CENTER FOR ADVANCED MATERIALS AND DEVICES (CAMD)

BML MUNJAL UNIVERSITY™

A Hero GROUP INITIATIVE

CENTER FOR ADVANCED MATERIALS AND DEVICES (CAMD)

About CAMD

One of the objectives of BML Munjal University (BMU) is to support inter or cross-disciplinary research in the university. In line with the vision of BMU, a Centre for Advanced Materials & Devices (CAMD) was created with the aim to provide basic and advanced research facilities to carry out translational research in different areas of science, engineering and technology including computational areas.

The CAMD enables faculty and researchers to work on cutting edge technologies and to keep pace with the developments taking place globally. The facility is encouraged to be used by postgraduate, doctoral and postdoctoral researchers and also the faculty members from all the departments/schools.

It is equipped with several scientific instruments that are available in some of the renowned universities/ IITs/ Institutes in India. The center is broadly classified into three research facilities:

- **Thin-films and Measurement Lab**
- **Material Characterization Lab**
- **Device Fabrication Lab**

Thin films and measurement lab includes some advanced physical papor deposition systems (sputtering, electron-beam-evaporation, cathodic-arc) and plasma enhanced chemical vapor deposition for thin films and surface engineering research.

Material characterization lab has some sophisticated equipment such as X-ray diffraction, scanning electron microscope, an Integrated system having atomic force microscope, scanning near optical microscope and Raman spectroscopy for advanced materials characterization.

Device and fabrication lab includes the instruments such as the glove box and laser pattern generator system.

BROAD RESEARCH AREAS

- ✓Large Area Flexible Electronics

  Carbon, Amorphous & Organic Materials

- ✓Energy storage

  Supercapacitors, Lithium Ion Batteries

- ✓Surface Engineering

  Tribological & Hard coatings, Optical coatings

- ✓Nanomaterials for Photo-catalysis

  Water Remediation & Purification

- ✓Artificial Intelligence

  Finding New Materials, Neuromorphic Devices

- ✓Aluminium Alloy Processing & Recycling

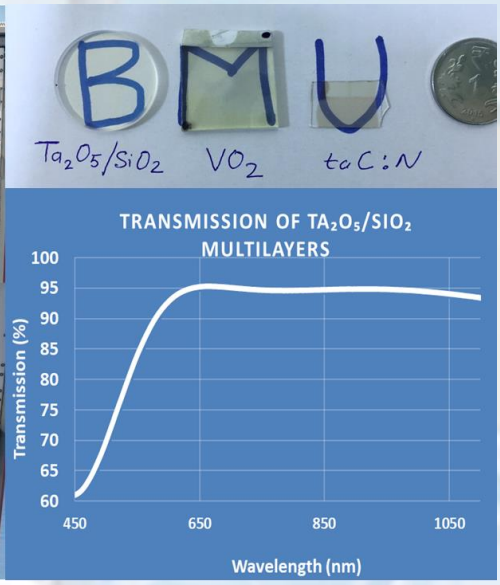
ONGOING AND COMPLETED PROJECTS

- ✓ Design, development and implementation of a course on Thin film Technology and Surface Engineering for Human Resource Development and Research with a focus on sensors and applications for Automobile industry, *sponsored by Royal Academy of Engineering (UK) [£ 50,000]* - Ongoing
- ✓ Development of Thermal Diffusion Barrier coatings for Cam chain Pins, *sponsored by Rockman Industries [Rs 17.5 Lakh]* – Ongoing
- ✓ ILow Dimensional Functional Materials for Energy Storage Applications, *sponsored by BML Munjal University under Seed Grant [Rs 5 Lakhs]* - Ongoing
- ✓ Assessment of Mechanical and Structural Properties of High - performance Polymer Blends for Automotive, Structural and Transmission Applications, *sponsored by BML Munjal University under Seed Grant [Rs 2.5 Lakhs]* – Ongoing
- ✓ Investigations of structure and properties of H bonded unsymmetrical n-type Organic semiconductors: towards efficient organic field effect transistors, *sponsored by Department of Science & Technology (DST) [Rs. 17 Lakhs]*- Completed

