devices with $AgBiI_5$ and $AgBiI_7$ perovskite layer. The minor modifications like rpm (rotations per minute), annealing time, anti-solvent dripping time and the amount of anti-solvent dripping time creates impact on the surface morphology of the perovskite layer effectively.

Keywords: Lead free perovskite, anti-solvent, annealing time, dripping

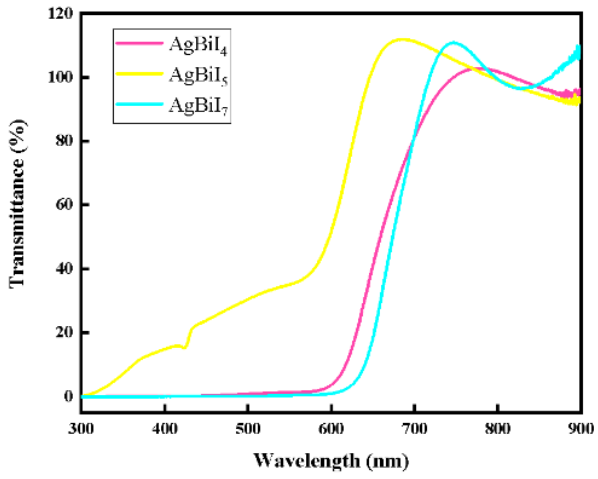


Fig. Transmittance graph of $AgBiI_4$, $AgBiI_5$ and $AgBiI_7$ perovskite thin films comparison.

J-021

Structural, microstructural, optical and vibrational studies on $Rb_3Sb_2I_9$ layered perovskite

Rakshitha H Ashwath, C. Sudakar
Multifunctional Materials Lab
Department of Physics, IIT Madras
ph20d028@smail.iitm.ac.in

Lead free perovskites are gaining significant importance in recent years due to their non-toxicity and stable nature unlike lead based perovskites. $A_3M_2X_9$ ($A=Cs^+$, Rb^+, $M=Sb^{3+}$, Bi^{3+} and $X=Cl^-$, I^- and Br^-) family of perovskites are promising as it is a non-toxic, stable compound with layered crystal structure. We synthesized micrometer-sized rhombus-shaped $Rb_3Sb_2I_9$ single crystals through precipitation method. XRD and elemental EDS analyses confirm the formation of phase pure compound. Bandgap of the compound is found to be 2.04 eV. $Rb_3Sb_2I_9$ crystals emit self-trapped excitonic (STE) emissions characterized by broad photoluminescence with large Stoke's shift. Vibrational and temperature dependent photoluminescence studies analyses reveal a strong electron-phonon coupling in this compound. This lead to strong STE emissions in $Rb_3Sb_2I_9$. These crystals exhibit exceptional stability under ambient conditions, exhibiting thermal stability up to 250 °C as evident from the thermogravimetry analysis. Suitability of these for solar cell and photodetector application are being explored.

J-023

Effect of Cuprous Oxide Nanocubes and Antimony Nanorods on the Performance of Silicon Nanowires Based Quasi Solid-state Solar Cell

Debanjan Maity[a], Partha Ghosal[b], Melepurath Deepa[a,*]

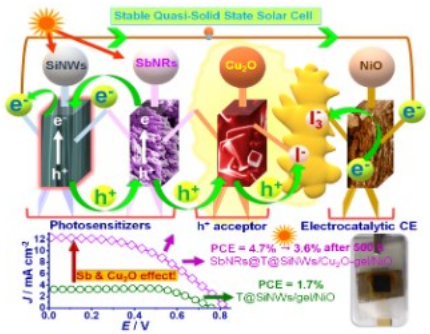
[a]*Indian institute of technology Hyderabad, India,*

[b]*Defence Metallurgical Research Laboratory, Defence Research & Development Organisation, India*

submitting author: cy19resch11009@iith.ac.in

corresponding author: mdeepa@chy.iith.ac.in

Abstract: Antimony nanorods (SbNRs) anchored to vertically aligned SiNWs serve as co-sensitizers and enhance the light absorption of NWs. The favorable position of valence band (VB) along with the p-type semiconducting nature of SbNRs allows fast hole extraction from SiNWs. A monolayer of N-[3-(trimethoxysilyl)propyl] aniline (TMSPA) protects the SiNWs from photo-corrosion. A quasi-solid state solar cell with a SbNRs@TMSPA@SiNWs photoanode connected to an electrocatalytic NiO counter electrode having a hole transporting p-type cuprous oxide nanocubes (Cu_2O NCs) dispersed in triiodide-iodide (I_3^-/I^-) redox couple based gel electrolyte showed a power conversion efficiency (PCE) of 4.7% (under AM 1.5G, 1 sun illumination). The solar cell also exhibits a noteworthy operational stability, for it endures 500 hours of continuous 1 sun illumination accompanied by a ~23.4% drop in its PCE. The solar cell having components with favorable energy level alignment, semiconducting/photoactive properties enable these materials to be used in other solar cells as well.



J-025

Evidence for the Band-Edge Exciton of $CuInS_2$ Nanocrystals Enables Record Efficient Large-Area Luminescent Solar Concentrators

Abhinav Anand[1]†, Matteo L Zaffalon[1], Graziella Gariano[2], Andrea Camellini[3], Marina Gandini[2], Rosaria Brescia[5], Chiara Capitani[1,2], Francesco Bruni[2], Valerio Pinchetti[1], Margherita Zavelani Rossi[3,4], Francesco Meinardi[1*], Scott A. Crooker[6] and Sergio Brovelli[1*]

[1]*Dipartimento di Scienza dei Materiali, Università degli studi di Milano-Bicocca, via Roberto Cozzi 55, I-20125 Milano, Italy*

[2] *Glass to Power SpA, Via Fortunato Zeni 8, I-38068 Rovereto, Italy*

[3]*Dipartimento di Energia, Politecnico di Milano, Via Ponzio 34/3, IT-20133 Milano, Italy*

[4] *IFN-CNR, Piazza Leonardo da Vinci 32, IT-20133 Milano, Italy*

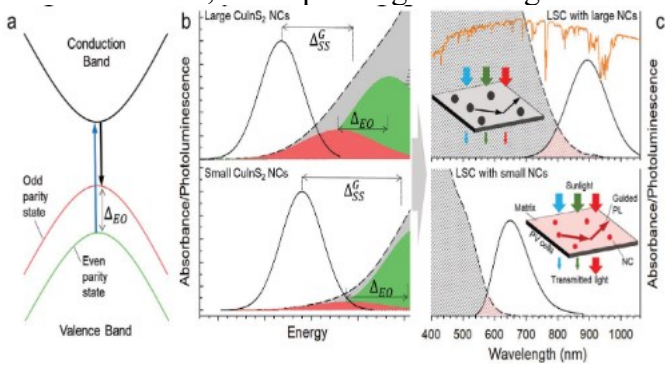
[5]*Istituto Italiano di Tecnologia, Via Morego 30, IT-16163 Genova, Italy*

[6]*National High Magnetic Field Laboratory, Los Alamos National Laboratory, Los Alamos, New Mexico 87545,United States*

† Vellore Institute of Technology, Vellore, 632007, India

abhinav.anand@vit.ac.in

Ternary I-III-VI_2 nanocrystals (NCs), such as $CuInS_2$, are receiving attention as heavy-metals free materials for solar cells, luminescent solar concentrators (LSCs), LEDs, and bio-imaging. The origin of the optical properties of $CuInS_2$ NCs are however not fully understood. A recent theoretical model [1] suggests that their characteristic Stokes-shifted and long-lived luminescence arises from the structure of the valence band (VB) and predicts distinctive optical behaviours in defect-free NCs. If confirmed, this would have crucial implications for LSCs as the solar spectral coverage ensured by low-bandgap NCs would be accompanied by increased. Here, by studying stoichiometric $CuInS_2$ NCs, it is revealed for the first time the spectroscopic signatures predicted for the free band-edge exciton, thus supporting the VB-structure model. At very low temperatures, the NCs also show dark-state emission likely originating from enhanced electron-hole spin interaction. The impact of the observed optical behaviours on LSCs is evaluated by Monte Carlo ray-tracing simulations. Based on the emerging device design guidelines, optical-grade large-area (30×30 cm^2) LSCs with optical power efficiency (OPE) as high as 6.8% are fabricated, corresponding to the highest value reported to date for large-area devices.



References

1. Shabaev, A., M.J. Mehl, and A.L. Efros, *Energy band structure of $CuInS_2$ and optical spectra of $CuInS_2$* nanocrystals. Physical Review B, **92**(3): p. 035431 (2015).

J-027

Highly textured (Ga, Mg) co-doped ZnO thin nanocrystalline thin films for optoelectronic applications

Aradhana Tiwari*, P. P. Sahay

Department of Physics, Motilal Nehru National Institute of Technology Allahabad, Prayagraj-211004, India

***Corresponding Author:** Email: aradhana.bindu@gmail.com; Contact No. 9453378828

Keywords: *(Ga, Mg) Co- doped ZnO thin films; spin coating technique; structural characteristics; optical properties*

ABSTRACT

(Ga, Mg) co-doped ZnO nanocrystalline thin films were produced on glass substrates by the spin-coating technique. The films were characterized for their structural and optical properties as a function of varying doping concentrations. As evident from Fig. 1, all the films are found to be highly textured along the (0 0 2) lattice plane possessing a ZnO hexagonal wurtzite crystal structure with crystallite sizes in the range of 28-49 nm. Upon doping and co-doping, the crystallinity (peak intensity) decreases owing to the formation of stresses in the films as the ionic radii of the zinc and dopants are different. The optical transparency in the visible region improves upon doping and co- doping and is maximum (> 95%) for the 1G3MZO film. The electrical conductivity of the film improves upon doping and co-doping with a maximum of 70.3 $(\Omega\text{-cm})^{-1}$ for the 1G3MZO film. The 1G3MZO film is best for the optoelectronic applications.[1]

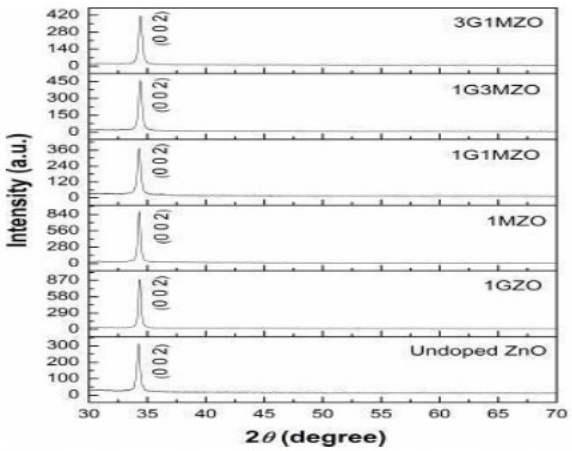


Fig.1: XRD pattern of undoped and co-doped ZnO thin films

References

[1] A. Tiwari and P.P. Sahay, *Opt. Mater*. **110**, 110395 (2020).

J-028

White Upconversion Luminescence of Pr^{3+}-Yb^{3+} ion co-doped *ex-situ* Sol-Gel Titania-Silicate Thin Film

Mrigankadeep Bharadwaj[1, 2], S. Rai[2], Ankita Gaur [1,*]

[3]*School of Energy Science & Technology, IIT Guwahati, Assam-785001, India*

[1]*Laser and Photonics Laboratory, Department of Physics, Mizoram University, Aizawl-796004, India*

submitting-mrigankadeepbharadwaj@gmail.com

[*]correspondence - ankitagaur@iitg.ac.in

Abstract: Herein, we demonstrate a novel ex-situ sol-gel synthesis route for Pr^{3+} and Yb^{3+} ion co-doped titania-silicate (STPY07) thin film (TF) on Si-substrate annealed at 900 C. The amorphous nature of thin film has been confirmed through x-ray diffraction (XRD) analysis. Field emission electron microscope (FETEM) coupled with energy dispersion spectrometer (EDS) reveals the formation of large size flaky and large cracks with inhomogeneous distribution throughout the coatings and presence of different doping elements (Si, Ti, Pr^{3+}, Yb^{3+} and O) respectively. The upconversion luminescence (UCL) spectra of STPYX-TF have been obtained by diode laser with excitation wavelength of 980 nm through transfer of energy from sensitizer (Yb^{3+}) ion to activator (Pr^{3+}) ions. The throughout spatially resolve PL mapping was observed via Photoluminescence (PL) confocal microscopy.

Keywords: Pr^{3+}-Yb^{3+} ion pair, titania-silicate, Thin film, *ex-situ* Sol-Gel, XRD spectra, FESEM, Upconversion, CIE chromaticity, PL mapping

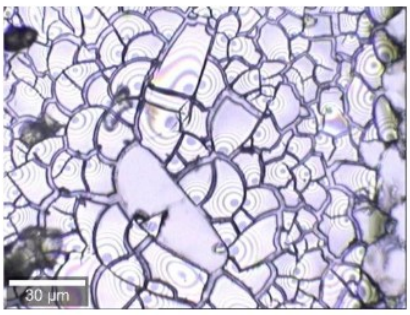


Figure 1: Photoluminescence (PL) confocal maping of the STPY07-TF sample annealed at 900 ºC

J-029

Development of $MAPbI_3$. H_2O and $MAPbI_3$ perovskite solar cells using TiO_2 and P3HT as charge transport layers

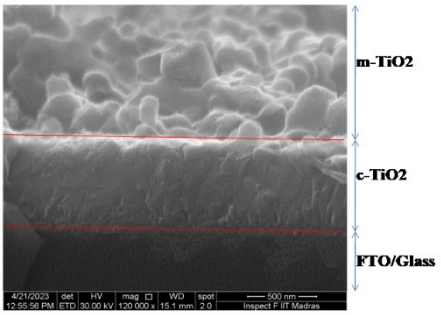
N. Sivakumar[1,2,*], Subhashis Saha[1], Narendra Bandaru[1], Jatindra Kumar Rath[1]

[1] *Department of Physics, DSEHC, Indian Institute of Technology Madras (IITM), Tamil Nadu-600 036, India.*
[2] *Functional Materials Research Laboratory (FMRL), Department of Physics, Sri Sai Ram Engineering College, Tamil Nadu-600 044, India.*

* Corresponding Author: sivakumar.phy@sairam.edu.in

Abstract

Investigations on crystalline $MAPbI_3.H_2O$ and $MAPbI_3$ perovskite solar cells (PSCs) at ambient conditions were performed. The transparent conducting oxide, fluorine doped tin oxide (FTO), coated glass slide serves as a substrate during the cell fabrication process. Spin coating technique was employed to fabricate cells with compact TiO_2 and mesoporous TiO_2 bilayer as an electron transport layers and P3HT as a hole transport layer. The crystal structures of the spin-coated TiO_2, $MAPbI_3.H_2O$ and $MAPbI_3$ perovskites were confirmed by XRD studies. The results confirmed that TiO_2 is in the anatase phase and that of $MAPbI_3.H_2O$ and $MAPbI_3$ perovskites in the tetragonal and monoclinic systems respectively. From the Tauc plot, the optical band gaps of these two perovskites are found to be 1.45 eV and 1.52 eV respectively, near to the optimum band gap proposed in S-Q calculation. Initial dark and AM 1.5 light I-V tests on these samples showed that $MAPbI_3$ perovskite has two orders of photo response. A solar cell was successfully fabricated with controlled growth rate of the various layers and the SEM cross-section (shown below) provides information regarding the thickness of each layer in the cell. Photovoltaic characteristics of these cells are being evaluated using a WACOM AM 1.5 solar simulator and the results of these two materials are being compared.



J-032

Photoelectrochemical hydrogen generation from water using ZIF-9 derived metal matrix.

Chippy Alphons Augustine[1], Ranjit Bauri[1]*, Somnath Chanda Roy[2]

[1]*Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai, 600036, India.*

[2]*Semiconducting Oxide Materials, Nanostructures and Tailored Heterojunction (SOMNaTH) Lab, and Functional Oxides Research Group (FORG), Department of Physics, Indian Institute of Technology Madras, Chennai, 600036, India*

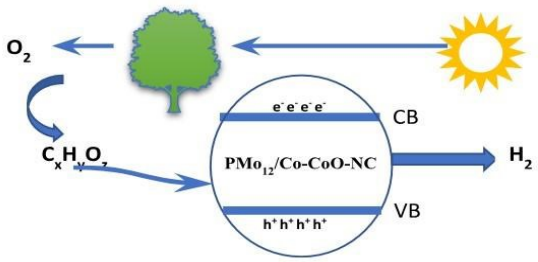
[a]chippyalphons@gmail.com

[b]rbauri@iitm.ac.in

[c]somnath@iitm.ac.in

Abstract:-

The growing global demands for sustainable energy have stimulated worldwide efforts in developing alternative energy conversion and storage devices. Hydrogen is an ideal energy carrier for the future with high energy capacity and photoelectrochemical (PEC) hydrogen production is one of the most promising approaches to produce green chemical fuel. Here, we report the synthesis of an N-doped carbon matrix modified cobalt- cobalt oxide (Co-CoO-NC) via post thermal treatment of the Zeolitic Imidazolate Framework(ZIF-9). This mesoporous material is in microdisk shape with a high surface area of 640 m^2/g. The electrochemical performance of Co-CoO-NC was appreciable and trapping $[PMo_{12}O_{40}]^{3-}$ (PMo_{12}) into this matrix enhances the PEC performance. The optimized catalyst achieves large photocurrents of 3.2 $mAcm^{-2}$. This material should serve as a better catalyst for the direct energy utilization of biomass.



J-033

Development of SnS quantum dot hybrid solar cells on TiO_2 nanorods

Subhashis Saha, N. Sivakumar, Narendra Bandaru, Somnath Chanda Roy and Jatindra Kumar Rath[1]

[1]corresponding authors: jkr@iitm.ac.in

The Successive Ionic Layer Adsorption and Reaction (SILAR) method was used to make SnS quantum dots (QDs) hybrid solar cells with a structure; Glass/FTO/TiO_2 nanorod/SnS QD/P3HT/PEDOT: PSS/Ag. Titanium dioxide (TiO_2) nanorods were grown on FTO-coated glass using hydrothermal process and the SnS QDs were deposited on the surface of nanorods by SILAR method. The hole transport layers P3HT and PEDOT: PSS were deposited in succession on top of the SnS QDs using spin coating technique. The cell is competed with metal contact (silver) deposited by thermal evaporation method. The current-voltage (I-V) measurement of these cells reveal that the electrical parameters like efficiency, series and shunt resistance depend on the number of SILAR cycles. Moreover SILAR deposition cycles have to be optimised to obtain suitable bandgap of the absorber material in addition to lowering of series resistance and increasing the shunt resistance. After 8 times of SILAR deposition the developed cells showing the best results with respectable open circuit voltage of 0.46V and a FF 43.1 % which we attribute to a high more than7 kilo Ohm cm^2 shunt resistance.

