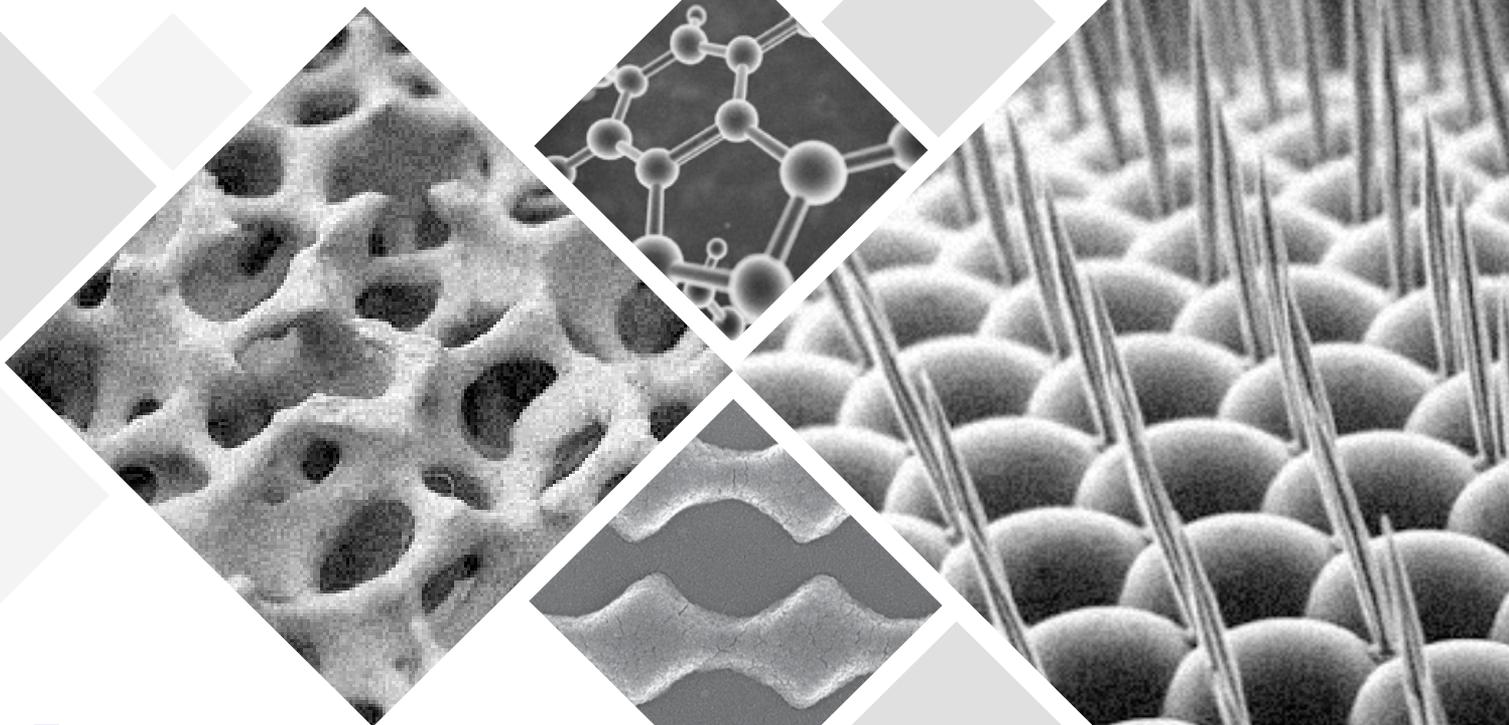


# The Central Lab at SBASSE LUMS



## ■ WHO WE ARE

The Central Lab at LUMS aspires to be a national center for advanced characterization and analytical techniques. It aims at becoming the go-to place for high-end characterization and analysis for academia and industry within the country. The Lab provides the possibility of consultation and expert analysis from world-class research faculty specializing in chemistry, materials science and spectroscopy at The Syed Babar Ali School of Science and Engineering LUMS. The Central Lab is an ideal melting point of modern scientific tools and ideas.



# See Inside

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# Overview

Excellence in research is intricately linked to the capability to measure and fabricate as accurately and precisely as possible. Research capacity in advanced testing and analysis not only benefit academia, but is also an enabler for innovative industrial solutions. The Central Lab facility housed in Syed Babar Ali School of Science and Engineering (SBASSE) at the Lahore University of Management Sciences (LUMS) is one such facility. The Central Lab at LUMS brings together world class instrumentation and outstanding staff and research faculty.

The Central Lab at LUMS aspires to be a national center for advanced analysis and diagnostic techniques. The continuing development of our core research facilities is an integral part of this strategy. The analytical and testing equipment housed at the central lab are geared to provide research-based solutions to many outstanding problems in health, food, water, energy, climate, communications, transport, manufacturing and national security.