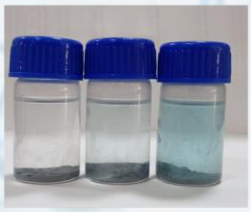
RESEARCH HIGHLIGHTS

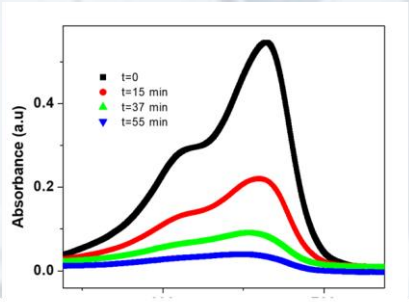
Hard & Wear Resistant Coatings

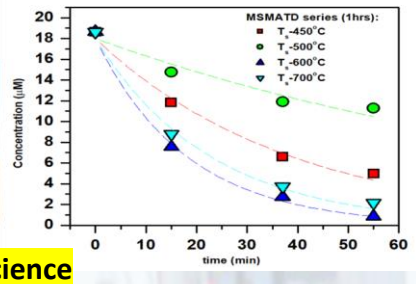
Transparent Electronics & Optical Coatings



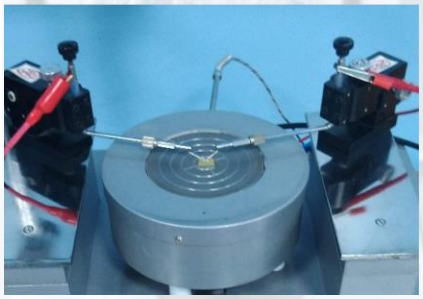
Materials for Water Remediation & Purification

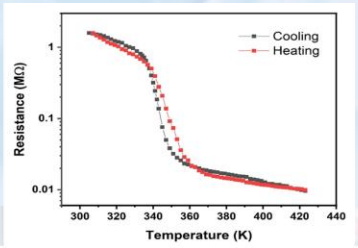


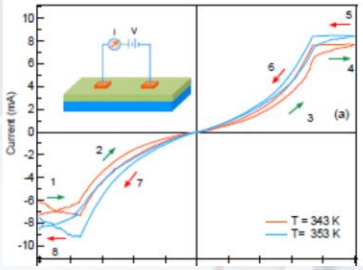




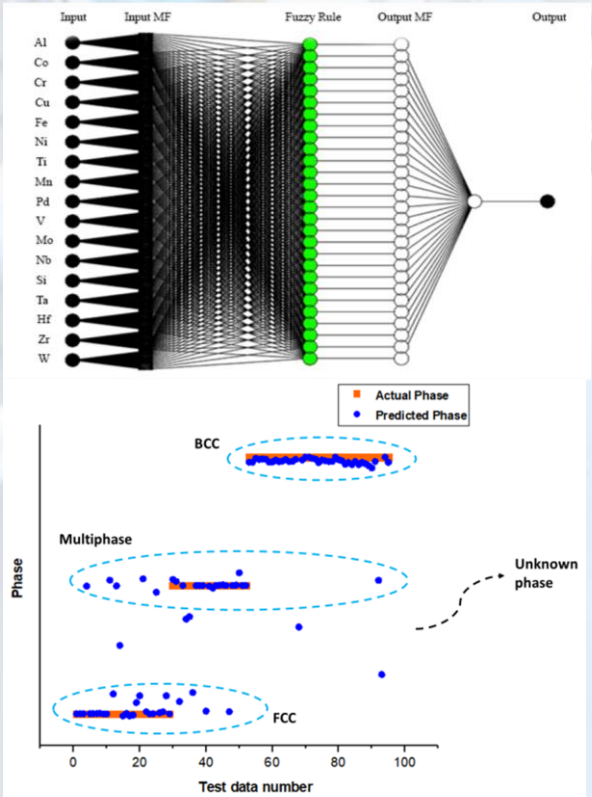
Materials for Sensors & Neuromorphic Devices