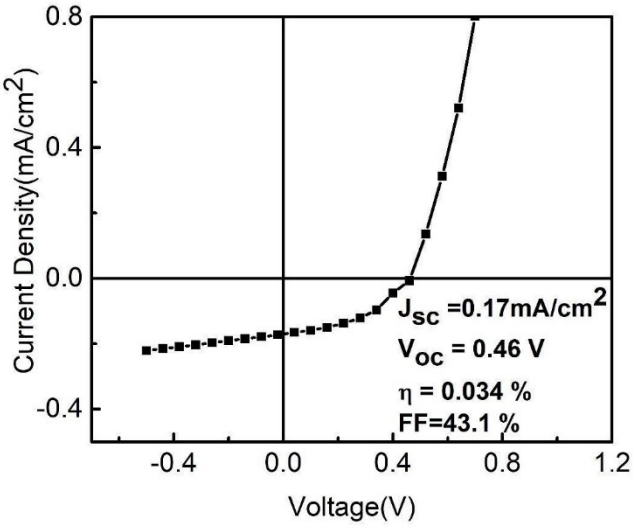


Figure 1: illuminated IV

J-036

Photo-induced surface modification of TiO_2 nanotubes functionalized with graphene oxide/ reduced graphene oxide for enhanced CO_2 reduction

Ragulkrishnan. V, Tiju Thomas, Somnath C. Roy

Department of Physics, Indian Institute of Technology Madras, Chennai – 600036, India

Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai – 600036, India

Ph17d301@smail.iitm.ac.in , somnath@iitm.ac.in

This study investigates the photocatalytic activity of TiO_2 nanotubes (TNTs) functionalized with graphene oxide/reduced graphene oxide (GO/rGO) for CO_2 reduction by modifying hydrophobic/hydrophilic sites. The TNTs were synthesized using anodization and wrapped with GO/rGO layers to form a unique nanostructure around the nanotubes that effectively separates the photo-generated charge carriers. Under ultraviolet irradiation, the GO/rGO functional groups induce hydrophobic sites on the photocatalytic surface, while the balanced hydrophobic/hydrophilic sites act as active sites for adsorption of CO_2/water molecules, enhancing CO_2 reduction. The photocatalytic efficiency of the rGO/TNTs samples was studied in an in-house designed reactor and compared with non-functionalized TNTs. The samples were characterized using X-ray diffraction, scanning electron microscopy, Raman spectroscopy, UV-Vis diffuse reflectance spectroscopy and the contact angle measurements before and after UV irradiation. The results indicate that the UV-irradiated rGO/TiO_2 photocatalyst exhibits a change in wettability that significantly enhances CO_2 reduction activity compared to bare TiO_2.

J-037

2D TiO_2 Nanosheets with enhanced visible light photocatalytic generation

Samim Hossain[1], **Somnath Chanda Roy**[1*], **Murugavel P**[1*]

[1] *Department of Physics, Indian Institute of Technology Madras, Chennai 600036 India*

Email: ph21d057@smail.iitm.ac.in

Recent studies have demonstrated a great potential for enabling effective and co-catalyst-free photocatalytic H_2 production from methanol/water mixtures by 2D TiO_2 Nanosheets. For the purpose of creating 2D TiO_2 Nanosheets and evaluating its photocatalytic efficiency, a solvothermal method has been selected. The microscopic feature, morphology, and phase are characterized. The TiO_2 nanosheets that were created have anatase phase with prominent (001) facets, according to the XRD results. To fabricate the photoelectrode, the nanosheets were deposited on a FTO coated glass substrate . Measurements of the hydrogen production and photocurrent generation under visible light irradiation were used to evaluate the PEC activity of the electrode. The benchmarking material P25 is outperformed by the as-prepared anatase TiO_2 single-crystal nanosheets with 87% (001) facets in terms of photoreactivity. Also, the photocatalytic performance was enhanced compared to bare TiO2 nanosheets using the visible light sensitizer $Ru(bpy)_3^{2+}$.

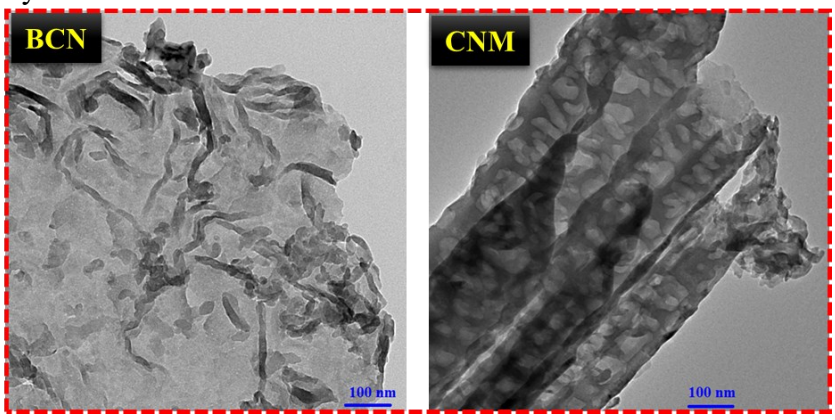
J-038

Integrated Design and Synthesis of O-doped Graphitic Carbon Nitride Nanostructures for Solar to H_2 Conversion Reaction

Rama Krishna Chava*, Hyerim Park and Misook Kang**

Department of Chemistry, College of Natural Sciences, Yeungnam University, 280 Daehak-Ro, Gyeongsan, Gyeongbuk 38541, Republic of Korea.
Email: rama@ynu.ac.kr (R. K. Chava); mskang@ynu.ac.kr (M. Kang)

Abstract:
Semiconductor based solar-driven photocatalysis for hydrogen evolution from water splitting has appeared as one of the most attractive renewable energy technology to address the energy crisis. Graphitic carbon nitride (g-C_3N_4) as metal-free polymeric semiconductor is recognized as one of the most favorable photocatalytic materials due to its visible-light response with suitable band gap (2.7 eV), nontoxicity and excellent chemical stability. However, its drawbacks such as low optical absorption in the visible-light region, small surface areas (~10 m^2/g) and ultrafast photogenerated electron-hole recombination rate, which severely restrict the photocatalytic activity of bulk g-C_3N_4. Thus, it is important to synthesize g-C_3N_4-based photocatalysts to enhance the visible-light absorption ability and accelerate the separation of photogenerated charge carriers. In this work, we reported an integrated design and synthesis of g-C_3N_4 via thermal polymerization of malonic acid treated melamine precursors and the resulted O-doped/Carboxylic acid functionalized g-C_3N_4 displayed improved photocatalytic H_2 evolution activity.



J-039

Absorption enhancement in perovskite-based thin film solar cells using Whispering Gallery modes of dielectric microspheres

Ayusmin Panda[1,2], C. Sudakar [1], and B. R. K. Nanda[2]

[1]*Multifunctional Material Laboratory, Department of Physics, Indian Institute of Technology Madras, Chennai-600036, India*

[2]*Condensed Matter Theory and Computational Lab, Department of Physics, Indian Institute of Technology Madras, Chennai-600036, India*

We have investigated $CsPbI_3$ thin-film solar cell in two different configurations. One in the planar and the other with the inclusion of periodically arranged TiO_2 microspheres which exhibit resonating whispering gallery modes (WGM). We show that the absorption in the $CsPbI_3$ active layer gets enhanced due to the presence of WGM microspheres. The incoming electromagnetic wave couples with TiO_2 microsphere and forms confined resonating modes. Since, the in-coupling element is lossless, energy stored in microspheres is absorbed efficiently by the underlying active material. This directly contributes to the increment in the current density of the solar cell. In this work absorption studies performed numerically by 3D full-field finite-difference time-domain (FDTD) simulations are presented. Different designs have been discussed for deciding the appropriate position of WGM spheres w.r.t. thin-film PSC featuring back-reflector and optimized anti-reflectance coating. We have also studied the influence of multi-sized array of spheres as well as perovskite coated dielectric spheres to propose an analytical model based on temporal coupled mode theory.

J-040

Meniscus-Confined 3D Printed Iron Pyrite for Solar Cell Application

Netrapal Singh [a, b,]*, Koyalada Bhavani Srinivas Rao [b], Hafsa Siddiqui [b], Mohammad Ashiq [a, b], Sathish Natarajan [a, b], and Surender Kumar [a, b]

[a] *Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India*

[b] *CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal-462026, India*

* E-mail: quantanetra13@gmail.com

Abstract

Meniscus-confined electrochemical 3D printing (MC-3DP) process has opened new dimensions for fabricating sub-micron-level complex structures directly through the localized electrodeposition from the salt solution of the requisite material [1]. Herein, MC-3DP printing of iron oxide (Fe_3O_4) nanocrystalline thin films (NTFs) is done on indium tin oxide (ITO) glass substrate. The phase pure Fe_3O_4 NTFs are further subjected to sulfurization under various conditions to obtain the iron pyrite NTFs. The phase purity of the sulfurized NTFs is confirmed using various characterization tools. The UV-Vis-NIR spectroscopic study shows the absorption coefficients ~10^5 cm^{-1} for the wavelength of the light lesser than 700 nm with indirect band gaps in the range of 0.78-0.86 eV. All the obtained pyrite NTFs show n-type conductivity with charge carrier density ~10^{19} cm^{-3}. The photoelectrochemical measurements show a stable photocurrent response, indicating the potential of obtained pyrite NTFs for solar cells.

Keywords: MC-3DP; iron oxide; iron pyrite; solar cell; 3D printing

References:

1. X. Chen, X. Liu, P. Childs, N. Brandon, and B. Wu, Adv. Mater. Technol. 2017, 2, 1700148.

R. P. Srivastava, A. P. Saxena and S. Ingole, Chalcogenide Lett. 2017, 14, 227-237.

J-042

Thermal induced morphological modification in covellite

Rao Pritty [1&3], Kumar Sanjiv [2], Vinayak Seema [1], Sharma Suresh C. [3]*
[1]Solid State Physics Laboratory, DRDO, New Delhi-110054, India.
[2]National Centre for Compositional Characterisation of Materials, BARC, Hyderabad- 500062, India(Retired).
[3]Delhi Technological University, New Delhi-110042, India.

[*]Corresponding author: prof_ sureshsharma@dtu.ac.in ; Ph-91-11-27296328

The copper sulphide system has many stoichiometric and non-stoichiometric polymorphs. Covellite (CuS) is the most Cu deficient and stoichiometric member of this family [1]. Covellite nanoparticles are attractive materials for energy and biological applications. The morphology of the nanoparticles is an important consideration in these applications. The paper presents preliminary investigations on the morphology of CuS powders prepared wet chemically at room temperature and subsequently heat treated in 393-523 K temperature range in an inert atmosphere. The morphology was measured by transmission electron microscopy. Conforming to the hexagonal structure of covellite, the powder treated at 393 K consists of regular and elongated hexagonal crystallites. Powders heat treated at 523 K retain their phase constitution, however, the crystallites tend to acquire spherical morphology. The minimisation of surface energy is probably the driving force behind this transformation. The study shows that wet-chemically prepared covellite nano-crystallites can be shape-tailored on thermal treatment.

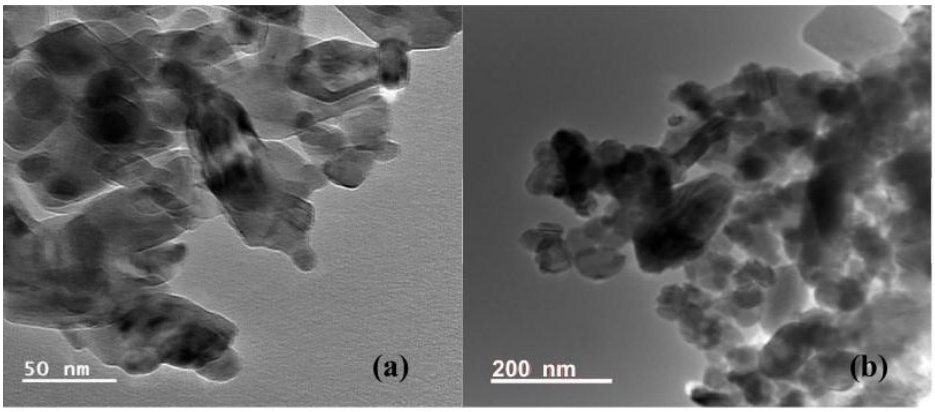


Fig.1: HRTEM images of CuS powder heat treated at a) 393 K and b) 473 K under argon atmosphere.

References:

[1] D. J. Chakrabarti and D. E. Laughlin, The Cu-S (copper sulfur) system, Bull. Alloy Phase Diagrams, 4 (1983) 254–271. https://doi.org/ 10.1007/bf02868665N. Barreau, Solar Energy, 83 (2009) 363-31.

J-043

Synthesis and optical properties of Cr^{3+} substituted $Cs_4CdSb_2Cl_{12}$: Near-infrared luminescent material

Multifunctional Materials Laboratory (MFML), Department of Physics and Department of Chemistry, IIT Madras

Tiasha Roy, Bhyrappa P. and C. Sudakar

ABSTRACT

All inorganic lead-free layered halide double perovskite (LHDP) have recently gained attention due to their promising optoelectronic and photovoltaic properties. In this work, the new $Cs_4CdSb_{1-x}Cr_xCl_{12}$ (x = 0.1 and 0.2) compounds were synthesized using the conventional solution-based co-precipitation method and further characterized. These compounds showed a near IR emission in the 700-850 nm range, which arises from the Cr^{3+} *d-d* transition. Powder X-ray diffraction and Raman studies indicate that the replacement of Sb^{3+} ($R_{Sb^{3+}}$ = 0.76 Å) with relatively smaller Cr^{3+} ($R_{Cr^{3+}}$ = 0.61 Å) causes no significant effect on the structure of the host material $Cs_4CdSb_2Cl_{12}$. The incorporation of Cr^{3+} shows characteristic peaks shift towards a lower diffraction angle suggesting the lattice expansion is mainly due to distortion of $[SbCl_6]^{3-}$ octahedra. Furthermore, the synthesis of higher Cr^{3+} substituted $Cs_4CdSb_{1-x}Cr_xCl_{12}$ is underway to explore their photovoltaics and light-emitting diode (LED) properties.

K-003

Low emissivity thin film coating on Glass Fiber Reinforced Plastic (GFRP) used for cryogenic applications

Uday Kumar [1, 2, *], Hitensinh B. Vaghela[1], Aarju Mathew Koshy[2], and Parasuraman Swaminathan[2]

[1]*ITER-India, Institute for Plasma Research, Ahmedabad, India*

[2]*Electronic Materials and Thin Films Lab, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai, India*

*uday.kumar@iterindia.in

Glass Fiber Reinforced Plastics (GFRP) are extensively used for internal structural support in large cryogenic transfer line systems due to their low thermal expansion coefficient and high specific strength and stiffness. GFRP has low thermal conductivity but high emissivity (about 0.86). due to which it acts as a thermal radiation source to the surrounding cryogenic components which are at relatively lower temperatures. During operation, this radiative heat transfer from the GFRP support significantly contributes to the static heat load of the cryogenic system. This heat load can be minimized by reducing the emissivity of GFRP. To achieve this, a thin film of pure aluminium on GFRP has been developed, and coating parameters optimized to achieve the desired emissivity (0.05 or lower). The sheet resistivity of the aluminium-coated GFRP has also been measured (less than 1.0 ohm/square) and related to the emissivity.

K-004

A Wearable High Performance Triboelectric Nanogenerator based on PDMS/MWCNT Nanocomposite for Haptic Applications

Suresh Nuthalapati[1], Aniket Chakraborthy[2], Injamamul Arief[3], R. Rakesh Kumar[4], Mehmet Ercan Altinsoy[1,2], Anindya Nag[1,2*]

[1]*6G-life Research Hub, Technische Universität Dresden, 01069 Dresden, Germany.*

[2]*Centre for Tactile Internet with Human-in-the-Loop (CeTI), Technische Universität Dresden, 01069 Dresden, Germany.*

[3]*Leibniz-Institut fu¨r Polymerforschung Dresden e. V., Hohe Straße 6, D-01069 Dresden, Germany.*

[4]*Energy Materials and Devices Laboratory, Department of Physics, National Institute of Technology, Warangal 506 004, India*

suresh.nuthalapati@tu-dresden.de, anindya.nag@tu-dresden.de

Abstract: -Triboelectric nanogenerators (TENGs) have been growing as promising and potential energy harvesters. However, the performance of the polymer based TENGs needs to improve for haptic and wearable applications. In this work, we have designed and developed polydimethylsiloxane (PDMS) and multi-wall carbon nanotubes (MWCNT) based TENG for haptic applications. Owing to the unique electrical properties of the human body, it was chosen as one of the triboelectric materials. MWCNTs enhanced the electrical properties of the nanocomposite, thereby the performance of the TENG. The as-fabricated film was operated in single electrode mode and studied its performance for various tapping forces with different frequencies. The TENG exhibited an open circuit output voltage of ~255 V and power density of 2.63 W/m^2 at a load of 3 MΩ. The TENG exhibited an excellent, stable electrical performance. 30 LEDS formed in TUD shape were driven by the TENG with very bright intensity. Hence, these flexible and wearable TENGs with high performance are mostly suitable for all haptic applications.

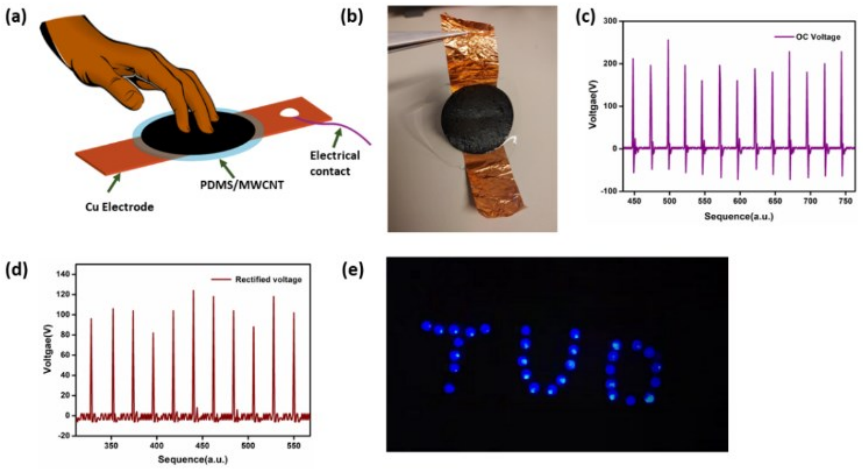


Figure.1 a) Schematic diagram of PDMS/MWCNT based TENG, b) Fabricated TENG, c) Open circuit voltage of TENG, d) Rectified output voltage at a load of 3 MΩ, e) ON state of 30 LEDs in TUD form, powered by the TENG.

K-005

First - Principal Calculation and Experimental Studies of Bismuth Telluride Thermoelectric Materials

Sarthak Roy, Kuldeep Bhardwaj, Avala Ramesh, Sukanti Behera*

Materials Chemistry Lab, Department of Chemistry, Maulana Azad National Institute of Technology Bhopal – 462003, India

*sukantib@manit.ac.in

Waste heat generated due to industrial and non-industrial processes often goes unutilized &/or underutilized. The salvaging of energy from such energy sources is tricky due to lower exergy levels. As such, bismuth telluride based thermoelectric materials are an obvious choice due to higher figure of merit at room temperature. To prepare thermoelectric modules, first-principles calculations by DFT simulations are run to predetermine the properties of the required materials, which are often woefully inaccurate due to usage of lower-level exchange correlations. In this presentation, we will discuss results based on density functional theory and experimental work of bismuth tellurides. So, our aim is to determine the electronic properties of bismuth telluride-based compounds through the use of hybrid exchange correlations in a Quantum Espresso environment and thereafter utilizing these data in BoltzTraP2 python module to determine thermoelectric properties. In doing so, we generate data that can be further utilized by machine learning enabled processes to simulate the design-performance parameters of thermoelectric modules, which helps in streamlining the experimental process.