# What the Central Lab Covers

- Scanning Electron Microscopy (*SEM*)
- Nuclear Magnetic Resonance (*NMR*)
- Physical Properties Measurements:  
*Cryogenic Vibrating Sample Magnetometry (VSM), Magnetotransport (MT)*
- Inductively Coupled Plasma and Optical Emission Spectroscopy (*ICP-OES*)
- X-Ray Diffraction (*XRD*)
- BET Surface Area Analyzer (*BSA*)





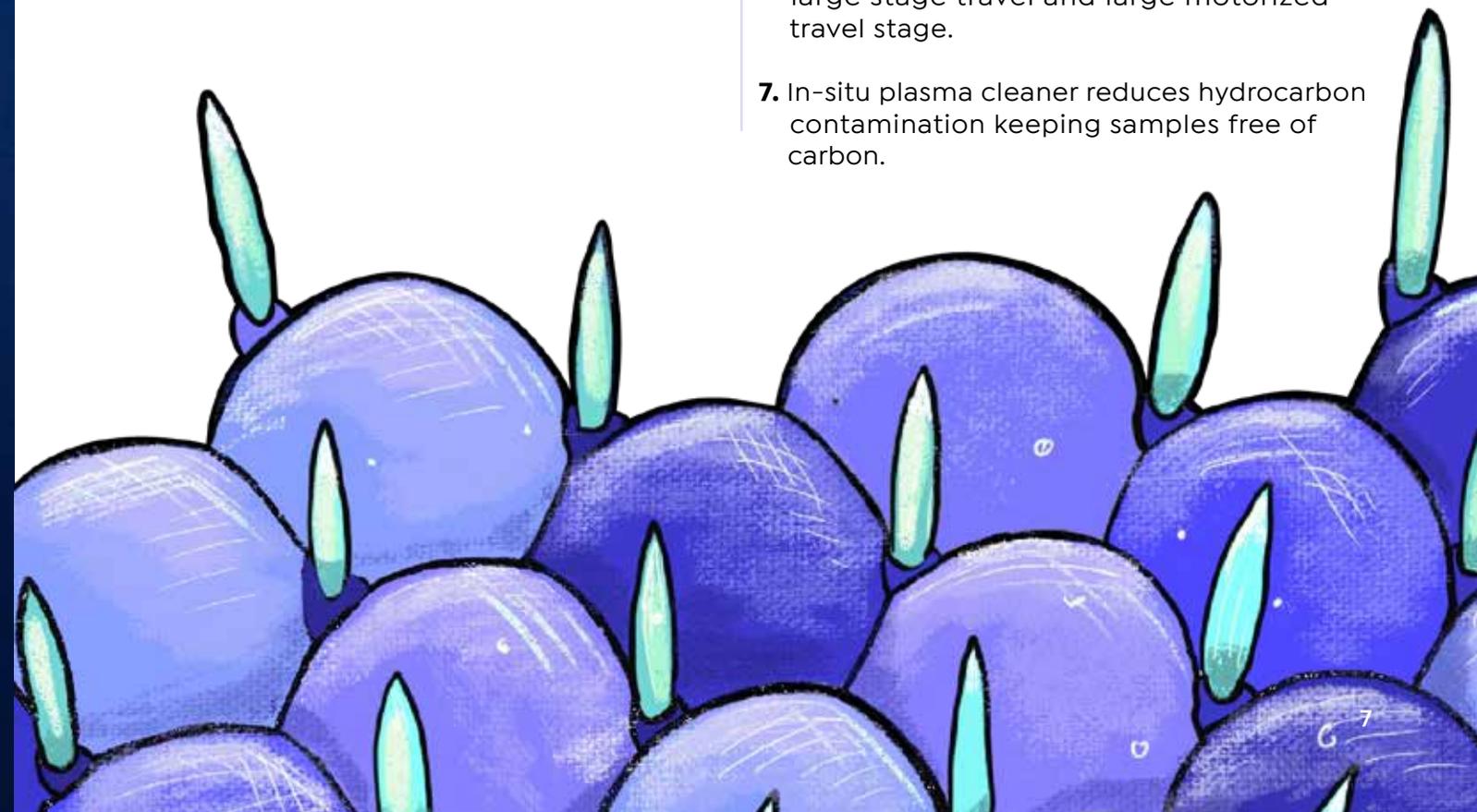
# Explore and Fabricate at the Micro and Nanoscale

## Scanning Electron Microscopy (SEM)

Scanning Electron Microscopy (SEM) is used to study topography, morphology, and local chemical and phase composition from nanometers to millimeters. The Central Lab hosts Nova NanoSEM 450 field-emission scanning electron microscope (FE-SEM), which has the best-in-class imaging and analytical performance. It is equipped with special capabilities, usually not found in standard SEM systems, including energy dispersive X-ray (EDX) spectroscopy and electron beam lithography (EBL).

### Capabilities:

1. High surface sensitivity and an ultimate resolution of  $\approx 1$  nm.
2. Can characterize a wide range of samples, both conductive and non-conductive.
3. Fast high-resolution imaging and scanning under low vacuum and low voltage.
4. For conducting samples: low voltage [1 kV] and high vacuum conditions achieve a resolution of  $\approx 1.4$  nm.
5. For non-conducting materials: low voltage [3 kV] and high vacuum achieves a resolution of  $\approx 1.8$  nm.
6. Can analyze big, bulky samples due to a large stage travel and large motorized travel stage.
7. In-situ plasma cleaner reduces hydrocarbon contamination keeping samples free of carbon.



# Scanning Electron Microscopy (SEM)

## Special Capabilities:

1. Directional or Concentric Backscattered Detector (CBS).
2. Scanning Transmission Electron Detector (STEM).
3. Energy Dispersive X-ray Spectroscopy (EDX).
4. E-beam Lithography (EBL).

## This will benefit:

1. Metallurgical industry
2. Textile Industry
3. Pharmaceuticals and paints industry
4. Researchers in life sciences
5. Biochemistry
6. Materials science and nanotechnology.
7. Researchers in renewable energy.
8. High performance engineering materials industry.