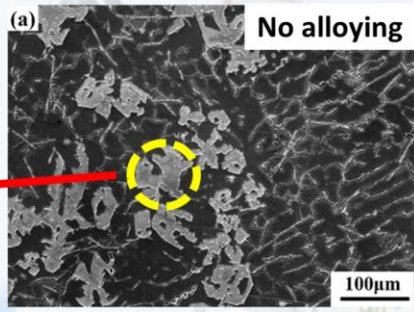


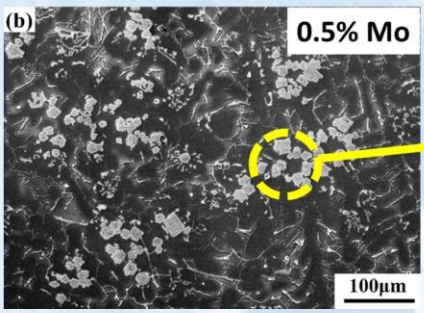


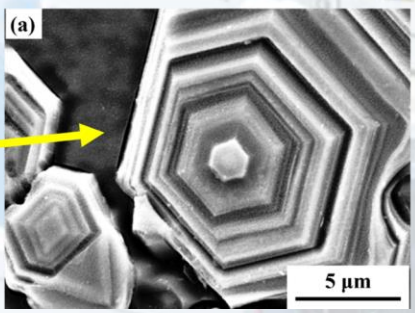
AI for Materials Science



Aluminium Alloy Processing & Recycling







SERVICES OFFERED AND INSTRUMENT CHARGES

Thin films and coatings: CAMD offers research consultancy in different research area, especially coatings using physical vapor deposition techniques and plasma enhanced chemical vapor deposition. Following are the instrument charges for various coatings facilities

Sr. No.	Equipment Name	Charges for Other Research Organization/Institute	Charges for Industry
1.	PECVD Clustor Tool	Rs. 1000/run excluding dep. material cost	Rs. 3000/run excluding dep. material cost
2.	RF/DC PECVD System	Rs. 750/run excluding dep. material cost	Rs. 1500/run excluding dep. material cost
3.	Cathodic Arc	Rs. 750/run excluding dep. material cost	Rs. 1500/run excluding dep. material cost
4.	RF/DC Sputtering System	Rs. 750/run excluding dep. material cost	Rs. 1500/run excluding dep. material cost
5.	E- Beam Thermal Evaporation System	Rs. 750/run excluding dep. material cost	Rs. 1500/run excluding dep. material cost

Materials characterization and testing: CAMD offers testing of various materials using some of the state-of-the-art tools. Following are the related instrument charges

Sr. No.	Equipment Name	Charges for Other Research Organization/Institute	Charges for Industry
1	Surface Profilometer	Rs. 300/hour	Rs. 600/hour
2.	X-ray Diffraction (XRD)	Rs. 500/hour (powder) Rs. 550/h (Thin film)	Rs. 1000/hour (powder) Rs. 1100/h (Thin film)
3.	UV - Visible System	Rs. 250/hour	Rs. 500/hour
4.	FTIR System	Rs. 300/hour	Rs. 600/hour
5.	EDAX (+SEM)	Rs. 500/hour	Rs. 1000/hour
6.	SEM (without coating required)	Rs. 400/hour	Rs. 800/hour
7.	Graphite coating for SEM	450/Sample	700/Sample
8.	Gold coating for SEM	550/ Sample	900/ Sample
9.	Raman Spectrometer	Rs. 500/hour	Rs. 750/hour
10.	NSOM Spectrometer	Rs. 500/hour	Rs. 1000/hour
11.	AFM	Rs. 500/hour	Rs. 1200/hour
12.	Laser Pattern Generator	Rs. 500/hour	Rs. 1000/hour
13.	Olympus Microscope	Rs 50/Sample	Rs 100/Sample

Device fabrication: CAMD offers microfabrication of devices using laser photolithography. The glove-box is also available for the research on organic electronics and Li-Ion battery.