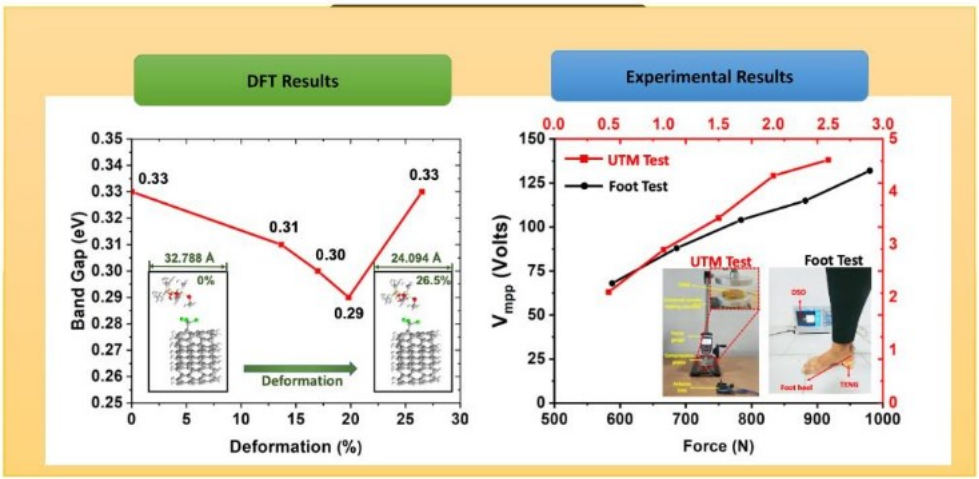
Keywords: Thermoelectric, Bismuth Tellurides, Density functional theory

K-007

Impact of Deformation on the Structural and Electronic Properties of MWCNT-PDMS based Triboelectric Nanogenerator

Akshpreet Kaur[1], Sukhbir Singh[1], Shivam Jadaun[1], Ankur Gupta[2], Gaurav Sapra[1*]
[1] *UIET, Panjab University, Chandigarh*
[2] *Department of Cardiology, PGIMER, Chandigarh*
akshpreet9386@gmail.com, gaurav.sapra@pu.ac.in

Multiwalled Carbon Nanotubes (MWCNT)-Polydimethylsiloxane (PDMS) nanocomposite serves as an excellent tribonegative layer in Triboelectric Nanogenerators (TENG). To enhance TENGs performance, it is essential to understand the charge distribution at atomic level due to deformations. Herein, a density functional theory approach has been utilised to explore the effect of deformations induced by contact force on structural and electronic properties of MWCNT-PDMS. The band structure, molecular energy spectrum, density of states, molecular orbital behaviour and excess charge generation has been evaluated under deformations (0%, 13.66%, 17%, 19.8%, 26.5%). The MWCNT-PDMS TENG is fabricated and compressive testing (0.5-2.5N) is performed. Experimentally, the effect of force is analysed by integrating TENG under the foot of individuals with varying body weights (60-100Kg). The outcomes depict an increase in the maximum peak-to-peak open circuit voltage (V_{mpp}) with increase in contact force that has been synergistically endorsed by decrease in band gap with increase in deformation.



K-008

Pyroelectric device architecture

Umamaheshwaran, L Reshma, S F Ali
IIT Madras
am21s023@smail.iitm.ac.in, am21r005@smail.iitm.ac.in, sfali@iitm.ac.in

Observing a rolling wooden block, human can figure out how to transform rotational motion into translatory motion, opening the door to energy harvesting. The ultimate aim is to harvest high grade energy. The current energy resources crisis has increased awareness of energy regeneration and harvesting. Thermal energy harvesters can make use of waste heat. By pyroelectric materials, thermal temporal gradient can be turned into electrical energy by spontaneous polarisation. In this work, COMSOL Multiphysics is used to model the fundamental architecture of the pyroelectric device and to plot graphs of temperature, current, voltage, and electric power over time. The results of the numerical simulation indicate that the perovskite matrix shows pyroelectric behaviour upto its curie temperature. Additionally, since pyroelectric materials are a subset of piezoelectric materials, study of piezoelectric effect is also included. Furthermore, the appropriate heat-exchanging application is chosen, and the device architecture is optimised for the analysis.

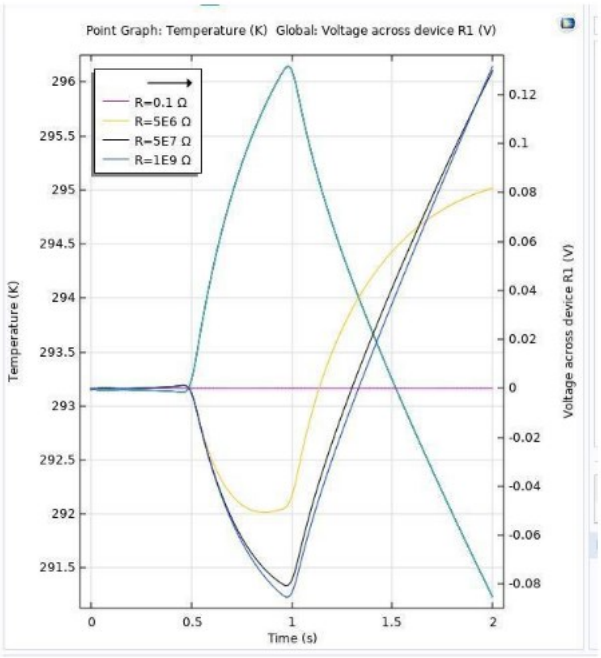


Fig. Temperature, Voltage vs Time

K-010

Enhancement of output in polyvinylidene fluoride nanofibers based triboelectric nanogenerator by optimizing layer thickness

M. R. Shijeesh[1], K. V. Vijoy[1], Anshida Mayeen[2], Honey John[2,3], K. J. Saji[1,2*]

[1]*International School of Photonics, Cochin University of Science and Technology, Kerala 682022, India*

[2]*Inter University Centre for Nanomaterials and Devices, Cochin University of Science and Technology, Kerala 682022, India*

[3]*Department of Polymer Science and Rubber Technology, Cochin University of Science and Technology, Kerala 682022, India*

Email: shijeesh.mr@gmail.com

Email: saji@cusat.ac.in*

Abstract

Triboelectric nanogenerators (TENGs) are a type of energy harvesting device that convert mechanical energy into electrical energy by utilizing the triboelectric effect. Polyvinylidene fluoride (PVDF) is a commonly used material in TENGs due to its ferroelectric and piezoelectric properties, which allow it to generate electrical charge in response to mechanical stress. In this work, we developed a TENG that consists of electrospun PVDF nanofibers (PVDF NF) to effectively harvest mechanical energy. The variation of open circuit voltage (Voc), short circuit current (Isc) and charge transferred (Q) with thickness/layer of neat PVDF NF mat were analyzed. The open circuit voltage of 55 V, short-circuit current of 9.87 μA and a charge transfer of 18.8 nC were obtained for optimized thickness. In wearable electronics, TENGs have the potential to be a new energy supply device that could reduce the dependence on batteries and improve the device's sustainability.

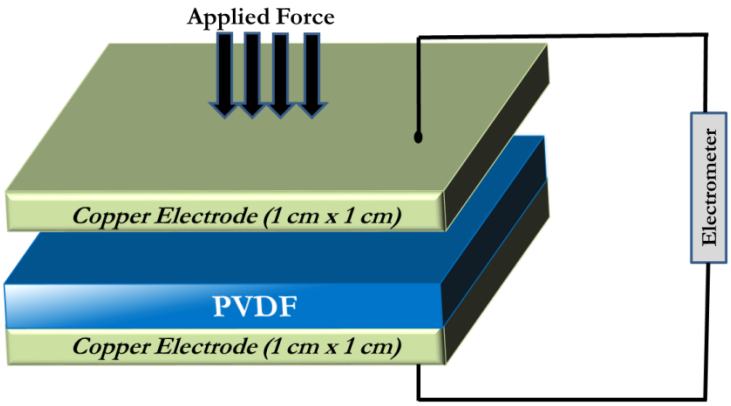


Figure 1: The schematic representation of the TENG

L-001

Stabilizing ultrathin Silver (Ag) film on substrates

Allamula Ashok[1], Satyesh Kumar Yadav[1,2,*]

1 Materials Design Group, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT) Madras, Chennai, India.

2 Center for Atomistic Modelling and Materials Design, Indian Institute of Technology (IIT) Madras, Chennai 600036, India.

ashok.allamula@gmail.com, satyesh@iitm.ac.in*

Indium Tin Oxide (ITO) is widely used as a transparent conductive electrode for optoelectronic applications like solar cells since it possesses good optical transmittance of ~80% and low sheet resistance (~20 Ω sq^{-1}) having a FOM of 5.3 (10^{-3} Ω^{-1}). Due to the high cost and brittle nature of ITO electrodes, there is a need for an alternative material to the currently used ITOs. Ultrathin noble metal films have been considered a viable option for use as transparent conductive electrodes due to their excellent optoelectronic properties. However, the growth of smooth and continuous thin (~5-15 nm) Ag film with good adhesion on a ceramic substrate has not been achieved. We grow ultrathin Ag metal films on a ceramic substrate by forming an atomic 3-D interface. 3-D interfaces have smoothly varying chemistry and results in better adhesion. Ag film have a FOM of 16.8 (10^{-3} Ω^{-1}), comparable to ITO.

L-002

High-yield exfoliation of MoS_2 nanosheets by a novel spray technique and the importance of soaking and surfactants

Suvigya Kaushik[1], & Gopinadhan Kalon[1,2]

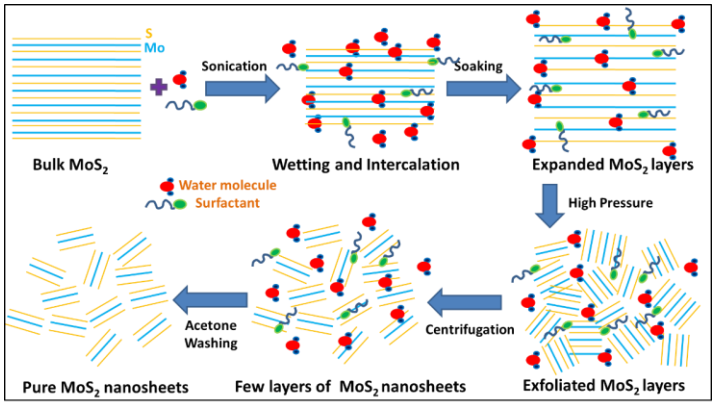
[1]*Discipline of Physics, Indian Institute of Technology Gandhinagar, Gujarat 382355, India*

[2]*Discipline of Materials Engineering, Indian Institute of Technology Gandhinagar, Gujarat* 382355, India

Abstract

Liquid-phase exfoliation of two-dimensional materials is very attractive for large-scale applications. Although used extensively, isolating MoS_2 layers (<10) with high efficiency is reported to be extremely difficult. Further, the importance of soaking and the surfactants' role in stabilizing MoS_2 nanosheets is poorly understood. Herein, we report a novel approach to exfoliating large quantities of MoS_2 via high-pressure liquid-phase exfoliation in deionized water. 4 to 7 layers of stable MoS_2 nanosheets were obtained from 60 days-soaked samples. Studies on the effect of three surfactants, sodium dodecyl benzenesulfonate (SDBS), sodium cholate, and tetra-butyl ammonium bromide, indicate that exfoliation of MoS_2 nanosheets in SDBS is highly efficient than the other two surfactants. The estimated yield reaches up to 7.25%, with a nanosheet concentration of 1.45 mg/ml. Hydrogen evolution reaction shows that nanosheets are stable in an acidic medium with a high hydrogen evolution rate of 30.13 mmol g^{-1} h^{-1} under ambient laboratory conditions.

Graphical Abstract



Synthesis of MoS_2 nanosheets involves soaking the bulk MoS_2 in surfactant solution, and then exfoliating the expanded MoS_2 layers using a high-pressure spray gun.

L-003

Optimization of the deposition process parameters of DC magnetron sputtering to achieve desired deposition rate using design of experiment method

Allamula Ashok[1,#], Vir Karan[1,#], Peela Lasya[1], Daljin Jacob[1], Parasuraman Swaminathan[3,4], and Satyesh Kumar Yadav[1,2*]

[1] *Materials Design Group, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT) Madras, Chennai, India.*

[2] *Center for Atomistic Modelling and Materials Design, Indian Institute of Technology (IIT) Madras, Chennai 600036, India.*

[3] *Electronic Materials and Thin Films Lab, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT) Madras, Chennai, India.*

[4] *Ceramics Technologies Group-Center of Excellence in Materials and Manufacturing for Futuristic Mobility, Indian Institute of Technology (IIT) Madras, Chennai, India.*

ashok.allamula@gmail.com, virkaran123456@gmail.com, lasyapeela99@gmail.com, daljinjacob@gmail.com, swamnthn@smail.iitm.ac.in, satyesh@iitm.ac.in*

# Have contributed equally as first authors

* Corresponding author: Dr. Satyesh Kumar Yadav

In a DC magnetron sputtering system, the deposition rate is significantly affected by sputtering power and working pressure and the precise nature of this dependence varies from machine to machine. we carry out a design of experiments (DOE) study on optimizing deposition process parameters using a Taguchi design methodology. Taking an example of Silver (Ag) deposited on Silicon (1 0 0) substrates using the DC magnetron sputtering method, we use a Taguchi L9 design to reduce the experimental design space from 27 to 9 combinations. The attributes of Ag thin films were quantified with respect to surface roughness (R_a), thickness (t), sheet resistance (R_s). The highest deposition rate for a maximum power considered (25 W) is achieved at an intermediate working pressure of 6.1×10^{-3} mbar. For the given substrate-material system, we also find the critical thickness below which the deposited films are non-conductive to be 16 nm.

L-004

NiO-Graphene Thin Films by Inkjet Printing for Sensing Applications

Abstract

The metal-oxide composite inks have the advantages of good shelf life, jettability, and stability. Composite inks prepared here are using nickel-oxide and graphene because it is the best example of a lattice matched case. NiO nanopowder for the ink was prepared using a wet-chemical approach. Various characterizations were done for powder, ink, and printed samples. For printing an extrusion-based direct writer system was used. NiO ink was prepared using 40, 60, and 70 wt.%, it was observed that the 60wt% gives double conductivity, and good quality printing. In NiO (60wt%) ink, graphene with different 0.5, 1, and 2wt% was added to form a composite ink. The best results were obtained for NiO (60wt%) and Graphene (0.5wt%). The surface roughness is decreased by 94%, and the conductivity is increased by 90% for the composite ink in comparison to the individual ink.

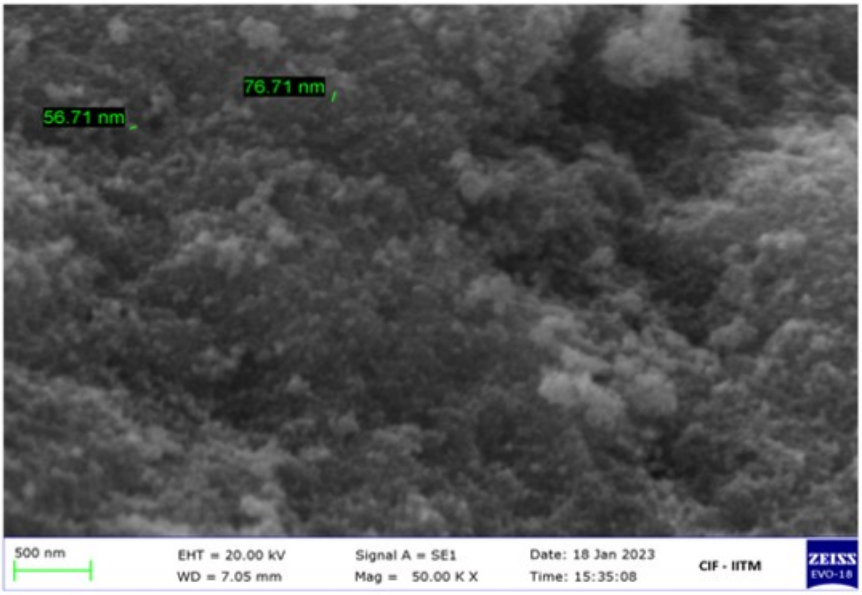


Fig: SEM for NiO powder showing the particle size in nm range

L-013

Scandium doping brings high thermal stability and resistive switching for novel phase-change memory

Surbhi Agarwal[1], Pooja Lohia[2], DK Dwivedi[1*]

[1]Photonics and Photovoltaic Research Lab
Department of Physics and Material Science
Madan Mohan Malviya University of Technology, Gorakhpur – 273010, India
[2]Department of Electronics and Communication Engineering
Madan Mohan Malviya University of Technology, Gorakhpur – 273010, India
Email: surbhi8076@gmail.com, todkdwivedi@gmail.com*

To overcome the gap of access time between storage systems and memories,storage class memory concept has been introduced based on non-volatile memory technology.To promote this,scandium has been added to get high thermal stability and suitable to improve switching characteristics of GeTeSe parent alloy.Differential scanning calorimetry(DSC) has been used for theoretical and experimental studies of $Te_{(1-x)}(GeSe_{0.5})Sc_x(0\leq x\leq 0.15)$ glasses.Fragility index reveals that the composition is consistent with potent glass-forming liquid.Heterogeneous nucleation occurs for the composition under study, and is then followed by a two- or three-dimensional crystal development phenomena by means of the mean values of kinetic exponent factors.XRD,SEM-EDX,XPS,Raman spectroscopy have been done. Refractive index(n) and extinction coefficient(k) have been investigated.Tauc's relationship has been used for calculating bandgap. Non-linear parameters have been calculated that reveals the material transparency in middle and far IR region.I-V switching has also been observed in this material.All these properties make the studied material suitable for optical data storage applications.