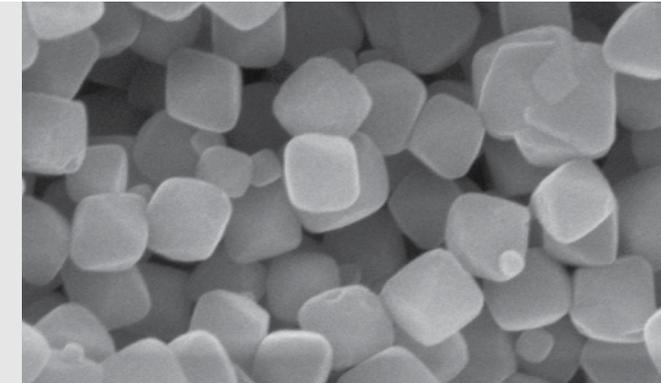
## Possible Applications:

1. Quality and texture analysis of machined metal surfaces.
2. Shape, size and morphology of nanostructures grown or fabricated in your lab.
3. Compositional analysis of contaminants in a product during the fabrication process.
4. Detailed nanoscale imaging of fiber quality in textile products.
5. Detailed nanometer scale structure of your biological specimen or microorganism.
6. Size, shape and composition of nanowires and nanostructures grown for sensing, cosmetics, clinical and biomedical applications.
7. High-resolution imaging for forensic analysis.

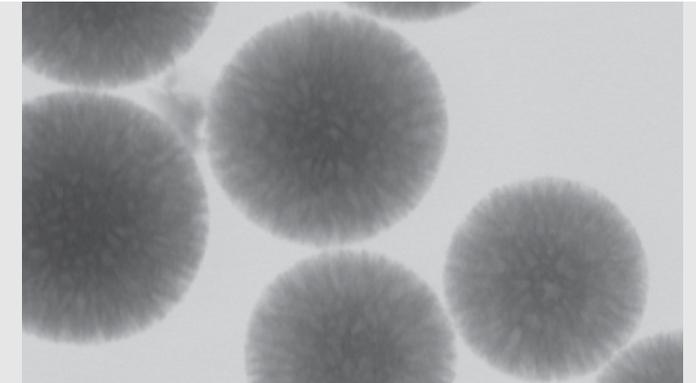
# Scanning Electron Microscopy (SEM)

## Research Highlights:

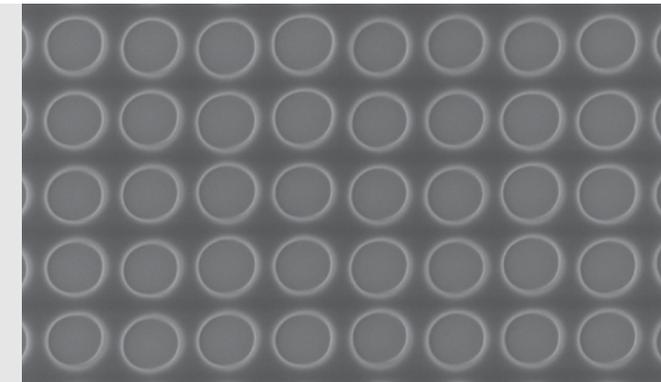
SEM micrographs of various micro and nanoscale structures and samples grown or fabricated in our labs.



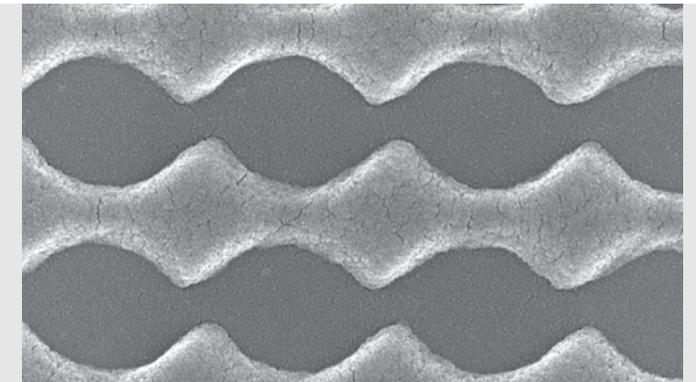
SEM micrograph of diamond shaped metal-organic frameworks (MOFs)



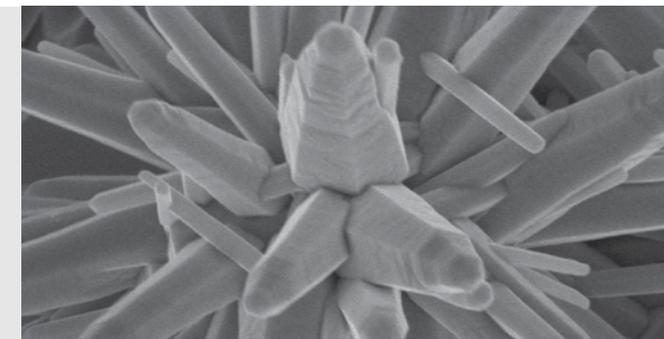
STEM image of drug loaded nanoparticles



SEM micrograph of periodic array patterned with e-beam lithography



SEM micrograph of periodic patterns of nano-springs for sensing applications fabricated with e-beam lithography