Sr. No.	Equipment Name	Charges for Other Research Organization/Institute	Charges for Industry
1	Glove Box	Rs. 400/hour	Rs. 600/hour
2.	Integrated Glove Box + Thermal Evaporation	Rs. 750/run excluding dep. material cost	Rs. 1500/run excluding dep. material cost
3.	Laser Pattern Generator	Rs. 500/hour	Rs. 1000/hour

SERVICES OFFERED AND INSTRUMENT CHARGES

Other facility usage charges

Sr. No.	Equipment Name	Charges for Other Research Organization/Institute	Charges for Industry
1.	DI Water system	Rs. 7/Litre	Rs. 14/Litre
2.	Spin Coating System	Rs. 100/run	Rs. 200/run
3.	Kaithley Semi conductor Characterization System	Rs. 200/hour	Rs. 200/hour
4.	Kaithley Electrometer	Rs. 100/hour	Rs. 200/hour
5.	Custom designed opto-electronic measurement unit	200/Sample	500/Sample
6.	Custom designed field-emission measurement unit	250/Sample	550/Sample
7.	Ultrasonication cleaning	30/Sample	50/Sample

Charges for Other Research Organization/Institute = Students, researchers belonging to educational/research institutes (Materials should be provided by the user)

Charges for Industry= Industry not linked to academics (Materials should be provided by the user)

PLASMA ENHANCED CHEMICAL VAPOR DEPOSITION CLUSTER TOOL (HHV)

Features

Chamber Size: 500 mm X 500 mm
Substrate Size: 150 mm (dia.)
Base Vacuum: <1 x 10^{-6} mbar
Power (RF): 300 W (Max)
Temperature: 400^{o} (Max)
Chambers: 4 (PECVD), 2 (Transfer & Load Lock
Gases: SiH_4, PH_3 B_2H_6 , NH_3, CH_4, N_2O, H_2
Safety: Detection of these gases and alarm system, Interlock

Capabilities

This high performance multi-chamber Plasma Enhanced Chemical Vapor Deposition (PECVD cluster tool is used for the deposition of thin films and multilayer for Solar Cell, Thin Film Transistors and Sensors applications. Particularly, this is conventionally used for amorphous, microcrystalline and nanocrystalline silicon based doped, un-doped, and its alloy materials in Individual process chamber, connected to central transfer chamber with load-lock having magnetic arm for substrates transfer. Gases after being used in PECVD process are neutralized by a scrubber before releasing in atmosphere.

PLASMA ENHANCED CHEMICAL VAPOR DEPOSITION (HHV)

Features

Chamber Size: 500 mm X 500 mm
Substrate Size: 150 mm (Max)
Base Vacuum: <1 x 10^{-6} mbar
Power: 600 W (Max) for RF, 2kW (1 kV, 2 A) for DC
Temperature: 400^{o} (Max)
Gases: CH_4, C_2H_2, N_2, O_2, H_2, Ar
Safety: Gas detection and alarm system, Interlock

Capabilities

This PECVD system is suitable for the deposition of carbon based thin films and nanomaterials. The plasma can be created by both radio frequency (RF) and direct current (DC) discharge between electrodes.

RF AND DC MAGNETRON SPUTTERING (HHV)

Features
Chamber Size: 500 mm X 500 mm
Substrate Size: 250 mm (Max)
Base Vacuum: <1 x 10^{-6} mbar
Power: 600 W (Max) for RF, 2kW (1 kV, 2 A) for DC
Temperature: 300^{o} (Max)
Gases: N_2, O_2, Other: Substrate Rotation

Capabilities: This system is versatile for depositing thin film with uniformity and reliability. The DC and RF power supplied gives flexibility in depositing metallic and insulating materials respectively. There is an option of introducing Nitrogen and Oxygen in order to react with the sputtered material to deposit oxides and nitrides.