Keywords: High thermal stability, phase change memory, resistive switching, Ge-Te-Se alloys, optical properties

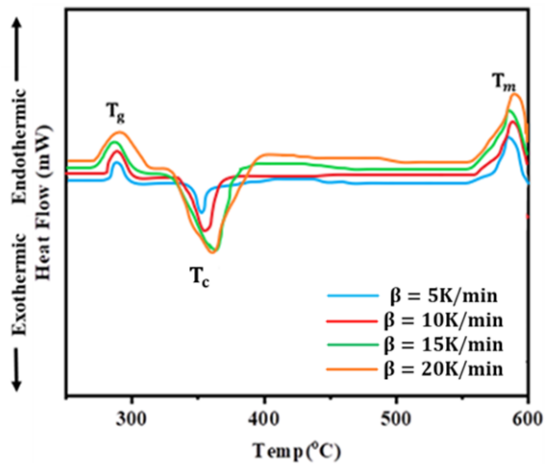


Fig. DSC curve of $Te_{(1-x)}(GeSe_{0.5})Sc_x(x = 0.15)$ glassy alloy at 5, 10, 15, 20 K/min heating rate

L-015

Tuning of electronic properties of co-evaporated Ag: SnS thin films for heterojunction devices

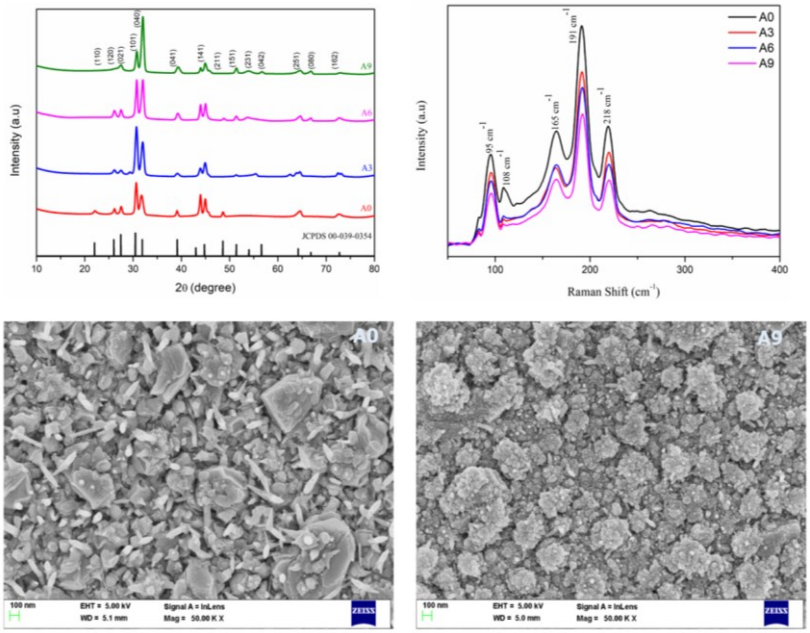
Neju Mathew Philip, M.C. Santhosh Kumar*

Optoelectronic Materials and Devices Lab, Department of Physics, National Institute of Technology Tiruchirappalli,620 015, India

*e-mail address of the corresponding author: *santhoshmc@nitt.edu*

Abstract: Co-evaporation method was used to deposit Ag doped SnS thin films at 300°C on soda lime glass substrates. The Ag concentration was varied from 0 to 9 wt%. Structural, morphological, optical and electrical properties with Ag concentration were investigated. XRD measurements showed improvement in crystallinity with the increase in Ag doping. Raman studies confirmed the formation of SnS without any impurity phases. SEM and AFM studies showed that the surface morphology is influenced significantly by Ag doping. Surface roughness is found to decrease with increase in Ag doping level. Optical bandgap of the deposited films is found to be in the range of 1.8 eV - 2 eV. Electrical studies showed that the deposited films are of p-type conductivity. Significant increase is observed in carrier concentration and mobility upon doping. Heterojunction devices are demonstrated with p-type Ag doped SnS films and RF sputtered n-type Al:ZnO films on ITO substrates.

Keywords: Thin films, Co-evaporation, Ag:SnS, Sputtering, Al:ZnO



L-015

Photocatalytic activity of indium doped zinc oxide seed layers and one-dimensional nanorods under solar irradiation

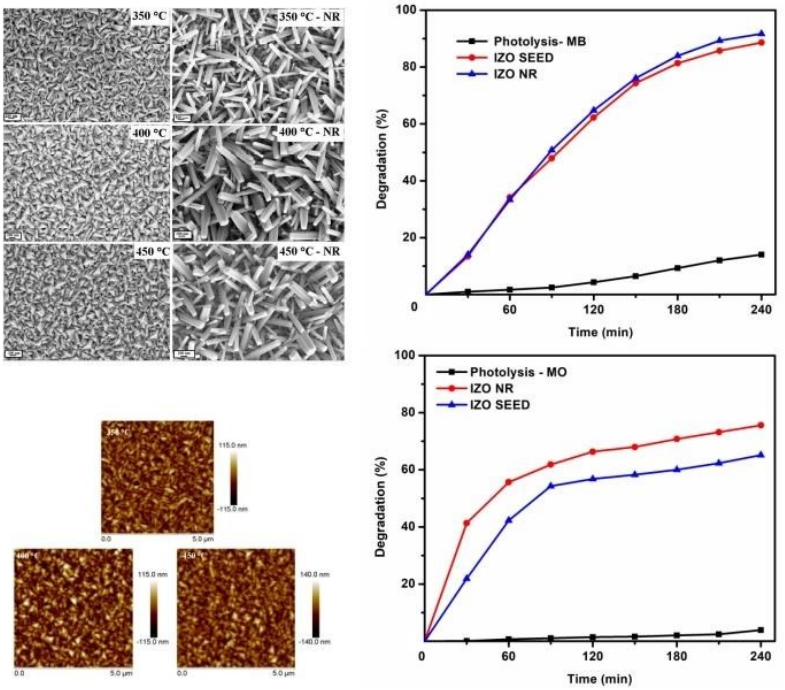
Devika Mahesh, John Paul and **M.C. Santhosh Kumar***

Optoelectronic Materials and Devices Lab, Department of Physics, National Institute of Technology Tiruchirappalli, Tamil Nadu – 620 015

*e-mail address of the corresponding author: *santhoshmc@nitt.edu*

Abstract: We report the deposition of indium doped zinc oxide thin films at various substrate temperatures 350 °C, 400 °C and 450 °C by spray pyrolysis technique. In: ZnO 1 D nanorods are grown on these thin film seed layers by aqueous chemical growth process. The scanning electron microscopy and atomic force microscopy indicate that the surfaces of the seed layers are topped by nanopyramids of size in the range 123 nm to 380 nm. The growth of 1 D nanorods is confirmed by SEM. The structural, morphological, optical and electrical properties of the seed layers and nanorods are studied. Enhanced visible luminescence has been observed for the 1 D nanorods grown on the seed layers, though the seed layers showed quenched emission characteristics. Photocatalytic activity of seed layers and nanorods grown at 450 °C are studied. Degradation efficiency of 90% and 70% against methylene blue and methyl orange dyes respectively.

Keywords: Zinc Oxide, 1 D nanorods, Surface morphology, Photoluminescence, Photocatalysis



L-015

Nanoflakes Bi_2Se_3 thin film on $TiSe_2$/Ti and Ti metal foil for photoelectrochemical water splitting application

Bheem Singh [a, b#], Sudhanshu Gautam [a, b], Govinda C. Behera[c], Vishnu Aggarwal [a, b], Rahul Kumar [a, b], Somnath C. Roy [c], R. Ganesan[d], S. S. Kushvaha [a, b, *]

[a]CSIR- National Physical Laboratory, Dr. K.S. Krishnan Road, New Delhi, India 110012
[b]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India 201002
[c]Department of Physics, Indian Institute of Technology Madras, Chennai, India 600036
[d]Department of Chemistry, Birla Institute of Technology and Science (BITS), Pilani, Hyderabad Campus, Medchal District, Hyderabad, Telangana, India 500078

[#]Presenting author: Bheem Singh

**Corresponding author Email: kushvahas@nplindia.org*

Abstract

In this century, the issues related to energy and the environment have tremendously attracted researchers at a global level. In this aspect, Hydrogen is considered one of the clean energy sources and is expected to become one of the significant sources of energy due to its environmentally friendly byproducts and high energy capacity. Photoelectrochemical (PEC) water splitting offers a green way for solar energy conversion by hydrogen generation, a renewable energy source, using solar energy **[1,2].** Various semiconducting materials such as metal oxides, transition metal dichalcogenides and selenides have been used as a photocatalyst to produce hydrogen as a clean energy source. Here, we have grown Bi_2Se_3 thin film by magnetron sputtering technique on flexible Ti metal foil with and without $TiSe_2$ and studied their photocatalyst performance towards PEC water splitting application. X-ray diffraction confirmed the successful growth of rhombohedral phase of Bi_2Se_3 thin film. Field emission scanning electron microscopy revealed the hexagonal nanoflakes morphology for Bi_2Se_3 on vertically grown $TiSe_2$ layered pyramid type morphology on Ti metal foil. X-ray photoelectron spectroscopy measurement further confirmed the chemical composition of Bi_2Se_3 and $TiSe_2$ compounds. The PEC measurement has been carried out in 0.5 M Na_2SO_4 aqueous electrolyte solution under the illumination of 100 mW/cm^2 (AM 1.5 G) solar light, which showed an enhanced and stable photo-current density for Bi_2Se_3/$TiSe_2$/Ti. This study on thin metal foil-based photoelectrodes paves the way toward the futuristic production of large-area PEC water-splitting devices.

References:

1. T. Bak, J. Nowotny, M. Rekas, C.C. Sorrell, Int. J. Hydrog. Energy 27: 991-1022 (2022)
2. M.A. Ehsan, R. Naeem, A. Rehman, A.S. Hakeem, M. Mazhar, J. Mater. Sci.: Mater. Electron 29:13209–13219 (2018)

L-021

pH dependent microstructural changes of α-$Ni(OH)_2$ hollow-sphere nanostructure thin films

Pushpendra Kumar[1*], Akash[1], Anshu Soni[1], Vipin Kumar[2], Rajneesh Kumar Mishra[2], Jin Seog Gwag[2], Rahul Singhal[3], Anoop Kumar Mukhopadhyay[4]

[1]*Department of Physics, Manipal University Jaipur, Jaipur-303007, Rajasthan, India*
[2]Department of Physics, Yeungnam University, Gyeongsan, 38541, Gyeongbuk-do, South Korea
[3]*Department of Physics, Malaviya National Institute of Technology, Jaipur-302017, India*
[4]*Department of Physics, Sharda School of Basic Sciences and Research, Sharda University, Greater Noida 201310, Uttar Pradesh, India.*

Email: pushpendra.kumar@jaipur.manipal.edu

Abstract

In this work we report the microstructural changes and variation in the properties of α-$Ni(OH)_2$ nanostructure thin films synthesized via dip coating. The cleaned glass substrate was dip alternatively in the the aqueous solution of Nickel nitrate hexahydrate ($Ni(NO_3)_2.6H_2O$) and sodium hydroxide (NaOH). The molarity of the precursor NaOH was varied. The no. of dip and molarity of $Ni(NO_3)_2.6H_2O$ was kept constant at 20 and 0.2M respectively. The synthesized nanostructured thin films were characterized using XRD, FESEM, FTIR and UV-Vis spectroscopy techniques. From FESEM images, interestingly the microstructure was changed with increase in NaOH molarity from hollow-sphere nanostructure to small nanoparticles. The change in NaOH molarity produces a pH change in the reactant solution. Accordingly, with increase in pH the crystallite size of synthesized $Ni(OH)_2$ decreases and the band gap of nanostructure thin films was increases. The change and detailed analysis of formation of nanostructure of thin film was discussed in terms of nucleation and growth along with the main crystal growth direction and supersaturation of the reactant solution on the glass substrate. Finally, the importance of these results in terms of microstructurally tuned nanostructure thin films developement for prospective futuristics industrial application in energy storage and energy harvesting devices are highlighted.

Keywords: hollow nanosphere, $Ni(OH)_2$ nanostructure thin films, active battery electrode material, microstructural change.

L-022

Decoration of steel with TiO_2 for corrosion protection in inhibitors-based solution: Experimental studies

Ishita Chopra[a], Saraswati Kumari Ola[a], S. Gopalakrishnan[b], Veena Dhayal[a*]

[a]Department of Chemistry, Manipal University Jaipur, Jaipur, India, 303007

[b]Department of Automobile engineering, Indian Institute of Science, Bangalore, India, 560012

*E-mail: dhayal21v@gmail.com, Tel. No. +91-141-3999100 Ext. 320

Abstract

The inhibition effects of acetoxime and titanium tetra-acetoximate on mild steel as well as on TiO_2 treated steel corrosion in 3.5%NaCl solution were studied with electrochemical data, gravimetric measurement and the surface analyzing of the metal was done by FTIR, contact angle and SEM coupled with EDS analysis. The results obtained from experiments revealed that TiO_2 decorated steel surface has increased roughness and high surface free energy. It was observed that both acetoxime and titanium tetra-acetoximate act as good corrosion inhibitors for mild steel protection. The high inhibition efficiencies were attributed to the titanium tetra-acetoximate on the TiO_2 treated steel surface.

L-023

One-step synthesis of low cost Manganese doped MoS_2 as an efficient photocatalyst for waste water treatment

Srishti Agarwal[1], Shivam Tyagi[1], Dhirendra Sahoo[2*], Bhaskar Kaviraj[1*]

[1]*Department of physics, School of Natural Sciences, Shiv Nadar Institution of Eminence, Goutam Buddha Nagar, UP-201314, India.*

[2]*KTH Royal Institute of Technology, Stockholm, Sweden.*

Email: ds728@snu.edu.in & Bhaskar.kaviraj@snu.edu.in

Abstract

In order to reduce the amount of pollutants in the world's water reservoirs, finding cost-effective ways to produce energy is a major goal. Transition metal dichalcogenides (TMDs) are known to have promising photocatalytic properties, and MoS_2 is commonly studied as a co-catalyst due to its impressive performance when breaking down organic dyes. To take advantage of this, metal atoms are added to MoS_2 to activate the surface of the basal planes and create more catalytically active sites. Manganese (Mn) doped MoS_2 synthesized hydrothermally in different concentrations, and different characterization techniques were used to observe the morphology and composition. Using Mn-doped MoS_2 nanostructures with effective bandgap engineering, rich of sulphur edges, and improved optical absorption can improve charge separation and dye degradation. The results indicated that, as the concentration of Mn-doped MoS_2 was raised from 5% to 20%, the MB dye degradation rate significantly improved, reaching 89.87% and 100% in 150 and 90 minutes, respectively. This illustrates that the Mn-doped MoS_2 nanostructures have remarkable photocatalytic efficiency when exposed to visible light and may be applicable to industrial wastewater treatment.

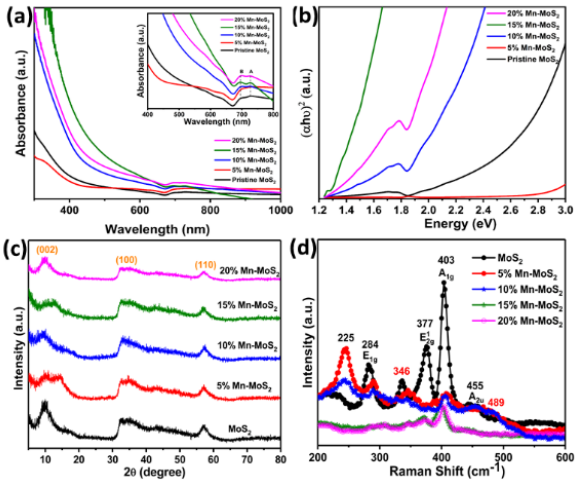


Figure: (a) UV-vis and (b) Tauc plots for all as-synthesized samples (c) X-ray diffraction pattern of all doped samples (d) Raman results of pure and Mn-doped.

L-024

Time-Resolved Photoluminescence Studies of Multicolour Carbon Dot Films in Conducting and Non-Conducting polymer matrix.

Aminakutty N, Vijayan C, and Jayeeta Bhattacharyya
Dept. of Physics, IIT Madras, 600036, Chennai, INDIA,
jayeeta@iitm.ac.in

Carbon dots (CDs) are a class of carbon-based nanoparticles ranging from crystalline dots like graphene quantum dots and carbon quantum dots to amorphous dots such as carbon nanodots and polymer dots. CDs exhibit intense photoluminescence, particularly in solutions, which makes them viable candidates for bio-imaging. However, CDs in thin films show decreased emission due to quenching mechanisms like FRET and aggregation effects. Encapsulation and functionalization techniques have been investigated to mitigate these effects. This study focuses on the steady state and transient photoluminescence properties of silica-coated CDs emitting blue, green, and red in different solvents. The emission decay times of bare and encapsulated CDs in solution and thin films are compared to better understand the decay processes and quenching mechanisms. Since CD emission is predominantly from the surface states, matrix molecules are important in deciding the emission intensity and wavelength from the CDs. The role of the matrix molecules will be discussed for CDs embedded in conducting and non-conducting polymer matrices. Upon optimization, CDs in conducting polymers are the potential for use in LEDs.

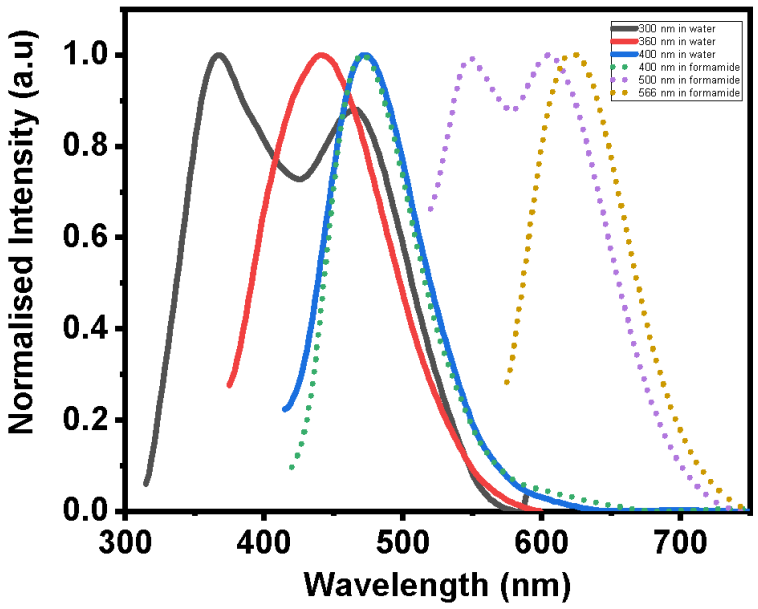


Figure: PL emission spectra of RCDs dissolved in Formamide and Water

L-026

Novel low temperature synthesis and characterization study of cubical and Kasterite $Cu_2ZnSnSe_4$ thin films for solar cell application

Sandesh B. Jirage[a], Pavan K. Pagare[b], Sagar D. Delekar[c] and Vijaykumar M. Bhuse[*a]

[a]*Thin Film Research Laboratory, Deptt. of Chemistry, Government Rajaram College, Kolhapur, 416004, India.*

[b]*Dr. A. P. J. Abdul Kalam Research Laboratory, Deptt. of Physics, Y. C. Institute of Science Satara, MS- India.*

[c]*Nanoscience Research laboratory, Deptt. Chemistry, Shivaji University, Kolhapur-416004, MS- India.*

*Corresponding author: vijaykbhuse13@gmail.com; Submitting author: jiragesandesh@gmail.com

Fax: +91-231-2531989; Tel: +91-231-2537840/2691100.

Abstract:

The progress of a new generation of photovoltaic cells based on $Cu_2ZnSnSe_4$ (CZTSe) looks promising and reliable as economical absorber layer technology due to its direct band gap high absorption coefficient ($>10^4$ cm^{-1}), naturally abundant and nontoxic composition of CZTSe furnishes high chance of fabrication of greener solar cells. So far we have synthesized high quality $Cu_2ZnSnSe_4$ thin films by simplest and inexpensive chemical bath deposition technique at low temperature and characterized by X-ray diffraction, Raman, Scanning electron microscopy, EDS, Optical absorbance, photoluminance, electrical conductivity and PEC techniques. The characterization study revealed a poly-crystalline and stable kasterite phase in a fair stoichiometry with a uniform cubical morphology for CZTSe thin films. The optical absorbance study estimates band gap at 1.0 eV strongly supported by photoluminescence spectra peak at 1196 nm. The conductivity measurement shows semiconducting nature and single type of conduction mechanism and PEC study shows 2.09%. stable conversion efficiency.

Keywords: Thin films; CZTSe; XRD; kasterite, cubical etc.