SEM micrograph of polymer designed in flower like structure

For more details on how the system works, contact our Facility Manager,  
**Dr. Murtaza Saleem:** [murtaza.saleem@lums.edu](mailto:murtaza.saleem@lums.edu)

**The Central Lab is one-of-a-kind national facility. It houses a variety of state-of-the-art analytical and characterization setups and equipment. Our strongest point is our independence in maintenance, upgradation, and repair of these sophisticated setups. The School of Science and Engineering takes pride in its trained manpower and technical expertise. It promises to provide expert services to other universities and industry in the country. We invite researchers working in academia or industry, looking for advanced testing and quality assurance solutions, to explore the facilities housed within The Central Lab at LUMS.**

# A deep look at the Molecular Structure

## Nuclear Magnetic Resonance (NMR) Facility

Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful tool in structural identification and characterization of pharmaceuticals (active pharmaceutical ingredients), natural products, fine chemicals, polymers, and bio macromolecules (including proteins, nucleic acids, and carbohydrates) and more.

The Central Lab is equipped with a 600 MHz Bruker Avance Neo spectrometer, one of a kind in the country outside Karachi. A triple resonance probe (TXI) is used for a diverse range of experiments, including 3D triple and double resonance, 2D homo and hetero-nuclear and 1D <sup>1</sup>H and <sup>13</sup>C experiments. Broadband probe (BBO) enables the detection of different types of nuclei such as <sup>11</sup>B, <sup>19</sup>F and <sup>31</sup>P. Central Lab NMR facility also provides commercial services to industrial clients and researchers from all over the country.

### ■ Capabilities:

1. Structure elucidation of small organic molecules to facilitate organic synthesis or discovery of new organic molecules from natural sources.
2. Structural information of bio macromolecules such as proteins, glycans, nucleic acids and fatty acids in connection to answering a diverse range of biological questions.
3. Analyze molecular interactions to understand molecular recognition phenomena.
4. Metabolic profiling of biological samples as part of metabolomics.

# Nuclear Magnetic Resonance (NMR) Facility

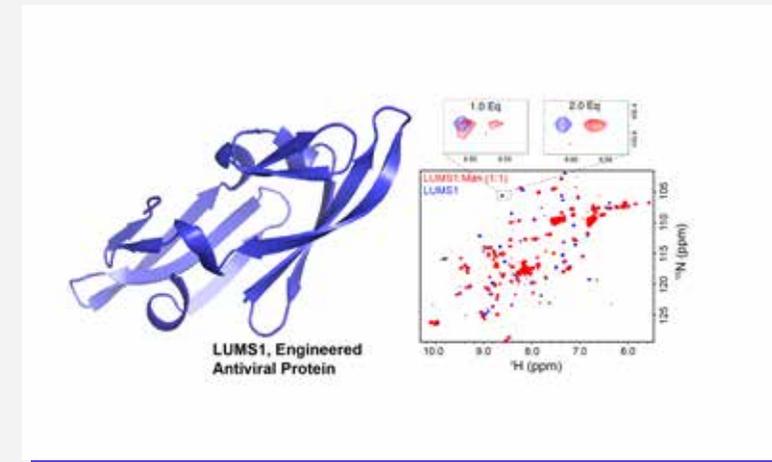
# Nuclear Magnetic Resonance (NMR) Facility

## Services:

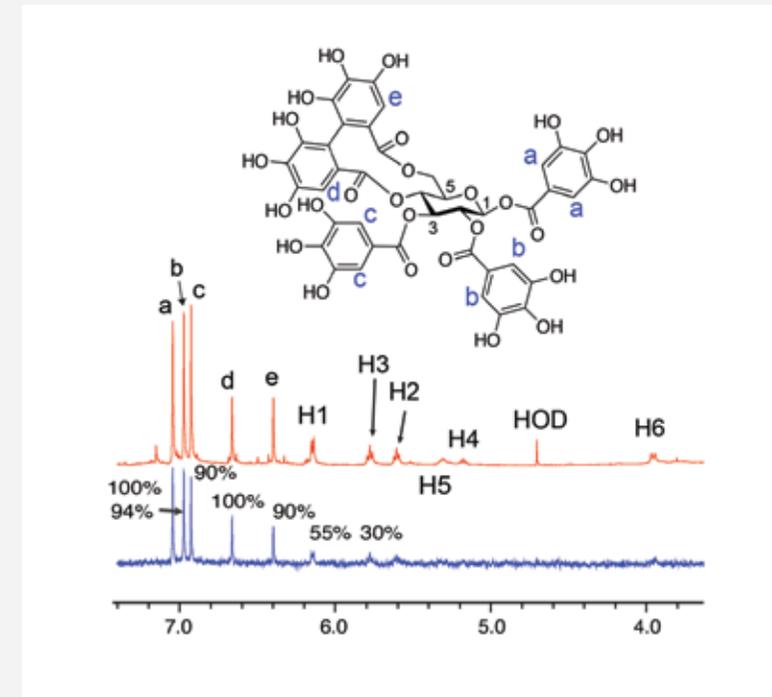
- 1D/2D NMR
- $^{31}\text{P}$ ,  $^{19}\text{F}$ ,  $^{11}\text{B}$ -NMR
- Drug Screening
- Mapping the structure of biological drugs
- Protein NMR Resonance Assignments
- Protein Dynamics Studies
- Protein Interaction Studies
- Nucleic Acid NMR
- NMR-based Metabolomics
- Mixture Analysis

For more details on how the system works, contact our Facility Manager, Dr. Muhammad Adil Raees [adil.raees@lums.edu.pk](mailto:adil.raees@lums.edu.pk).