RF DC CATHODIC ARC (HHV)

Features:
Chamber Size:500 mm X 500 mm, Substrate Size: 250 mm, Base Vacuum: <1 x 10^{-6} mbar
Power: 10 kW (50V, 200A) for arcing, 2 kW (10 V, 200 A) for substrate biasing, 2kW for magnetic filtering
Temperature: 300 ^{o} (Max), Gases: He, H_2, N_2

Capabilities: Cathodic arc deposition is used to deposit thin films of various allotropes of carbon (especially diamond like carbon) and metal-nitrides for hard coatings. This system is also equipped with a linear filter to remove macro-particles

ELECTRON BEAM AND THERMAL EVAPORATION SYSTEM (HHV)

Features:
Chamber Size: 500 mm X 500 mm, Substrate Size: 200 mm dia. (Max), Base Vacuum: <1 x 10^{-6} mbar, Temperature: 300^{o} (Max) IR Lamps, Power (Electron Beam): 6 kW (10 kV, 600 mA), Power (Thermal Evaporation): 2 kV (10 V, 200 A), Thickness Monitoring: Quartz crystal , Other: Substrate Rotation, Gases: N_2, O_2

Capabilities: This versatile system is capable of depositing variety of thin films, especially for metals, metal-oxides and metal-carbides and multilayers without breaking the vacuum. There are two source filaments for thermal evaporation and one boat for EBM.

SNOM/AFM/RAMAN SPECTROSCOPY (WITEC ALPHA 300)

Features

Photoluminescence & Raman Spectroscopy: Acquisition of a single spectrum and Imaging, 3D confocal Raman imaging
AFM operation: Contact, Non-Contact, Taping Mode Imaging and Force Spectroscopy.
SNOM modes: bottom up, top down mode, collection mode, Confocal Microscopy in Transmission, Reflection, SNOM-AFM combinations
Vibration Isolation: Active
Variable temperature: 100^{o} (Max)

Capabilities

This is an integrated system for Raman imaging in combination with Scanning Near-field Optical Microscopy (SNOM), atomic force microscopy and confocal microscopy. This system is more suitable for solid samples in thin films and powder form. It is equipped with two Lasers having 535 nm & 325 nm wavelengths for Raman Spectroscopy, Photoluminescence and SNOM measurements.

X-RAY DIFFRACTION (EMPYREAN, PANALYTICAL)

Features

X-Ray Generator: 4 kW (60 kV, 100 mA),
Goniometer: -111 < 2θ < 168^{o} max range,
0.0001^{o} min Increment, 15^{o}/s max angular speed
Sample Stage: With X-Y-Z Motion
Samples: Powder and Thin Films
Detector: Proportional Counter
Radiation Level: < 1 µpSv per hour

Capabilities

This is a multi-purpose instrument, suitable for samples in both powder and thin film form. It can be used in both X-ray diffraction and X-ray reflectivity mode. This system has movable sample stage in X-Y-Z directions. In addition to conventional structural information, this system has flexibility of measuring various properties in thin films such as thickness and stress.

GLOVE BOX (DANVEC)

Features

Maximum power rating: 2.654Kw
Supply pressure range: 6 bar
Flow rate: 2.3 lpm
Thermal evaporation system integrated for depositions.

Capabilities:

Glove box is widely used in organic electronics, solar cell and energy storage devices. It is also used to store materials and carry reactions in inert air and moisture free conditions. This system is equipped with a thermal evaporation in-situ.

LASER PATTERN GENERATOR (LASER LITHOGRAPHY)

Features

Direct-write (maskless) lithography system
Laser sources of two different wavelengths: 405 nm and 356 nm.
CleWin software for generating patterns.
Spin coater available for generating photoresist films of desired thickness.