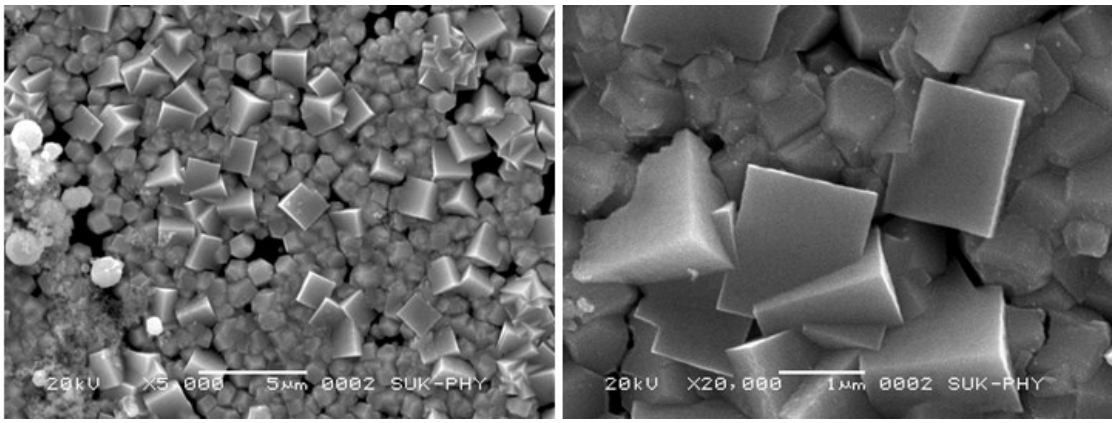


Fig. SEM of cubical morphology of CZTSe thin films

L-030

Synthesis and Electrochemical Characterization of Few Layers WSe_2 Nanosheets through One-step Liquid Phase Exfoliation

Shivam Tyagi[1], Srishti Agarwal[1], Dhirendra Sahoo[2*], and Bhaskar Kaviraj [1*]

[1]Department of physics, School of Natural Sciences, Shiv Nadar Institution of Eminence, Gautam Buddha Nagar, UP-201314, India
[2] KTH Royal Institute of Technology, Stockholm, Sweden.

Email: *ds728@snu.edu.in & *bhaskar.kaviraj@snu.edu.in

Abstract

Exfoliating transition metal dichalcogenides (TMDs) from liquid phase precursors is a suitable synthesis method for large-scale production. It is still challenging to produce TMD nanosheets on a large scale for a variety of industrial applications. We report a one-step LPE process to produce luminescent WS2 nanosheets in organic solvents that have less mismatch in surface energy, viz. isopropanol + water, N-Methyl-2-Pyrrolidone (NMP), ethanol, and dimethyl formamide (DMF) with no pre-refining process. Our research differs from previous reports in the ease and eco-friendliness of bath sonication at a controlled temperature and the low concentration of powdered WSe2. UV-Visible spectroscopy, Raman spectroscopy, and scanning electron microscopy (SEM) were used to determine optical, vibrational, and morphological properties of our as-prepared samples. For electrochemical study, characterizations like Cyclic voltammetry and Linear Sweep voltammetry are used and further calculation of overpotential and turn over frequency are done. On a large scale, this study can be extended to synthesize other layered and non-layered 2D materials.

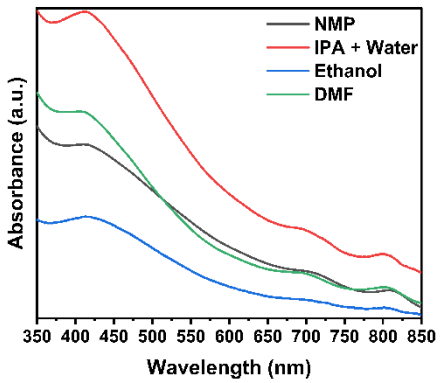


Fig. UV-VIS absorption plot of as-synthesized WSe_2 nanosheets

L-032

Iron-Cobalt Sulfides Nanomaterials- Based Electrocatalysts For Improved Oxygen Evolution Reaction

A. Shankar, S. Marimuthu, G. Maduraiveeran*

Materials Electrochemistry Laboratory, Department of Chemistry, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu, 603 203, India

*E-mail Address: maduraig@srmist.edu.in

Three dimensional (3D) binary Earth-abundant transition metal derived layered nano-materials are presently considered as the emergent catalysts for the oxygen evolution reaction (OER). In the present study, we demonstrate morphology-controlled bimetallic iron-cobalt (FeCo) nanoclusters (~3.2 nm) embedded in 3D nanosheets (3D-FeCoS NS) on nickel foam (NF) electrode using of single-step electrodeposition method. The self-standing 3D-FeCoS NS-B employ as the potential electrocatalysts and the results exhibited an exceptional catalytic OER activity, including a low overpotential (η), small Tafel slope, high mass activity, high turnover frequency (TOF), and long-term stability. More significantly, the 3D-FeCoS NS-B‖PtC couple attained the cell voltage of ~1.53 V, comparing positively with the state-of-the-art RuO_2‖PtC couple. The abundant active sites of nanoclusters and edges of the sheets, synergy between the heterostructures, and accompanied by the presence of surface sulfides/oxides yield improved the OER activity.

Reference:

[1] A. Shankar, S. Marimuthu, and **G. Maduraiveeran**, *Int. J. Hydrog. Energy*, **2023**, *48*, 7683.

L-033

Enhanced erosion resistance of Ti/TiN nanolayered multi-layered coating due to energy absorbing nanoporous Ti layers

Venkataramana Bonu,*[1] Jeevitha M,[1] Praveen Kumar V,[1] Siju,[1] Harish C Barshilia[1]

[1]Nanomaterials Research Laboratory, Surface Engineering Division, CSIR-National Aerospace Laboratories, Bangalore-560 017, India.

E-Mail: ramana@nal.res.in

Abstract

Metal porous layers are usually used in armours and car crash protection due to their energy absorbing capacity. In the present work, their energy absorbing property is smartly used to enhance the solid particle erosion (SPE) resistance of Ti/TiN nanolayered multi-layered coatings. The coatings were deposited on Ti6Al4V substrates using an unbalanced magnetron sputtering system. Two nanoporous Ti layers were sandwiched between three stacks of dense Ti/TiN (3.5/4 nm) bi-layers (Fig. 1). The total thickness of the coating is ~9 µm. The porous layers were created in the magnetron sputtering chamber by following the Thornton model [1]. The optimized coating hardness, elastic modulus, and toughness are 18 GPa, 261 GPa, and 3.2 MPa $m^{1/2}$, respectively. SPE resistance of the coatings was tested according to ASTM-G76 standards @ 400 °C. The optimized coating showed 18 times better erosion resistance compared to the bare Ti6Al4V substrate for 100 m/s erodent speed.

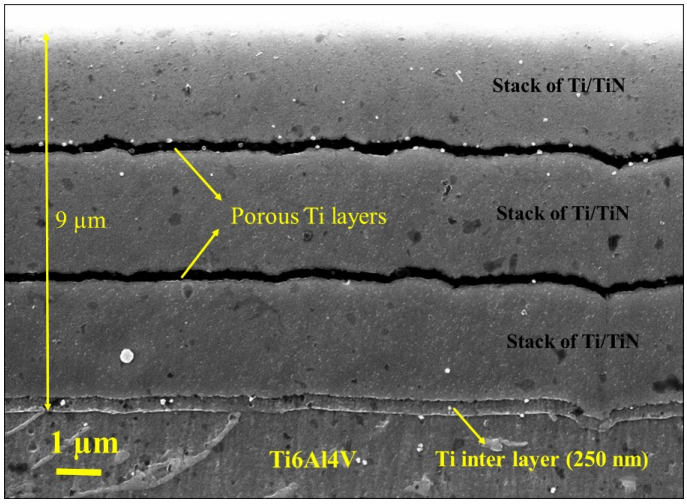


Fig. 1 Cross-sectional FESEM image of Ti/TiN nanolayered multi-layered coating.

Reference:

1. John A. Thornton The microstructure of sputter-deposited coatings J. Vac. Sci. Technol. A 4 (6), 3059-3065, 1986.

L-034

Shift Free Narrow Band pass Optical Filter for Space Applications

Madhumalathi G. R*, Girish M. Gouda, S. Ajith Kumar
Laboratory for Electro-Optic Systems, 1st Stage, 1st Cross, Peenya Industrial Area, Bengaluru, India
Submitting author: *madhumalathi6@gmail.com
Corresponding author: *madhumalathi6@gmail.com, girishmg.g@gmail.com

Application based remote sensing studies demands a high precision and high resolution narrowband optical filter with a bandwidth of 10 nm or less. The optical filters need to have a tight tolerance of ± 1 nm on bandwidth and center wavelength, a very sharp steepness and a high optical density out-of-band spectral transmittance up to 350 nm in the lower wavelength side and up to 1100 nm in the higher wavelength side. Multiple cavity etalon combined with edge filter designs were used to achieve the spectral requirements of the filters and fabricated using ion beam sputtering technique with optical monitoring mechanism. The large number of layers requires re-optimization of coating design during the filter deposition to achieve accurate spectral parameters. The filters fabricated were subjected to various environmental durability tests. The design, fabrication, space qualification details and spectral results of single component shift free narrow band optical filters are presented.

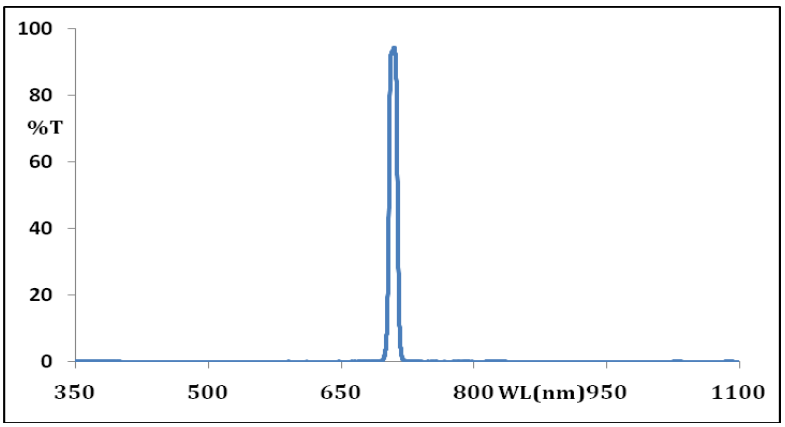


Figure: Spectral transmittance of narrowband optical filter.

L-036

Synthesis of Multi-Walled Carbon Nanotubes on Nichrome and Nickel by using Rapid Thermal Processing Furnace

Sakshi Nigavekar[1,2], Debashree Das[1], Madhumalathi G. R.[1], Girish M. Gouda[1*]

[1]*Laboratory for Electro Optics Systems (LEOS), ISRO, Peenya Indl. Estate, Bengaluru 560058*

[2]*School of Nanoscience and Technology, Shivaji University, Kolhapur- 416004*

Submitting author: sakashi2020@gmail.com

Corresponding author: girish@leos.gov.in

Abstract

A new method has been evolved to synthesize carbon nanotubes (CNTs) by using a Rapid Thermal Processing (RTP) furnace. Catalysts nichrome and nickel were deposited on silicon wafer by electron beam evaporation technique. Multi walled carbon nanotubes (MWCNTs) were synthesized in the RTP furnace which was heated to 750 °C for 30 minutes in an atmosphere of acetylene and argon mixture. The experimental parameters like acetylene and argon flow rate, growth temperature and growth duration were kept the same. The CNTs grown on these substrates were subjected to various tests and evaluations to understand the effect of the catalyst layer and its thickness. FESEM images revealed carbon nanotubes having diameter ranging from 30 nm to 70 nm. Also, we have observed helical, branched and bundles of CNTs in the SEM micrographs. MWCNTs having more than 80 layers were observed in high resolution TEM images.

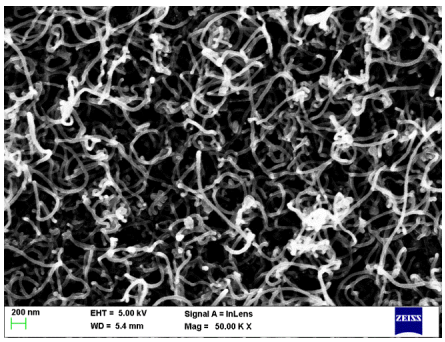


Fig. FESEM image of multi walled carbon nanotubes

References

1. N. Sano, S. Yamamoto, H. Tamon, Chemical Engineering Journal, 242 (2014) 278-284, https://doi.org/10.1016/j.cej.2013.12.073
2. N. K. Reddy, J. Meunier, S. Coulombe , Materials Letters, 60 (2006) 3761-3765, 10.1016/j.matlet.2006.03.109
3. S.A. Moshkalyov, A.L.D. Moreau, H.R. Guttiérrez, M.A. Cotta, J.W. Swart, Mater. Sci. Eng. B 112 (2004) 147-153, https://doi.org/10.1016/j.mseb.2004.05.038

L-037

Magneto-dielectric behavior of nano $BaCoFe_{12}O_{19}$

O. Ramanjaneyulu, K. Chandra Babu Naidu*

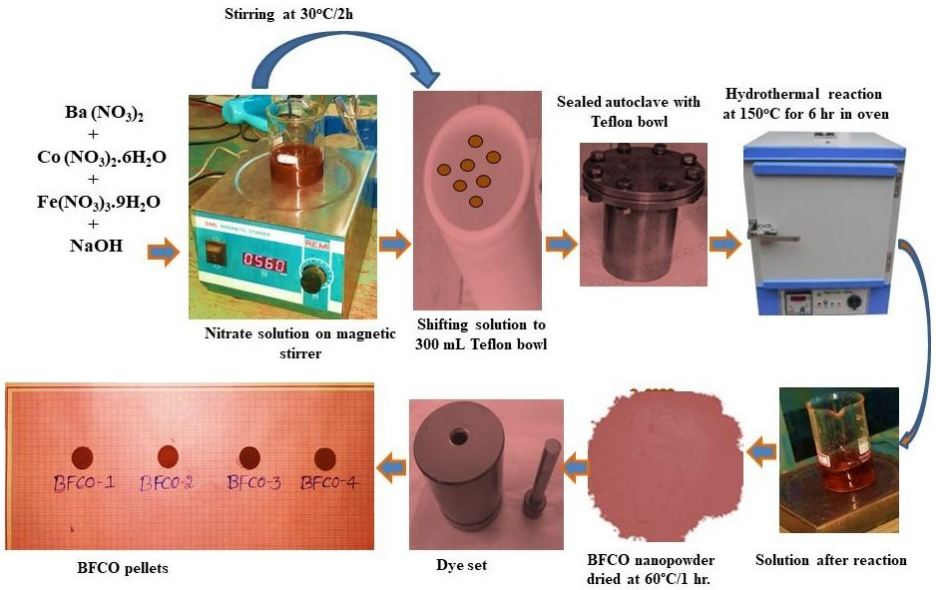
Department of Physics, GITAM Deemed to be University, Bangalore-561203, India

***Correspondence Email:** chandrababu954@gmail.com

Abstract

The hexagonal structure was confirmed using XRD analysis. The FESEM & TEM images showed the existence of spherical nanoparticles. The M_s value was decreased from 56.1 to 49.7 emu/g (for x = 0.2 to 0.4). For further increase of composition, it was increased from 49.7 to 57.3 emu/g. The M_r/M_s values of x = 0.2 – 0.8 were found to be less than ½ suggesting the existence of multi-domain magnetic nanoparticles. The n_B values were noted to be high in magnitude for all samples indicating the predominant magnetic super-exchange interactions between Fe-O-Fe in case of BFCO system. It was evident that for x = 0.6, the high ε' ~ 9.54 & low ε"~ 0.12 values were noticed suiting the high charge storage with low noise capacitor applications. Non-Debye relaxations were clearly seen among the Cole-Cole plots.

Keywords: Hexaferrites; Nanomaterials; Dielectric Constant; Magnetic Properties; Thermal Properties.



L-038

High saturation magnetization in $NiEuFe_2O_4$ nanoparticles

M. Yellanna, K. Chandra Babu Naidu*

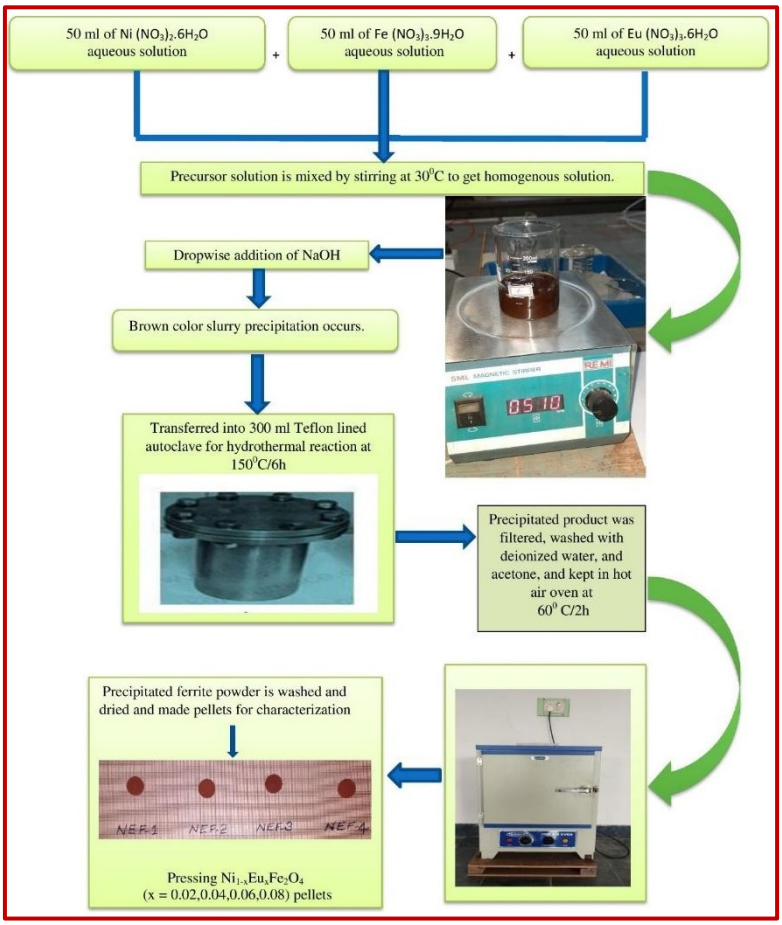
Department of Physics, GITAM Deemed to be University, Bangalore-561203, India

***Correspondence Email:** chandrababu954@gmail.com

Abstract

$Ni_{1-x}Eu_xFe_2O_4$ (x=0.02, 0.04, 0.06 & 0.08) nanoparticles are prepared via hydrothermal approach. The cubic spinel structure is confirmed using X-ray diffraction patterns. The microstructure reveals the asymmetrical spheres like nanosized grains, and particles. The magneto-dielectric behavior is studied using vibrating sample magnetometer, and LCR controller, respectively. The high saturation magnetization is recorded for x=0.08. The frequency dependence of dielectric, and impedance parameters is investigated in detail. The mass loss, and transition temperatures are determined using TG-DTG, and TG-DSC curves.

Keywords: Nanoparticles; Hydrothermal; Diffraction; Microstructure; Dielectric; Thermal.