## Research Highlights:



NMR studies of an anti-viral protein named LUMS1. The protein was engineered at Biology LUMS and can be a potential candidate for anti-viral therapies. Details in M. Shahid *et al.*, *Viruses* 12(2), 199 (2020).



NMR based characterization of atomic level interactions of a compound identified from cloves with Dengue Protease describes the mechanism of Dengue virus inhibition by the potential drug. Details in Nosheen, *et al.* *CS Omega* 4.1, 1525–1533 (2019).

# Investigate Physical properties

## Cryogenic VSM

The main setup consists of a cryogenic vibrating sample magnetometer (VSM). The Central Lab at LUMS houses a cryogen-free high-field VSM system, which is a versatile and powerful investigative device capable of measuring physical properties of thin films and powder at temperatures as low as  $-272\text{ C}^\circ$  (1 K) and under magnetic fields as high as 5 Tesla. A number of probes may be used with the basic system to extend its capabilities.

### Capabilities and Probes:

*The system comes with a variety of probes to analyze temperature and magnetic field dependence of various physical parameters*

- Measurement of magnetic moment by the vibrating sample technique
- Heat-capacity measurement by AC calorimetry
- Resistivity and magneto-transport
- Seebeck effect and thermal transport
- Hall effect measurement
- AC susceptibility

### Current Services Available:

- FC and ZFC Temperature scan
- Temperature dependent hysteresis (room temperature to 4 K and field of zero to 5 T)

# Analyze Trace Elements

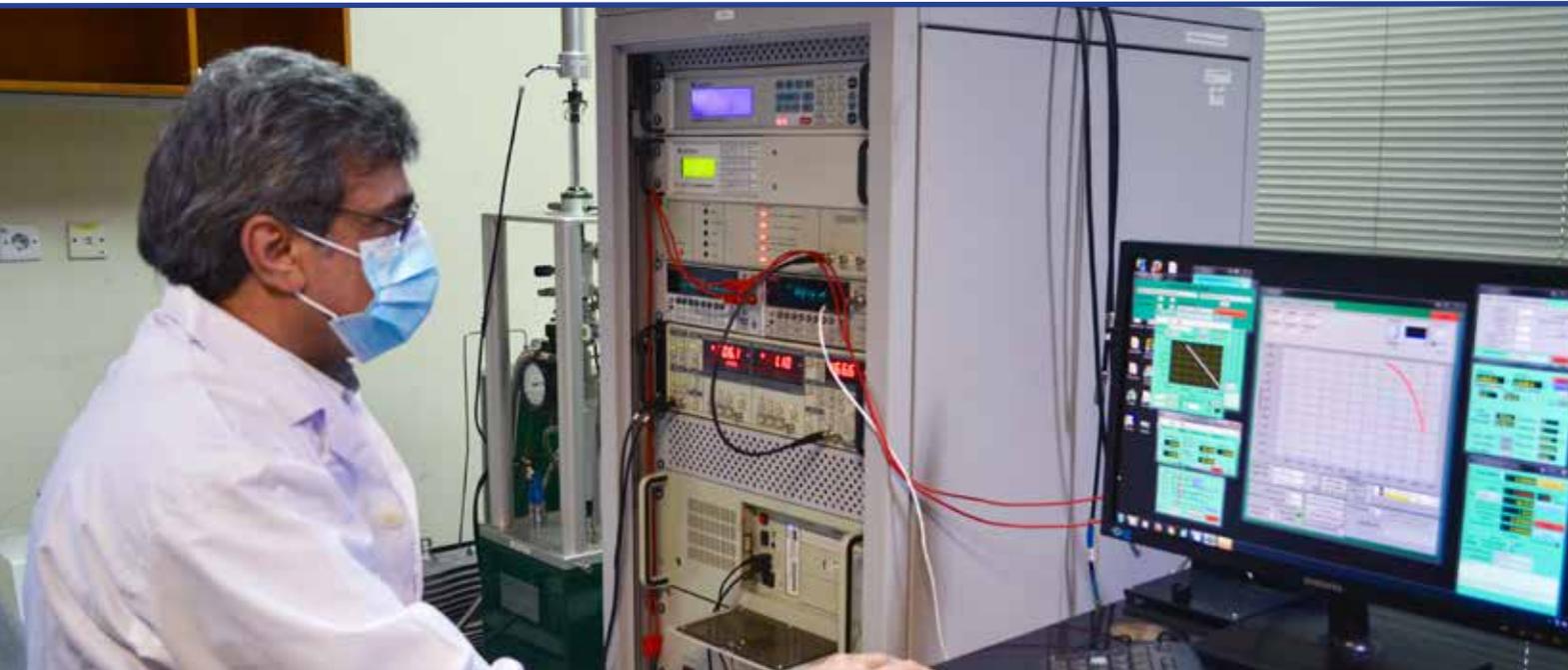
## Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)

The ICP-OES is a trace-level, elemental analysis technique that can perform qualitative and quantitative analysis on a wide variety of samples. Our lab is equipped with a state-of-the-art Agilent Technologies 5110-vdv ICP-OES system, which is capable of highly accurate trace metal detection even with the toughest samples. The detection limits are in higher mg/L (ppb) range. Concentrations of metal ions in a wide range of samples can be analyzed.