Capabilities:

Resolution: Patterns of dimensions of 1 microns can be achieved.
Lenses: 1, 2, 4 and 8 microns.
It is used in fabrication of submicron devices for superconductivity, photovoltaics, integrated optics, MEMs, microfluidics, biosensors, and field effect transistors.

Faculty Profile

Dr. A. K. Prasadd Rao, Faculty in-charge Materials Characterization Lab

Dr. A.K. Prasada Rao (Prasadd Ayyagari) is specialized in casting and solidification processing of light-weight alloys. Some of his earlier contributions include the development of technology for producing an Al-clad Mg-alloy strip through twin-roll casting, which inspired and attracted the attention of many other researchers. With his team at Brunel University, UK, he significantly contributed to the development of melt-conditioning and successfully upscaled to SAPA aluminium (Sweden). As a part of this work, he had an opportunity to work with University of Oxford, UK. He has authored around 60 articles, in peer reviewed journals and conference proceedings with nearly 660 citations and holds two patents. His research interests include solidification processing of metallic systems and sustainable manufacturing of metallic systems; 3D-printing of metallic materials. Dr. Rao also serves as a reviewer for several research funding bodies of Malaysia, Czech Science Foundation, and many reputed journals in his domain.

Dr. Abhimanyu Singh Rana, Faculty in-charge Thin Films and Measurement Lab

Research Area

Oxide Electronics

Low dimensional materials

Solar and Energy Storage

Dr A S Rana did his PhD in Physics from University of Pune in the year 2012, while working at CSIR-National Chemical Laboratory, India. His PhD research was mainly focused on studying quantum tunneling and resistive switching properties in spintronic materials and devices. Thereafter, he moved for his postdoctoral research at National University of Singapore (2012-2014), subsequently at the University of Twente (2015-2017) through selection by prestigious funding agency (NWO/FOM) in the Netherlands. During postdoctoral research, he led projects on the growth of thin films and nanomaterials using physical vapor depositions, nano- and microfabrication of devices and characterization. He has authored 20 publications in SCI Journals (mostly Q1) with with average impact factor ~ 5+, hold one 1 US Patent and more than 40 publications in International conferences. He visited USA, Australia, Singapore, Netherlands, Italy, Luxembourg, Germany, Switzerland and China for different scientific assignments and conferences

Faculty Profile

Dr. Suchitra Rajput Chauhan, Materials Characterization Lab

Dr. Suchitra Rajput Chauhan did her schooling in Delhi and graduation in physics honors from Delhi University. She studied at IIT Delhi for her post-graduation, M.Sc in Physics and then M.Tech in solid state materials. She researched in Thin Film Laboratory, IIT Delhi for PhD degree. During her doctorate she worked on bulk and tapes of High temperature superconductors. She worked as project scientist on spintronics at IIT Delhi. She went to Turkey for post doctorate on superconducting wires. She visited many countries including USA, France, Turkey, etc. and interacted and worked at many places. She wrote 15+ journal papers as corresponding author and first author in reputed journals and multiple papers in conferences. She is designed parts of many instruments. She received many fellowships and awards. She recently hold a SERB supported and Royal Academy supported National level conference as a convener. She has been editor of research proceeding with ISBN. Dr. Suchitra has worked in multiple research fields including Thin films, superconductors, tapes, wires, phase transitions, memory alloys, spintronics. She is expert of electrical and magnetic characterization, thin film fabrication, and x-ray diffraction. Presently, she is actively researching on remediation of textile dye contaminated water via photo-catalysis .