L-044

Temperature-dependent ferroelectric phenomena in sputtered, undoped HfO_2 thin-film devices

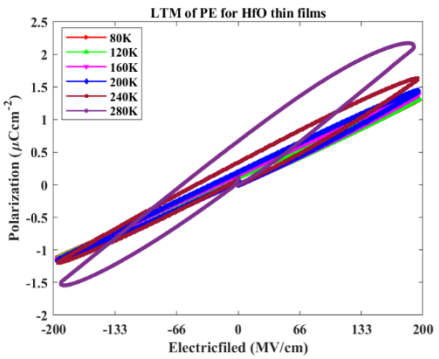
Shah Zahid Yousuf [1], N. V. L. Narasimha Murty [1]

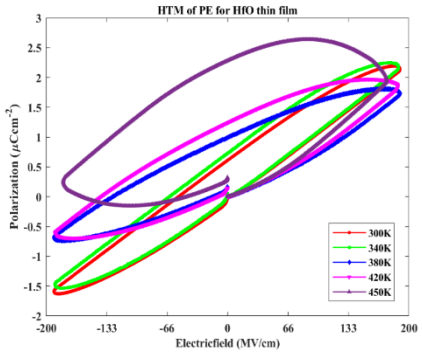
[1] Department of Electrical Engineering, IIT Tirupati, Andhra Pradesh 517619, India

ee20d003@iittp.ac.in, nnmurty@iittp.ac.in

Abstract

Ferroelectric HfO_2 plays a significant role in the present era of non-volatile memory devices due to their scalability and compatibility with the existing silicon CMOS technology. The stability of the ferroelectric properties over a wide temperature range and under intense radiation environments is yet to be established. In this work, Metal/HfO_2/Metal capacitive devices are fabricated and temperature-dependent current-voltage and hysteresis characteristics are investigated. Undoped HfO_2 films were sputtered onto a pre-cleaned FTO-coated glass substrate followed by sputtering of the top platinum electrode. The coexistence of monoclinic and orthogonal phases in HfO_2 was revealed by XRD which was carefully optimized by the sputtering process. The device exhibited rectifying characteristics in forward and reverse bias conditions with a current density of 8.2 mA/cm^2 at +1V and 4.0 mA/cm^2 at -1V at 300K. Temperature dependence of leakage current and polarization in the fabricated devices was further investigated in two temperature regimes named LTM (Low-Temperature Measurement: 80K-280K) and HTM (High-Temperature Measurement: 300K-450K). The leakage current of the Pt/HfO_2/FTO capacitive device was 10^3 times lower at 80K compared to 450K. Polarization-Electricfield (P-E) measurements also showed a maximum polarization (P_{Max}) of 2.24 μC/cm^2 by applying an electric field of 200MV/cm at 340K. For LTM, suppressed polarization was observed in the device with a decrease in temperature from 280K to 80K. The device showed the PE loop up to 420K and above 420K distortion in the PE loop was observed possibly due to high leakage current. The stable performance of the Pt/HfO_2/FTO capacitor indicates the device is an encouraging candidate for the implementation of nanoscale lead-free memory applications. The device was able to exhibit stable ferroelectric properties over a wide range of temperatures of 80K-420K which may open up the device application in harsh environments.





L-046

Synthesis of Transparent Conductive $Ti_3C_2T_x$ MXene Thin Films

Varsha Vijayan[a1], Anamika Ashok[b1], Asha A S [c1,2,3]

[1]Nanomaterials for Emerging Solid-State Technology (NEST) Research laboratory, Department of Physics, Cochin University of Science and Technology, Kochi, 682022
[2]Centre of Excellence in Advanced Materials, Cochin University of Science and Technology, Kochi, 682022
[3]Inter University Centre for Nanomaterials and Devices, Cochin University of Science and Technology,Kochi, 682022
[a)]Varsha Vijayan : varshavijayan@cusat.ac.in
[b)]Anamika Ashok : anamikaashok@cusat.ac.in
[c)]Dr. Asha A S : asa@cusat.ac.in

Abstract

As an emerging member of two-dimensional material family, MXenes have found applications in various optoelectronic [1] and energy storage [2] applications. The present work synthesizes Ti_3C_2Tx MXene via milder in situ HF etching technique. The delaminated stable colloids obtained by sonication of multi-layered MXene were deposited onto glass substrate by ultrasonic spray coating. The thin film fabricated at a deposition time of 30 minutes at 100ºC has the characteristic XRD peak along (002) plane and the plasmonic peak around 780nm with a high conductivity of $\approx 2400\ S\ cm^{-1}$. The dependence of flake size on conductivity was studied. The high electrical conductivity of spray coated films is attributed to the large flake size and improved orientation of flakes. Conductivity and transparency can be tuned by varying the concentration of the MXene solution, substrate temperature and the duration of spray to develop MXenes thin films for memristor applications.

References

[1] J. Lipton et al., "Scalable, Highly Conductive, and Micropatternable MXene Films for Enhanced Electromagnetic Interference Shielding," Matter, vol. 3, no. 2, pp. 546–557, 2020, doi: 10.1016/j.matt.2020.05.023

[2] S. B. Ambade, R. B. Ambade, W. Eom, S. H. Noh, S. H. Kim, and T. H. Han, "2D Ti3C2 MXene/WO3 Hybrid Architectures for High-Rate Supercapacitors," Adv. Mater. Interfaces, vol. 5, no. 24, pp. 1–11, 2018, doi: 10.1002/admi.201801361

L-047

The study of liquid phase laser irradiated C_{60} in different organic solvents

Debashree Das[1,2], Girish M. Gouda[1], Jinesh K B[2]

[1]*Laboratory for Electro Optics Systems, ISRO, Peenya Industrial Estate, Bengaluru-560058*

[2]*Indian Institute of Space Science and Technology, Valiamala, Trivandrum-695547*

Submitting Author: du2013.debashree@hotmail.com

Corresponding Author: kbjinesh@gmail.com

Abstract

C_{60} and its derivatives exhibit unique properties that have high potential for applications like super-capacitors, hydrogen storage, nano-electronics and memory devices. This work focuses on functionalization of C_{60} using a pulsed Nd: YAG laser impinged on Fullerene dispersions in organic solvents like Methanol, Ethanol and Iso-propyl alcohol. RAMAN Spectroscopy, XPS, FTIR and Absorption spectroscopy were carried out to do a comparative study of the derivatives of C_{60} which resulted due to the attachment of different functional groups from the organic solvents in the laser irradiation process. This paper describes how the laser ablation affects dispersed fullerene in different liquid phases and results into C_{60} derivatives.

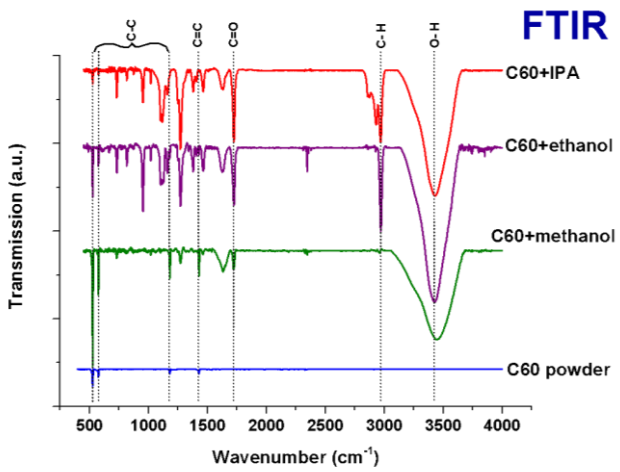


Fig.1. FTIR spectra of laser irradiated C_{60} in Ethanol, IPA and Methanol

References

1. Teguh Endah Saraswati, et.al, Open Chem., 2019; 17: 1198–1212
2. Pierson H.O., Handbook of carbon, graphite, diamonds and fullerenes, 1st ed., William Andrew Publishing, Oxford, 1994.
3. Billups W.E., Ciufolini M.A., Buckminsterfullerenes, VCH Publishers, Inc., New York, 1993
4. Koiry S.P., Jha P., Aswal D.K., Nayak S.K., Majumdar C., Chattopadhyay S., et al., Chem. Phys. Lett., 2010, 485(1), 137-141

L-048

Effect of annealing temperature on electrochemically oxidised nickel for electrochromic application

Meenu Maria Solly[1,2] and Parasuraman Swaminathan[1,2]

[1]*Electronic Materials and Thin Films Lab, Department of Metallurgical and Materials Engineering, IIT Madras, Chennai, India*

Centre of Excellence in Ceramics Technologies for Futuristic Mobility, IIT Madras, Chennai, India

Email: meenumaria28@gmail.com, swamnthn@iitm.ac.in*

Electrochromic materials are capable of reversibly changing color under the application of an electric potential. In this work, we report the synthesis of nickel oxide (NiO) electrochromic films by room temperature electrochemical oxidation of Ni films. The films are grown by chemical reduction followed by air annealing [1]. The morphological, and optoelectronic properties of the films are investigated by various techniques and from the transmittance data it is shown that films annealed at 100 ℃ (EN-100) show maximum transparency and optical modulation. The films exhibit cyclic stability, and the coloration and bleaching times obtained are 1.78 and 2.86 s respectively.

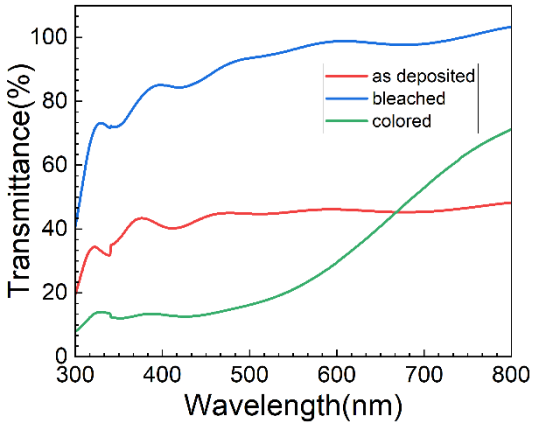


Figure 1: UV-Vis transmittance spectra of EN-100 film with transmittance data of the as deposited, colored and bleached states.

References

1. Ali, F., Neelakantan, L. and Swaminathan, P., 2022. Electrochromic Displays via the Room Temperature Electrochemical Oxidation of Nickel. *ACS omega*, *7*(43), pp.39090-39096.

L-049

A Facile One-Step PMMA-assisted Transfer of Monolayer MoS_2 Devices for Transistor Applications

Roshan Padhan,[1,2] Sameer Kumar Mallik,[1,2,*], Mousam Charan Sahu,[1.2] Satyaprakash Sahoo[1,2,]

[1]*Laboratory for Low Dimensional Materials, Institute of Physics, Bhubaneswar-751005, India*
[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai, 400094, India*

*Corresponding Author email: skmphy1994@gmail.com

Abstract

Atomically-thin layered two-dimensional (2D) materials, exhibit a wide range of electrical and optical properties and are currently considered as the primary candidates for the next generation low-power electronic devices.[1] Fabrication of such devices include various steps such as dry/wet transfer of CVD grown/exfoliated samples, lithography, electrode deposition etc. In this work, we have demonstrated a state-of-the art technique named direct device transfer (DDT) using PMMA adhesive layer that can be used to achieve two different electronic behaviour of monolayer MoS_2 based transistors. The DDT method enables a damage-free transfer of both atomically thin MoS_2 channel and metal electrode to a fresh substrate without affecting the metal-semiconductor junctions. Hysteresis inversion and mobility alterations are observed while characterizing the devices before and after transfer. Furthermore, we unravel two plausible mechanisms i.e. charge trapping and mobile ion-accumulation at the dielectric/channel interface. Our work paves new experimental techniques to study 2D materials based devices towards memory, sensors, and neuromorphic computing applications.

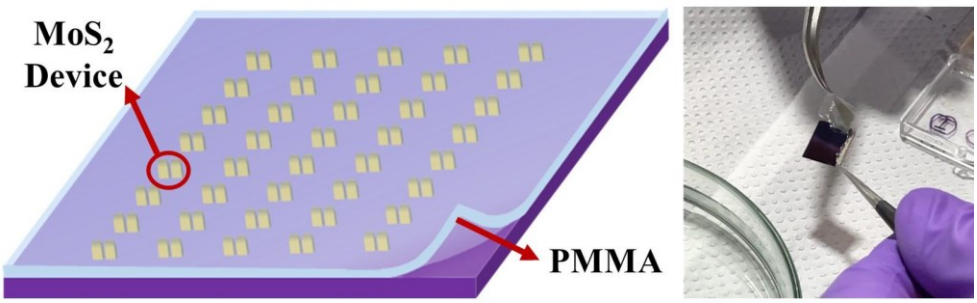


Fig. 1 Demonstration of PMMA-assisted MoS_2 device transfer

References

1. Fiori, G. *et al.* Electronics based on two-dimensional materials. *Nat. Nanotechnol. 2014 910* **9**, 768–779 (2014).

L-050

Properties of thickness graded $LaCoO_3$ by using Combinatorial Pulsed laser deposition

Bhargav Pathak, Kuman Gagliya, Swati Pachauri, U.S. Joshi

Department of physics electronics and space sciences, Gujarat University, Ahmedabad, Gujarat-380009.

Corresponding author: bhargavpathak.phy@gmail.com; usjoshi@gmail.com

Abstract:

Functional properties of oxide films largely depend upon its thickness. In conventional one-by-one thin film deposition single thickness can be achieved. Here, we have employed the concepts of combinatorial chemistry in pulsed laser deposition system for the deposition of inorganic compounds. The combinatorial PLD allows one to obtain large variations of thickness onto one substrate in a single experiment. $LaCoO_3$ is chosen to demonstrate the thickness dependent functional properties. Across 9 mm of substrate, more than 20 nm thickness variations were achieved on a 10 mm quartz plate. Controlled mask motion with synchronised laser pulses were used to fabricate continuously varying film thickness across the substrate. Structural and surface properties were examined by X-ray diffraction and AFM respectively. Systematic variations in the optical band gap were observed with film thickness. The parallel fabrication of films and high throughput characterization will be presented.

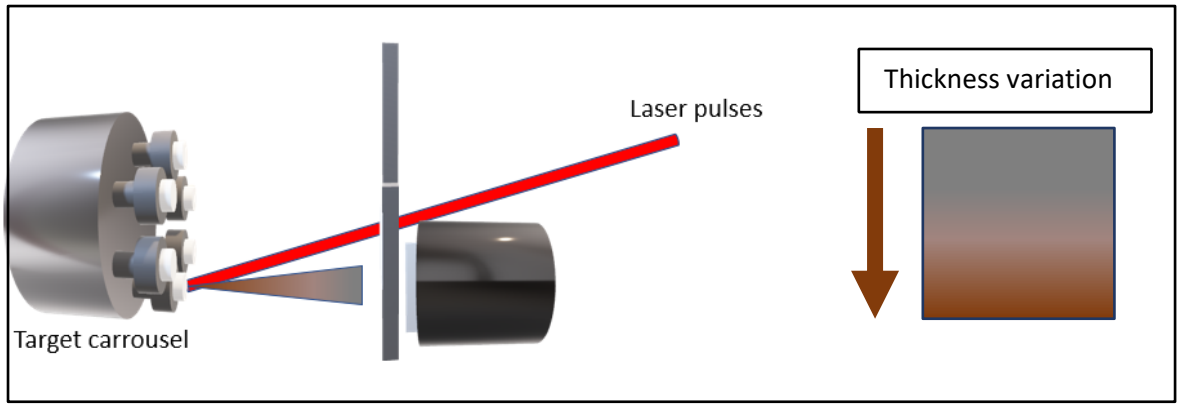


Figure 1 *Schematic of continuous deposition with synchronized mask motion*

L-051

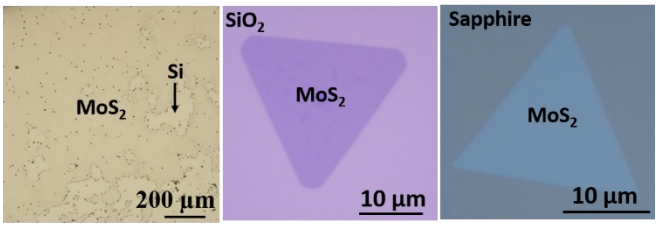
Scalable synthesis of high-quality monolayer MoS_2 films by CVD: Effect of underlying substrate

Rajarapu Ramesh[1†], Renu Yadav[1], Bubunu Biswal[1], Saroj Poudyal[1], Prahalad Kanti Barman[1], Mrinal Deka[1], Wahidur Rahman[1], Pramoda K. Nayak[1*], Abhishek Misra[1*]

[1]*Department of Physics, 2D Materials Research and Innovation Group, Indian Institute of Technology Madras, Chennai-600036, India*

†,*Email: rajarapuramesh855@gmail.com ; abhishek.misra@iitm.ac.in; pnayak@iitm.ac.in

Abstract:



Two-dimensional (2D) layered transition metal dichalcogenides (TMDCs) have stimulated modern technology in the present time due to their unique and tunable electronic and optical properties.[1,2] Therefore, there is a primary need to synthesize high-quality large-area monolayer TMDCs to explore their promising properties in various applications.[3] In the present work, we report the scalable synthesis of high-quality monolayer MoS_2 films on diverse substrates using a chemical vapor deposition (CVD) method. The films have been characterized using Raman spectroscopy as well as low-temperature photoluminescence (PL) measurements. The prepared films exhibit a high degree of crystallinity with a prominent FWHM of A_{1g} and E^1_{2g} peaks in the Raman spectrum and the low-temperature PL measurements reveal strong excitonic emission peaks indicating the high optical quality of the MoS_2 films. We have grown a large area (~1 mm) of monolayer MoS_2 on the silicon substrate and the advantages of growing MoS_2 directly on silicon substrates include compatibility with existing silicon-based technologies and demonstrate the potential for further research in the development of MoS_2-based electronic and optoelectronic devices.

Keywords: TMDCs, MoS_2, growth, Raman

References:

(1) Mak, K. F.; He, K.; Shan, J.; Heinz, T. F. Control of Valley Polarization in Monolayer MoS_2 by Optical Helicity. *Nat. Nanotechnol.* **2012**, *7* (8), 494–498.

(2) Zheng, J.; Yan, X.; Lu, Z.; Qiu, H.; Xu, G.; Zhou, X.; Wang, P.; Pan, X.; Liu, K.; Jiao, L. High-Mobility Multilayered MoS_2 Flakes with Low Contact Resistance Grown by Chemical Vapor Deposition. *Adv. Mater.* **2017**, *29* (13), 2–7.

(3) Wang, S.; Rong, Y.; Fan, Y.; Pacios, M.; Bhaskaran, H.; He, K.; Warner, J. H. Shape Evolution of Monolayer MoS_2 Crystals Grown by Chemical Vapor Deposition. *Chem. Mater.* **2014**, *26* (22), 6371–6379.

L-052

Investigation of analog resistive switching in ZrO_2 nanostructured film.