### Possible Applications:

*The system is capable of measuring trace levels of metals in samples from:*

- The Environment (water and soil)
- Polymers
- Food
- Agriculture
- Agro-chemicals
- Chemicals in general (fertilizers, batteries, raw organic and inorganic products)
- Minerals & metallurgy
- Rare-earth elements
- Cement, ceramics & glasses
- Petrochemistry
- Pharmaceutical and cosmetic products



For more details on how the system works, contact our Facility Manager, Mr. Ghulam Sarwar [ghulam.sarwar@lums.edu.pk](mailto:ghulam.sarwar@lums.edu.pk).



# Dive into Crystal Structure

## X-Ray Diffraction (XRD)

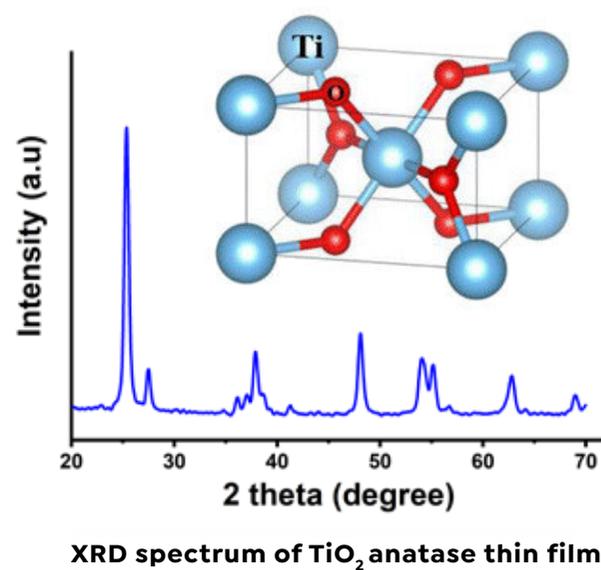
X-ray powder diffraction (XRD) is a rapid analytical technique, primarily used for phase identification of a crystalline material and can provide information on unit-cell dimensions within the crystal structure. Our lab is equipped with Bruker D2-Phaser, an advanced XRD system.

The system is capable of identifying crystal structure of a wide variety of powder samples and also a few types of thin films with high accuracy. X-ray powder diffraction is most widely used for the identification of unknown crystalline materials (e.g. minerals, inorganic compounds).

Determination of crystal structure of unknown solids is critical to studies in geology, environmental science, material science, engineering and biology.

### Capabilities:

- Non-destructive identification of crystalline phase and orientation of a unknown powder samples. Also capable of characterizing many thin film samples as well.
- Determine structural properties like grain size, strain, phase composition, and order-disorder transformation.
- Determine atomic arrangement



### Possible Applications of how our XRD can be utilized:

- **Geological applications:** XRD is a key tool in mineral exploration and can be used for identification of crystalline phase and orientation of unknown minerals and even clays.
- **Forensic Science:** Contract trace analysis of samples like paint flakes, hair, glass fragments and loosely powdered materials.
- **Pharmaceutical industry:** Characterize the composition of pharmaceuticals compounds and overall solid-state drug analysis. Beneficial at all stages of drug development, testing and production.
- **Glass Industry:** Identification of tiny faults in bulk glass, measurement of crystalline coatings for texture etc.





# Analyze Surfaces

## BET Surface Area Analyzer

Surface area and surface porosity plays a vital role in product development besides its importance in research on functional material development. The Central Lab at LUMS has a state-of-the-art BET based surface analyzer Nova2200e Quantachrome. (BET stands for Brunauer–Emmett–Teller theory.) It performs a fully automated multi-point BET analysis on a variety of samples from powder to porous materials.

### ■ Possible Applications:

**Pharmaceuticals:** Useful shelf-life and dissolution rates of drugs depends upon surface area and porosity of materials. It also plays an important role in the purification and processing of drugs.

**Activated carbons/carbon black:** Surface area of carbon affects the performance of tyres, gas masks, skin care, water purification, inks, laser printers and copiers.

**Paints and Coatings:** Surface area and porosity of the pigment or filler affect the gloss, texture, color, color saturation, brightness, solids content, film adhesion properties, fluidity and drying or setting time of paints and coatings.

**Catalysts:** Surface area and porosity affect mass transport phenomena in solid catalysts used in fertilizer industry, fuel cells and petrochemical industries.

**Materials:** Characterization of zeolites, carbon nanotubes, carbon nanofibers, MOFs, ceramics, fillers, desiccants, explosives etc.

# Collaboration Opportunities

*Machines and equipment are nothing without human understanding, ingenuity and expertise.*

## Technically Skilled Human Resource:

SBASSE LUMS takes pride in its highly trained human resource. We have trained technicians who constantly maintain, repair, and keep facilities and equipment in working order. In the last decade, our School and the University has not only added an impressive list of analytical and characterization equipment but also trained technical staff in the maintenance, repair, and upkeep of these setups. It has enabled us to become largely self-sufficient in operating sophisticated analytical and characterization machinery.

## Faculty Research & Collaborations:

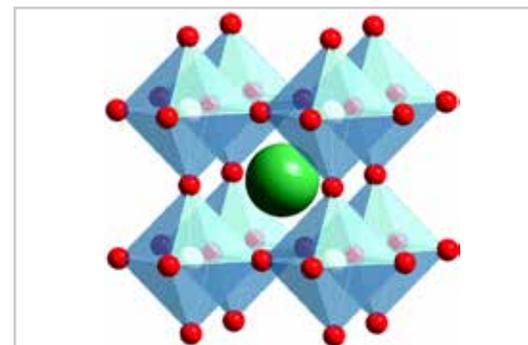
SBASSE has an outstanding faculty with a wealth of international exposure to high quality research. Our faculty is always open to ideas for research collaborations and consultation services for local industry.