Dr. Nirupama M.P. Faculty Member- Device & Fabrication Lab

Dr.Nirupama M.P is specialised in fabrication and characterization of nanocarbon materials and its various manifestations. Her work focus on growth and study of nanocarbon based vacuum nanoelectronic emitters for nanosatellite propulsion. She had an opportunity to work as Project Assistant at National Aeronautics Laboratory (NAL), Bangalore and at RV College of Engineering, Bangalore as Senior Research Fellow. Her area of research include vacuum nanoelctronics devices, Aerospace and VLSI design & fabrication. She has published her research work in peer reviewed journals, in national & international conference proceedings. Dr. Nirupama is from Bangalore, she enjoys adventure sports and writes poetry. She is also a member of Human Rights Defenders Forum, Karnataka and involve herself in social work.

Faculty Profiles

Dr. Sanmitra Barman, Faculty Member- Device & Fabrication Lab

Dr. Barman did PhD in Chemistry from Kansas State University and postdoctoral research from the university of Texas Austin. He was trained during his doctoral studies as a synthetic chemist. He worked in homogeneous catalysis for the synthesis of different chiral functional groups. During his postdoctoral work, he gained experience in supramolecular sensing and catalysis. His current research interests are designing and synthesizing photocatalysts that can undergo water splitting. He is also working in photocatalytic pollutant removal from the waste water.

Research Area: Photocatalysis, proton reduction, Chiral catalysis

Dr. Amarnath Bheemaraju, Faculty In-charge- Device & Fabrication Lab

Dr. Bheemaraju's primary research interest is in the area of synthesis of novel materials, optimization of structure and molecular packing for improving the efficiency of organic electronic devices. He is also interested in understanding the optical / photophysical properties of organic/inorganic semiconductors. He previously worked on making organometallic complexes for catalytic applications. He is exploring new compounds for electronic applications. He is currently also exploring ways to improving the quality of water and air. He did PhD in Chemistry from UMass Amherst and postdoctoral research from the WSU.

Research Areas: Organic Electronics, Photophysics of materials, Catalysis

Faculty Profiles

Dr. O S Panwar, Mentor CAMD

Dr. O. S. Panwar joined BML Munjal University is currently a Professor in Physics mentor to the Centre of Advanced Materials and Devices (CAMD). He was Chief Scientist in CSIR-National Physical laboratory, New Delhi-12. He obtained his M.Sc. in Physics degree from the Meerut University, Meerut in 1975 and Ph. D. on Pure and Doped Chalcogenide Glasses of As-Ge.-Te from Panjab University, Chandigarh in Jan. 1980. He was Research Fellow from Oct. 1987 to June 1988 at Trinity College, Dublin-2 (Ireland), Honorary Research Fellow from May-June 1988 at the Department of Electrical and Electronic Engineering, The Queen's University of Belfast, Belfast-9, Northern Ireland (U.K.)

and Raman Research Fellow from May to July 2001 at the Engineering Department, Cambridge University, Cambridge CB2 1PZ, England. MRSI medal in 2011, Bharat Jyoti Award in 2013 and Fellow/Academician, Asia Pacific Academy of Materials (APAM) in 2015. He is the life member of Semiconductor Society of India, Solar Energy Society of India, Materials Research Society of India and member of American Nano Society, American Vacuum Society and Society of Scientific Values.

Dr. Yarramaneni Sridharbabu, Member, CAMD

Dr. Yarramaneni Sridharbabu is one of the first-generation faculties at BML Munjal University. He obtained his Ph.D. from Kurukshetra University in February 2006, while working at Department of Physics, Regional Engineering College [presently National Institute of Technology], Kurukshetra.

He has expertise in electrical characterization of polymer composite materials. He has extensively used field induced thermally stimulated depolarization currents technique in investigating the charge transport mechanisms in composite polymers. His present research interest is charge transport mechanisms and dielectric relaxations behaviour in nanocomposite materials.

He is a life member of Indian Association of Physics Teachers, Indian Physics Association, Indian Science Congress Association and Nuclear Track Society of India. He has presented his research paper at international conferences held in Seoul, South Korea, 2016 and in Barcelona, Spain, 2018.

Contact

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