Aman Sharma[1], Mohd Faraz[2], Neeraj Khare[1,2]

1 Department of Physics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India

2 Nanoscale Research Facility (NRF), Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India.

Emails: phz198001@physics.iitd.ac.in (Submitting author), nkhaare@physics.iitd.ac.in (corresponding author)

Abstract

In this paper, we report the synthesis of nanostructured Zirconium Oxide (ZrO_2) using hydrothermal approach, and the fabrication of a resistive switching device is done (FTO/ZrO_2/Ag) utilising spray coated ZrO_2 nanostructured film. The XRD spectrum of the film reveals that it has formed into a nanostructure consisting of a single-phase of ZrO_2. I–V measurement of the device that was shows gradual set and reset at 0.8 and 0.7 V, respectively,

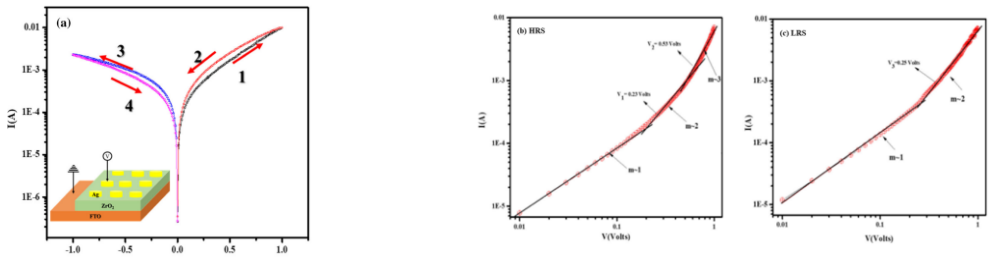


Fig.1. (a) I-V measurement of the switching device, (b) lnI-lnV of HRS of pure ZrO_2, (c)lnI-lnV of LRS of pure ZrO_2 device

which supports the presence of analogue switching in the device as shown in fig 1(a). The conduction mechanism has been investigated using an I–V fitting model in both a high and a low-resistive state, respectively.Fig.1(b) shows high resistive state of the device stays in the ohmic region at lower bias however at higher bias (above V=0.23 Volts) due to filling of available traps the electrical transport is dominated by space charge limited conduction (SCLC)[1]. Fig.1(c) shows, lnI-lnV in low resistance state, charge carriers are detrapped till V=0.25 Volts and the electrical conduction process is again governed by SCLC conduction[1,2].

References:

1. Cui, Yimin, et al. "Complementary charge trapping and ionic migration in resistive switching of rare-earth manganite $TbMnO_3$." *ACS Applied Materials & Interfaces* 5.4 (2013): 1213-1217.
2. *Tiangui, You, et al. "Bipolar Electric-Field Enhanced Trapping and Detrapping of Mobile Donors in BiFeO3 Memristors." (2014).*

L-053

Single step chemical synthesis of TiO_2 thinfilm/ α-Fe_2O_3 nanorods heterojunction for efficient photoelectrochemical water splitting

Govinda C. Behera[1,3*], Jatin K Rath[3], Somnath C. Roy[1]

[1]*Semiconducting Oxide Materials, Nanostructures, and Tailored Heterojunction (SOMNaTH) Lab, Department of Physics, IIT Madras, Chennai 600036, India*

[3]*Photovoltaic Lab, Department of Physics, IIT Madras, Chennai 600036, India*

Email- *gvndbhr143@gmail.com

ABSTRACT

Iron oxide based photocatalysts are not only environment safe but also highly suitable for solar water splitting using visible light. Particularly, α-Fe_2O_3 is an attractive material for its low band gap, readily availability on earth crust, relatively easy to synthesize, stable in harsh chemical environments e.g., basic solution. But the low electrical conductivity, short hole diffusion length hinders its successful applications in solar water splitting. Heterojunction formation with other material can help in charge separation with reduced recombination[1]. In this work we have synthesized vertically aligned Fe_2O_3 nanorods through single step chemical bath deposition method on Ti metal substrate. The heterostructure was characterized by XRD, FE-SEM, Uv-Vis-DRS, Raman, XPS, EDAX. The photoelectrochemical performance of the bare Fe_2O_3 ,TiO_2 and composite material were evaluated using three electrode photoelectrochemical cells. The composite one shows higher photo-current density as compared to bare Fe_2O_3 nanorods on FTO and bare TiO_2 on Ti metal substrate. Electrical impedance spectroscopy and Mott-Schottky plots were also studied, which shows low charge transfer resistance and better charge carrier density at the interface for TiO_2 thinfilm/Fe_2O_3 nanorods heterostructure sample. We have proposed an energy band diagram showing interfacial charge transfer mechanism, depending upon the device architecture and enhanced photocurrent.

Keywords: composite material; heterojunction; iron oxide; titanium dioxide; nano-structure

References

[1] G.C. Behera, S. Rani, N. Khatun, J.K. Rath, S.C. Roy, WS_2 nanosheets functionalized Fe2O3 nanorod arrays as a type II heterojunction for photoelectrochemical water splitting, Appl. Surf. Sci. Adv. 11 (2022) 100293. https://doi.org/10.1016/j.apsadv.2022.100293.

L-054

Studies of Mn doped Zinc Oxide nanoparticles thin film as electron transport layer in $MAPbI_3$ based photodetector

Ankur Rana[1,2] , Riya Malik[1,2], Megha Rana[1,2], Suraj P. Khanna[1,2], Ritu Srivastava[1,2] , C.K. Suman[1,2*]

[1]*CSIR-National Physical Laboratory, Dr. K.S. Krishnan Marg, New Delhi-110012, India*

[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India*

*Email: sumanck@nplindia.org

Mn-doped ZnO thin films with different doping concentration were synthesized by sol-gel method. We systematically investigated structural, optical and electrical properties of Mn-doped ZnO thin film with different concentrations. The XRD pattern confirmed the hexagonal wurtzite structure of the synthesized material. The surface morphology shows a good uniformity for all ZnO and Mn doped ZnO films. The flat absorption peak of all the studies thin films are in the range of 300nm to 365nm. The absorption is found to be broaden by 10nm of wavelength with the doping of Mn. The increase of Mn concentration in ZnO results to decrease of the optical band gap from ~3.3eV to 3.0eV. The electrical properties were studied on the device as shown in figure 1. The impedance studies shows the device may be modelled as a parallel RC electrical circuit. The synthesized thin films were introduced in $MAPbI_3$ based photodetector as electron transport layer.

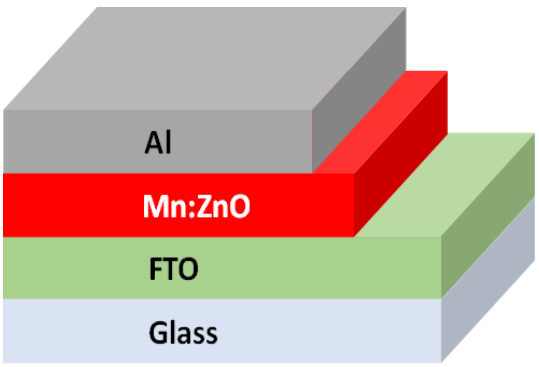


Figure 1. Shows the fabricated Device structure

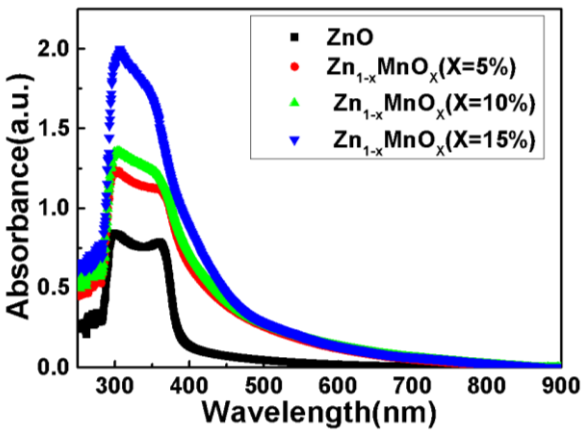


Figure 2. Shows the absorption vs wavelength graph

Keywords: bandgap, responsivity, mobility, interface, crystal.

L-055

Development of Ru-doped Titania Photoanodes for Dye Sensitized Solar Cell Application for various Internet of Things

Chaitali Jagtap, Vishal Kadam, Nandu Chaure and Habib Pathan

Advanced Physics Laboratory, Department of Physics,

Savitribai Pule Pune University, Pune- India 411007

(* Corresponding Author Email: habib.pathan@gmail.com)

Abstract. Over the past few decades, dye-sensitized solar cells (DSSCs) have received tremendous attention from the scientific community and commercial interests. Recently, the research of the DSSCs has advanced by leaps and bounds, especially in the field of pursuing a cost-effective solution process with high power conversion efficiency. In principle, the charge extraction is closely related to the kinetic selectivity depending upon the difference between the energy band levels of the photoanode and dye sensitizer layer. In the third regard, controlling the energy band positions over the interface, i.e., between the photoanode and dye sensitizer layer, is essential. Solar photovoltaics can harvest light energy and convert it into electrical energy in two ways, outdoor and indoor. The indoor utilization of emerging photovoltaics is promising, but power conversion efficiency (PCE) under indoor lighting is still challenging. A DSSC is one of the most excellent options to harvest and convert artificial indoor light into electricity. We observed a substantial improvement in the PEC of the solar cell under light illumination. Another important parameter in DSSCs is morphology, and it is easy to tune the morphology easily in TiO2 semiconducting materials. Nanorods are efficient electron transport layers with a high surface area and efficient dye loading. Here, we synthesized bare and Ru-doped TiO2 by a hydrothermal method to prepare nanorods. As shown in figure 1 dye sensitized solar cell is fabricated. The nanorods were characterized by various techniques, such as X-ray powder diffraction, scanning electron microscopy, UV-visible spectroscopy, photoluminescence, Raman spectroscopy, solar cell characterization, and impedance spectroscopy. Figure 2 shows the graph of current density vs voltage (J-V) of the rutile phase bare TiO2 and 1%, 3%, 5%, and 7% ruthenium-doped TiO2. The solar cell efficiency was the highest observed for 3% Ru-doped TiO2 with 0.78 V VOC, 6.48 mA/cm2 JSC, 0.7 FF, 3.54 Efficiency.

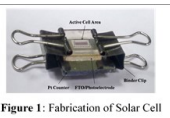


Figure 1: Fabrication of Solar Cell

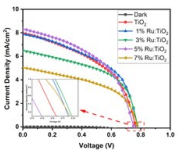


Figure 2 Graph of current density vs voltage (J-V) of the rutile phase bare TiO_2 and 1%, 3%, 5%, and 7% ruthenium-doped TiO_2.

Figure 3: Actual photograph of fabricated dye-sensitized solar cell Internet of Things working on fabricated Ru-doped TiO_2

ACKNOWLEDGEMENTS

CVJ is grateful to the Kiran Division, Department of Science and Technology, Government of India, for partial financial support through Women Scientist Scheme-A, vide Sanction Order SR/WOSA/PM-11/2019(G).

L-056

One-Step Deposition of Nanostructured $Ni(OH)_2$/rGO for Supercapacitor Applications

Vishal S. Kadam[1], Chaitali V. Jagtap[1], P. E. Lokhande[1,2*] Ravindra N. Bulakhe[3], Habib. M. Pathan[1,*]

[1]Advanced Physics Laboratory, Department of Physics, Savitribai Phule Pune University, Pune, India-411007

[2]Department of Mechanical, Manufacturing, and Biotechnology Engineering, Trinity College Dublin, Dublin 2, Ireland

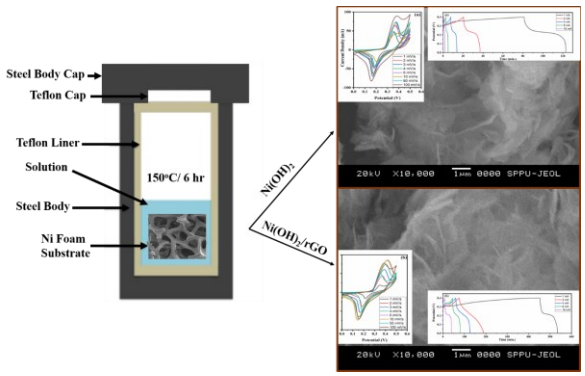
[3]Soft Energy Systems and Laser Applications Laboratory, School of Mechanical Engineering, Chung-Ang University, Seoul 06974, Republic of Korea

Corresponding Authors: prasadlokhande2007@gmail.com; pathan@physics.unipune.ac.in

Abstract:

To use nanostructured materials for practical applications, scaled quantity production becomes a necessary part of synthesis. The present work demonstrates the simple one-step easy synthesis of $Ni(OH)_2$/rGO nanocomposites for supercapacitor applications at scaled quantities. Direct deposition of $Ni(OH)_2$/rGO on nickel foam for a supercapacitor was performed using a hydrothermal method. Depending on the size of the autoclave, it is possible to deposit an active mass on a selected substrate. Crystallography and microstructural study results showed the formation of good quality and required morphology material. The electrochemical characterization performed on $Ni(OH)_2$/rGO/Ni exhibited a specific capacitance of 1900 Fg^{-1} at a current density of 1 Ag^{-1}. Capacitance retention of 92.5% is demonstrated after 5000 cycles at a scan rate of 50 mVs^{-1}. The obtained results suggest that the synthesized material can be used for supercapacitor applications at the mass scale.

Keywords: $Ni(OH)_2$, rGO, nanocomposite, supercapacitor.



Acknowledgment: Authors are thankful to DST SERD sponsored major research project via file no. DST/TMD/CERI/RES/2020/47(C) for partial financial support.

L-057

Defects associated K-doped ZnO nanoparticles for Hydroelectric Cell

Priyambada Sahoo, Ambesh Dixit*

Advanced Material and Device Laboratory (A-MAD), Indian Institute of Technology, Jodhpur, Rajasthan, India, 342030

* ambesh@iitj.ac.in

ABSTRACT

Recent global energy problem compels to explore green energy solutions to mitigate the energy crisis.[1] Hydroelectric cell (HEC) is designed to get electricity from the dissociation of water without any external energy source. The device comprises of Zn anode, Ag cathode assembled with pellet structure as active porous nanomaterials. Herein, potassium doped zinc oxide (K-ZnO) nanomaterial is synthesized using chemical auto-combustion process. The structural, microstructural, and electrical properties are studied to understand and establish the correlation between process parameters and device performance. The Figure 1(a), showing the nanopores morphology and room temperature Raman spectrum confirming the phase purity together with the onset of defect modes. A maximum current density of 42.33 $\frac{mA}{cm^2}$ and 0.63 V open circuit voltage with 27.29 mW off load power output is recorded for optimal device (Area = 4.84 cm^2). The results show the potential of scaling HEC device for any practical uses.

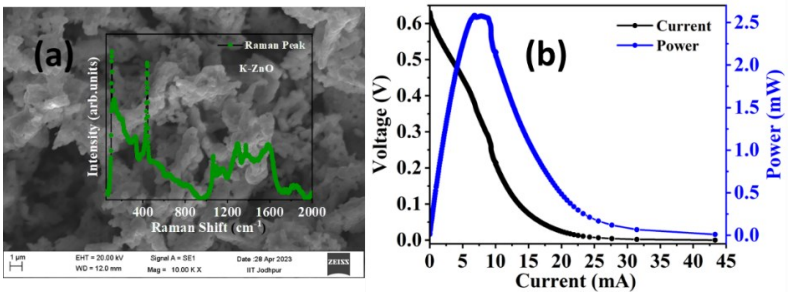


Figure 1. (a) Scanning electron microscopy image with inserted Raman spectra of K-ZnO nanoparticles, and (b) V−I polarisation plot of K-ZnO based Hydroelectric cell and power output when distilled water is sprinkle over the surface.

Keywords: Hydroelectric cell, nanomaterials, defects, V-I polarisation.

REFERENCES

[1] R. K. Kotnala, R. Gupta, A. Shukla, S. Jain, A. Gaur, and J. Shah, "Metal Oxide Based Hydroelectric Cell for Electricity Generation by Water Molecule Dissociation without Electrolyte/Acid," *J. Phys. Chem. C*, vol. 122, no. 33, pp. 18841–18849, 2018, doi: 10.1021/acs.jpcc.8b04999.

[2] I. Ayoub *et al.*, "Advances in ZnO: Manipulation of defects for enhancing their technological potentials," *Nanotechnol. Rev.*, vol. 11, no. 1, pp. 575–619, Jan. 2022, doi: 10.1515/ntrev-2022-0035.

L-060

Resistive switching characteristics of HfO_2 and Ta_2O_5 thin film for flexible non-volatile memory devices

Darshika Sanjay Khone*[1], Abhimanyu Singh Rana*

Centre for Advanced Materials & Devices, BML Munjal University, Gurgaon 122413, India

**Corresponding author:1)* darshikakhone@gmail.com

Flexible resistive random-access memory (RRAM) has received a lot of interest due to the rising need for various flexible electronic memory systems. This study used physical vapour deposition to create a highly flexible resistive switching (RS) memory device with a structure of Hfo_2/ITO coated polyethylene naphthalate (ITO-PEN) and Ta_2O_5/ITO coated polyethylene naphthalate (ITO-PEN). The devices demonstrated high transparency in the visible light range and repeatable and durable ReRAM features. Bipolar resistive switching has been observed in flexible Ta_2O_5/ITO-PEN and HfO_2/ITO-PEN-based ReRAM devices with low operating voltages. The device displays great performance, extraordinary flexibility, and mechanical endurance in bending tests. The proposed devices show promise for use in future flexible and transparent neuromorphic devices.

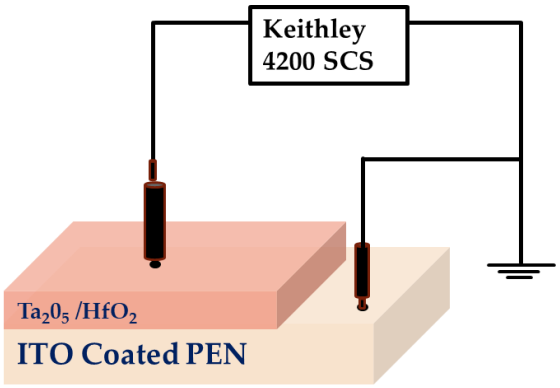


Figure: Schematic illustration of flexible resistive-switching devices composed of Hfo_2/ITO coated polyethylene naphthalate (ITO-PEN) and Ta_2O_5/ITO coated polyethylene naphthalate (ITO-PEN)

Keywords: Flexible Resistive Random Access Memory, Tantalum Oxide, Hafnium Oxide, ITO-PEN, Physical Vapor Deposition

L-067

$MoSe_2$/n-GaN hybrid structures for Enhanced UV Photodetector

Rahul Kumar[a,b], Vishnu Aggarwal[a,b], Sudhanshu Gautam[a,b], Aditya Yadav[a,b], Bheem Singh[a,b#], G. Gupta[a,b], S. S. Kushvaha[a,b,*]

[a]*CSIR-National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi, India 110012*

[b]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India 201002*

[#]*Presenting author: Bheem Singh*

* *Corresponding author E-mail: kushvahas@nplindia.org*

Abstract

Photodetectors (PDs) play an important role in the field of optical communication, space communication, flame detection, environmental monitoring, biochemical analysis, etc [1-2]. Gallium Nitride (GaN)-based Ultraviolet (UV) PDs are in great demand in the modern optoelectronics industry due to their ability to function in challenging environmental circumstances. Here, we have grown molybdenum diselenide ($MoSe_2$) thin film on the epitaxial GaN/sapphire (0001) by using the magnetron sputtering system. Raman vibrational in-plane (E_{1g}, E^1_{2g}) and out of the plane (A_{1g}) modes revealed that a good structural quality and semiconducting phase (2H) of $MoSe_2$ were grown. The surface morphology of $MoSe_2$ thin films was studied using AFM in tapping mode and rms surface roughness obtained to be 5.69 nm for the 2 μm × 2 μm scan area. The X-ray photoelectron spectroscopy measurement was performed to study the chemical and electronic states of $MoSe_2$. We fabricated metal-semiconductor-metal (MSM) type PDs devices on these hybrid $MoSe_2$/GaN structures i.e. on the film (lateral) and junction (vertical). The photo-response measurements have been done on these devices at various external voltages (0.5-5) V and laser powers (1-15) mW using a laser source of wavelengths 355 nm. Photoresponse measurement revealed high photoresponsivity for $MoSe_2$/GaN hybrid structures which paves the way for the fabrication of enhanced UV-PDs for various applications.