Faculty at SBASSE has established world-class research facilities in the field of organic and inorganic chemistry, materials science (functional and biocompatible materials), spectroscopy and photonics. Your contact with The Central Lab can be a step towards advancing your career as an academic, uplifting education for your research students or enhancing quality and finesse of your industrial processes or products.

## Entrepreneurial Opportunities:

One of the strengths of SBASSE is the facilitation it provides for startup ventures. SBASSE building houses the National Incubation Center (NIC), which provides expert consultation services for entrepreneurial ideas. Under NIC, the building has a Makers Lab, which is equipped with state-of-the-art machining, CNC, and 3D printing tools. It provides a one-stop solution for prototype development and products manufacturing process optimization. Research work at Physics Department has resulted in the formation of one of the country's first startup of its kind Qosain Scientific, which specializes in the designing and manufacturing of a diverse suits of experiments and equipment for both teaching and research.

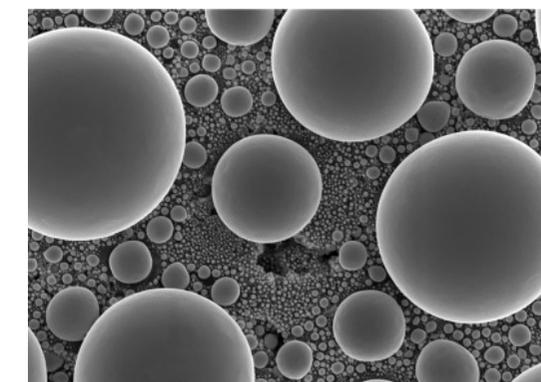
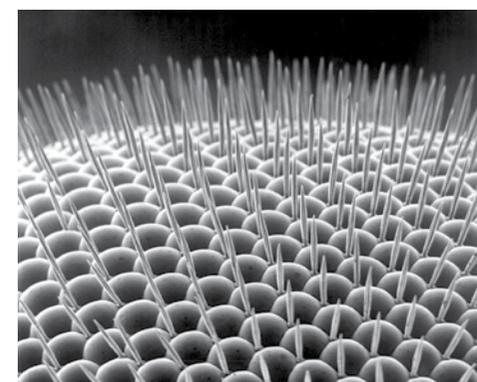
# Explore with Us



Crystal Structure



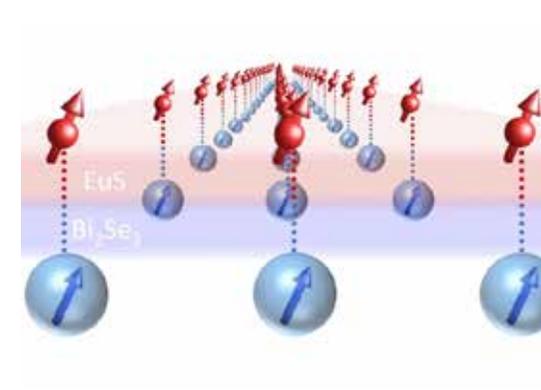
Molecular Structure



The Micro & Nano Scale



Surface Porosity



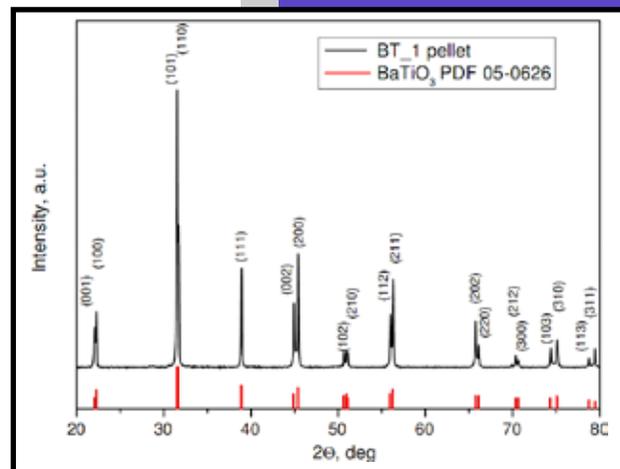
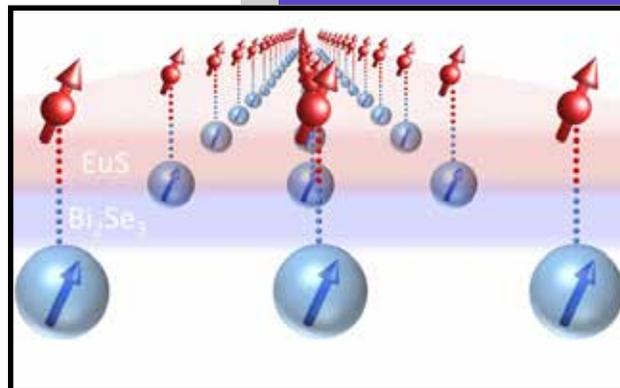
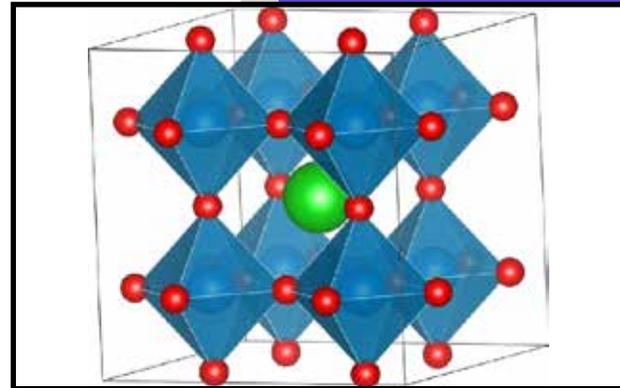
Physical Properties



# Look Forward to

*Apart from the available services mentioned in this brochure, Central Lab at LUMS is planning to open up more analysis and characterization setups for external users. Some of these proposed facilities include:*

- Fourier Transform Infrared (FTIR) spectroscopy
- UV/Visible spectroscopy
- Raman spectroscopy
- Testing services for Photovoltaic modules: solar simulators and External Quantum Efficiency (EQE) Detection
- Temperature dependent electrical conductivity and specific heat



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### YouTube:

SBASSE LUMS

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<https://www.linkedin.com/company/sbasse-lums/>

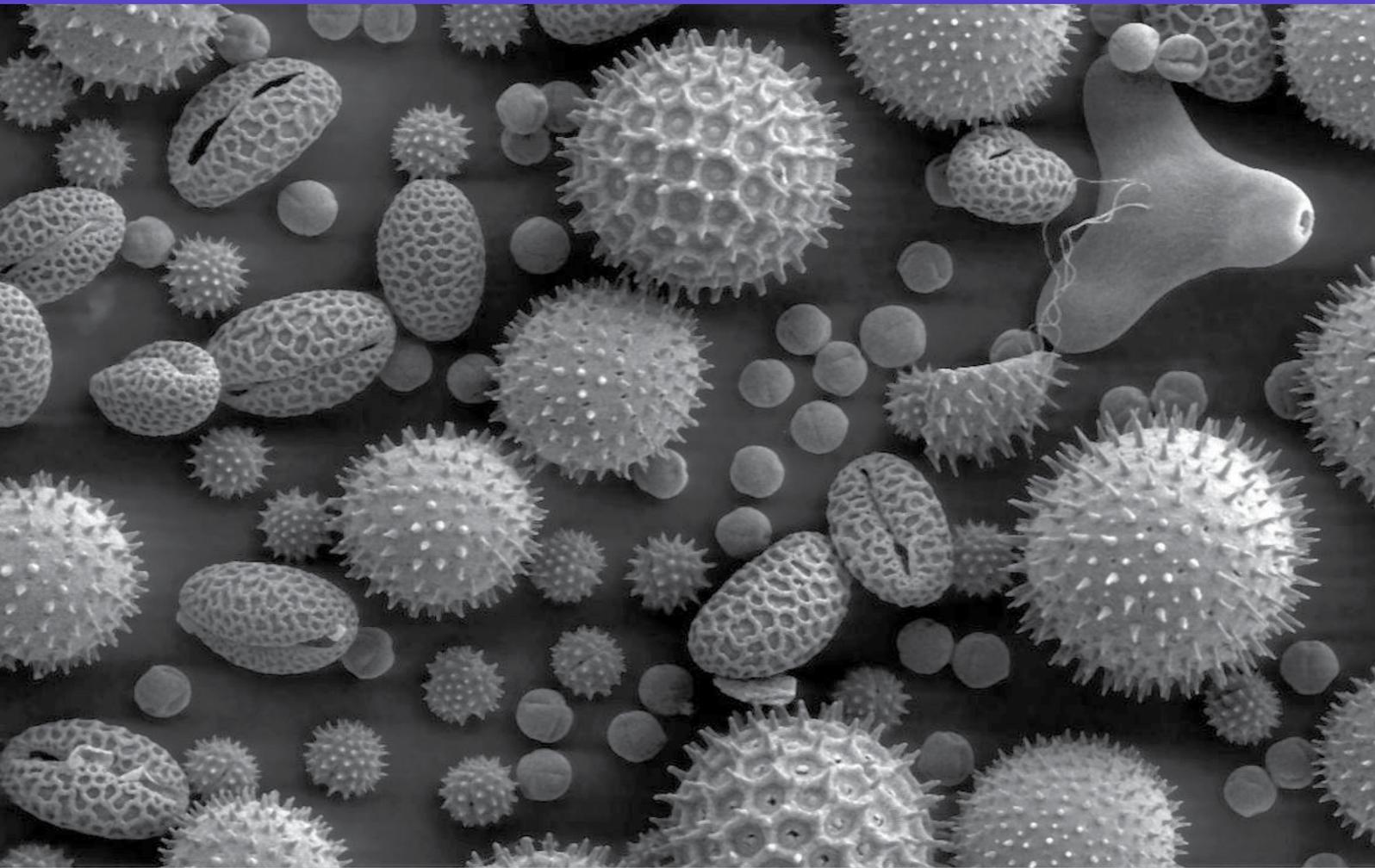
### Twitter:

<https://twitter.com/sbasselums/>

### Website:

<https://sbasse.lums.edu.pk/>

Keep checking [centrallab.lums.edu.pk](http://centrallab.lums.edu.pk) for the updates.



**For queries and details please  
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the resources:**  
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