References:

(1) Y. Tian, Y. Shao, Y. Wu, X. Hao, L. Zhang, Y. Dai, and Q. Huo, Sci. Rep. 5: 10748 (2015).

(2) V. Aggarwal, S. Gautam, U. Varshney, A. K. Mauraya, R. Kumar, G. Gupta, R. Ganesan, M. S. Kumar, S. S. Kushvaha, J. Mater. Res. 38: 429-438 (2023).

L-069

Synthesis and characterization of oxime modified graphene oxide: An efficient corrosion inhibitor

Priyanka Choudhary[a], Dalip S Shekhawat[b] and Veena Dhayal[a]

Department of Chemistry, Manipal University Jaipur, Jaipur-303007, Rajasthan, India

Department of Automobile Engineering, Manipal University Jaipur-303007, Rajasthan, India

*E-mail: dhayal21v@gmail.com, Tel. No. +91-141-3999100 Ext. 320

Abstract

Graphene oxide (GO) is considered as an efficient corrosion inhibitor to protect metals and their alloys such as, iron, aluminum, steel. But due to high surface energy of GO, which induces their agglomeration, their dispersion in a polymer paint is a challenging task. Modification of GO is suggested to reduce its agglomeration in a polymer paint. In the current study we have modified GO nano-sheets with an organic moiety, acetoxime. The acetoxime modified graphene oxide (GO-Ac) was characterized by Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction analysis (XRD), UV-Vis spectroscopy and the surface analysis of the materials were done using SEM and EDX analysis. The corrosion inhibition effect of GO and GO-Ac on Aluminium 5083 in 3.5% NaCl solution were investigated by electrochemical data, EIS and PD. The obtained results suggest that modification of GO with acetoxime enhances its corrosion protection efficiency for aluminum metal.

L-070

Optimized and Efficient Silicon Nanostructures integration for antibacterial behavioural study using Metal Assisted Chemical Etching

Shubham Gupta [1,2], Aayush Jain [1,2], Harsh Vardhan[1,2], Sagar Yadav[1,2], Dhaneshwar Mishra [3,4*], Kulwant Singh [1,2*]

[1]FlexMEMS Research Centre (FMRC), Manipal University Jaipur-303007,
[2]Department of Electronics & Communication Engineering, Manipal University Jaipur-303007,
Rajasthan, India
[3]Multiscale Simulation Research Centre (MSRC), Manipal University Jaipur-303007,
[4]Department of Mechanical Engineering, Manipal University Jaipur-303007,
Rajasthan, India
Address for Correspondence: dhaneshwarmishra@jaipur.manipal.edu, *eckulwant@gmail.com

Abstract:

Of the various techniques used for synthesis of SiNs involving top down photolithography approach and Chemical Vapour Deposition method generating fine Si nanowiskers under bottom up SiNs fabrication sequence, we mainly discuss about MAC-etching technique evolved as a cost effective, morphological controlled synthesis sequence producing unique geometrical orientations of SiNs functioned by operating parameters viz. Temperature, etching time and design parameters like orientation of Si wafer, type of Si wafer, geometry of metal catalyst etc. Further, samples obtained after MAC-etching of Si were transferred to FESEM and eventually realized using iMAGEJ software simulation tool. The so obtained plots showed large proportion of particles having high surface to volume ratio functioning as potential candidates for convenient bacterial strains (E. Coli and S. Aureus) interfacing and carrier.Highly nanoporous SiNs demonstrates enormous drug loading capacity, targeted drug delivery, negligible bacterial resistance and efficient destruction of bacterial strain cells exploited as an effective replacement for antibiotics related treatment.The governance of operating parameters (etching time, operating temperature) determines the morphologies of as-synthesised SiNs which in turn controls the bacterial response to different morphology. Moreover, the role of Ag+ used as metal catalyst for chemical etching has been found to be critical in inhibition of bacterial populations and its malfunctioning. The results highlights that depositing Ag+ ions from outside on the so generated SiNs exhibited better results in terms of toxicity of bacterial growth when using mere Ag+ suspended TSB solution.Our work prospects projects SiNs as smart bio-implanatable material for effective interfacing with bacterial strains along with SiNs accompanied Ag+for easy inhibition and malfunctioning of bacterial populations.

Keywords: Silicon Nanostructures (SiNs), Silicon Nanoparticles (SiNPs), Metal Assisted Chemical Etching (MAC - Etching)

Selected Results:

Si <111> p-type wafer was chemically etched at a temperature of 50 ˚C with etching time 5min to yield SiNs as shown in Figure 1 (SEM image of the MAC-etched Si at given operating conditions). The results of SEM image were populated by iMAGEJ simulation tool to obtain plot as shown in Figure 2 highlighting the fact that majority of the SiNs were in low surface to volume ratio range, thus posing huge potential for easy interface with bacterial cells.

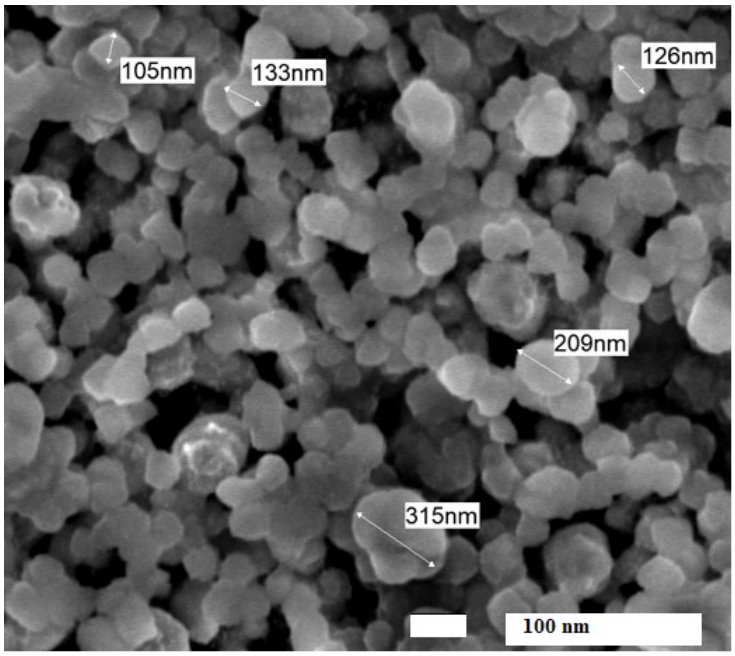


Figure 1: Top view of Si (p-type) Nanoporous structures (shown in scale of 100 nm) were observed for etching time 5 min at temperature of 50 ˚C with etchant HF/$AgNO_3$ taken in molar ratio of 4.6 M/0.02 M.

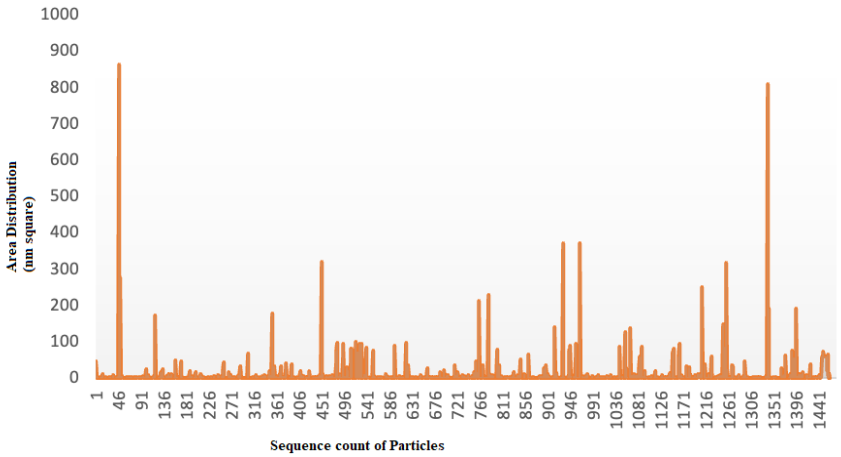


Figure 2: Plot between sequence counts of particles versus area of corresponding particle using iMAGEJ analysis.

Acknowledgement

The authors are thankful tothe Sophisticated Analytical Instrument Facility (SAIF),Manipal University Jaipur to provide the Field Emission Scanning Electron Microscope (FESEM) analysis support.

References:

[1]. Peng K, Hu J, Yan Y, Wu Y, Fang H, Xu Y, Lee S, Zhu J (2006) Fabrication of Single-Crystalline Silicon Nanowires by Scratching a Silicon Surface with Catalytic Metal Particles. Adv Funct Mater, 16, 387-394

[2]. Peng K, Fang H, Hu J, Wu Y, Zhu J, Yan Y, Lee S (2006) Metal-Particle-Induced, Highly Localized Site- Specific Etching of Si and Formation of Single–Crystalline Si Nanowires in Aqueous Fluoride Solution. Chemistry- A European Journal, 12, 7942-7947

[3]. Chen H, Wang H, Zhang X-H, Lee C-S, Lee S-T(2010) Wafer-Scale Synthesis of Single-Crystal Zigzag Silicon Nanowire Arrays with Controlled Turning Angles. Nano Letters, 10(3), 864-868

[4]. Pham VT, Dutta M, Bui HT, Fukata N (2004) Effect of nanowire length on the performance of silicon nanowires based solar cell. Advances in Natural Sciences: Nanoscience and Nanotechnology, 5, 1-5

[5]. Han H, Huang Z, Lee W(2014) Metal assisted chemical etching of silicon and nanotechnology applications. NanoToday, 377, 1-34

[6]. Kim J, Han H, Kim Y-H, Choi S-H, Kim J-C, Lee W (2011) Au/Ag Bilayered Metal Mesh as a Si EtchingCatalystfor Controlled Fabrication of Si Nanowires. ACS Nano, 5(4), 3222-3229

[7]. Qi, G., Li, L., Yu, F., & Wang, H. (2013). Vancomycin-Modified Mesoporous Silica Nanoparticles for Selective Recognition and Killing of Pathogenic Gram-Positive Bacteria Over Macrophage Like Cells. ACS Applied Materials & Interfaces, 5(21), 10874–10881.

[8]. Zhai, X.; Song, B.; Chu, B.; Su, Y.; Wang, H.; He, Y. Highly fluorescent, photostable, and biocompatible silicon theranostic nanoprobes against Staphylococcus aureus infections. Nano Res. 2018, 11, 6417–6427

[9]. Kumar, A., Devi, M., Kumar, M., Shrivastava, A., Sharma, R., Dixit, T., Singh, V., Shehzad, K., Xu, Y., Singh, K. and Hu, H., 2022. Silicon Nanostructures and Nanocomposites for Antibacterial and Theranostic Applications. Sensors and Actuators A: Physical, p.113912.

L-072

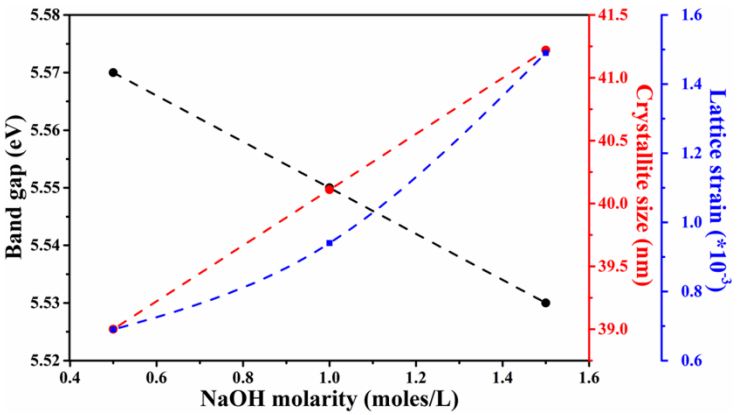
Band Gap Tuning in Calcium Hydroxide-Nitrate Nanocomposite Materials

Akash[1], Vipin Kumar[2], Jin Seog Gwag[2], Rahul Singhal[3], Moti Kumar Jha[4], Anoop Kumar Mukhopadhyay[5], Pushpendra Kumar[1]

[1]*Department of Physics, Manipal University Jaipur, Jaipur-303007, Rajasthan, India*
[2]*Department of Physics, Yeungnam University, Gyeongsan, 38541, Gyeongbuk-do, South Korea*
[3]*Department of Physics, Malaviya National Institute of Technology, Jaipur-302017, India*
[4]*Sophisticated Analytical Instrument Facility, Manipal University Jaipur, Jaipur-303007, Rajasthan, India*
[5]*Department of Physics, School of Basic Sciences and Research, Sharda University, Greater Noida 201310, Uttar Pradesh, India.*
pushpendra.kumar@jaipur.manipal.edu

Abstract:
This study reported the band gap engineering in calcium hydroxide-nitrate nanocomposite materials (CHNNCs). The CHNNCs are produced by the simple chemical precipitation technique from an aqueous $Ca(NO_3)_2$-NaOH system. The molarity of precipitator NaOH is deliberately varied from 0.5M, to 1M, and 1.5 M by keeping the constant molarity (e.g., 1M) of the precursor $Ca(NO_3)_2.4H_2O$ solution. After that, the produced CHNNCs are examined using XRD, FESEM, FTIR, and UV-Vis spectroscopic methods to investigate the structural, morphological, surface functional, and optical characteristics of the various synthesized CHNNCs. The XRD study suggests an increase in crystallite size from 53 nm to 99 nm. The increase in crystallite size with an increase in the molarity of precipitator NaOH is discussed in terms of nucleation and growth due to the presence of sodium nitrate. The FESEM photomicrographs also exhibit the impact of sodium nitrate on the surface morphology of the various synthesized CHNNCs. The UV-Vis spectroscopy results demonstrate accordingly a decrease in band gap from about 5.57 eV to about 5.53 eV with the increase in crystallite size. The regulated development and nucleation of the $Ca(OH)_2$-nitrate nanocomposite shape opens up a wide range of potential applications.

Keywords: Calcium hydroxide-nitrate nanocomposite, Molarity variation, Sodium nitrate, nucleation and growth.



L-079

Influence of heavy ion (Ar) irradiation on tungsten oxide (WO_3) thin films and their optical, electrical, photocatalytic and post photocatalytic properties

Shanmugapriya Periyannan[1], Govinda C Behera[1], Kabi Raj[2], Sanju Rani[3]*.

Affiliation: [1]Indian Institute of Technology Madras, India; [2]IUAC – Inter University Accelerator Center, New Delhi, India; [3]SRM University, Ramapuram, Chennai, India.

*Corresponding author – Sanju Rani.

We report the study of the influence of 0.5 MeV Ar2+ ion irradiation on WO3 thin films and its effect on their optical, electrical, structural and photocatalytic properties. WO3 thin films were sputter deposited and annealed in presence of air. The films were analyzed by varying techniques like X-Ray diffraction(XRD), Raman spectrometer, Photoluminescence(PL), Scanning Electron Microscopy(SEM&EDAX), Diffuse Reflectance Spectroscopy(DRS) and, X-ray photoelectron spectroscopy(XPS). XRD confirmed the presence of WO3 and showed evidences of structural changes on account of ion irradiation, whereas SEM microstructures remained the same. Notable variations in the atomic percentages of tungsten and oxide was seen in EDAX, while optical and electrical analyses also showed significant effects as an effect of irradiation. And the photo electrochemical studies on irradiated WO3 showed improved photo-response as compared to non-irradiated WO3. Besides, post photocatalytic studies were carried out to understand the changes on the electronic structure of the material.

Keywords: ion irradiation, WO3, thin films, electronic structure, photocatalysis.

Best Poster Winners

Name	Poster Title	Affiliation
Sangeeth John	Solar light assisted simultaneous power generation and water purification utilizing brownmillerite and chalcogenide electrodes	Anna University, Chennai
Lavudya Devendar	Intercalated and surface water-mediated Electromechanical Response of 2D Materials on Flexible Substrates.	Indian Institute of Technology Madras
Subodh Khamari	A study of Exchange Bias effect in Fe_3O_4@MnO Core shell Hetero nanostructures	Indian Institute of Technology Bhubaneswar
Garima Gupta	$ZnCo_2O_4$ - g-C_3N_4 as an electrode material for photo-assisted Zinc-ion supercapacitor application	Indian Institute of Technology Madras
Sandhyarani Sahoo	High Responsivity in Monolayer MoS_2 Photodetector via Controlled Interfacial Carrier Trapping	Institute of Physics, Bhubaneswar
Tanushri Das	Enhanced Ammonia Sensing Performance of Zn Doped $BaFe_{12}O_{19}$ Nanoparticles-Based Sensor for Noninvasive Detection of Ammonia in Exhaled Breath of Patients with Renal Diseases	CSIR- Central Glass and Ceramics Research Institute, Calcutta
Debanjan Maity	Effect of Cuprous Oxide Nanocubes and Antimony Nanorods on the Performance of Silicon Nanowires Based Quasi Solid-state Solar Cell	Indian institute of technology Hyderabad
Akshpreet Kaur	Impact of Deformation on the Structural and Electronic Properties of MWCNT-PDMS based Triboelectric Nanogenerator	Panjab University, Chandigarh
Rahul Kumar	Nanoflakes Bi_2Se_3 thin film on $TiSe_2$/Ti and Ti metal foil for photoelectrochemical water splitting application	CSIR-National Physical Laboratory, Delhi
Neju Mathew Philip	Tuning of electronic properties of co-evaporated Ag: SnS thin films for heterojunction devices	National Institute of Technology Tiruchirappalli

Profile of Prof. Somnath C Roy

ACADEMICS

- Born and Schooling : Jamshedpur
- BSc (Physics Hons.) , BHU Varanasi 1997
- MSc (Solid State Physics) , BHU Varanasi 1999
- PhD (Physics) IIT Delhi 2005

COURSES TAUGHT AT IIT MADRAS

- PH 1010 General Physics and Mechanics
- PH1020 Electromagnetics
- PH 3120 Waves and Oscillations
- PH 5160 Semiconductor Physics
- PH 7320 Characterization of Materials
- PH 5340 Dielectric, Optical and Magnetic Materials
- PH 7890 Foundations of Experimental Physics
- ID 7650 Introduction of Nanoscience and Nanotechnology

OTHER PROFESSIONAL ROLES

- Chairman , Glass Blowing Section, IIT Madras 2021-
- Warden, Ganga Hostel, IIT Madras, 2019-
- Faculty Coordinator, Facilities and Requirement (F & R) Team , Saarang (IITM Student Festival) 2019 -
- Member , Board of Academic Research (BAR) , IIT Madras 2014 -16
- Member, Board of Industrial Consultancy and Sponsored Research (ICSR) , 2016-17
- Member, Materials Research Society of India (MRSI), and Materials Research Society (MRS), USA

DOI: 10.47715/JPC.B.978-93-91303-85-3
ISBN: 978-93-91303-85-3

ISBN 978-93-91303-85-3
9 789391 303853

JUPITER PUBLICATIONS CONSORTIUM
www.jpc.in.net