J. C. Bose University of Science & Technology, YMCA Faridabad, Haryana (India)

Organizing

One Week

National Workshop and Hands-on Training

on

Spectroscopic and Analytical Techniques

19th – 23rd, January 2026

Organized by

Central Instrumentation laboratory (CIL)

Limited Seats

PhD Scholars and faculty Members only

Organizing Team

Dr. Anuj Arya, Physics
Dr. Deepansh Sharma, Life Sciences
Dr. Sanjay Kumar, Mechanical Engineering
Dr. Arun Kumar, Physics
Dr. Sitaram, Chemistry
Dr. Navish Kataria, Environmental Sciences
Dr. Somvir Bajar, Environmental Sciences
Dr. Ashima Sharma, Life Sciences

Registration Link: https://forms.gle/UbwqBjKQ5WC4KYeD7

PATRON
PROF. RAJIVE KUMAR
Hon'ble Vice Chancellor

PROGRAM ADVISOR
PROF. MANEESHA GARG
Director CIL

PROGRAM CONVENER
DR. VINOD KUMAR

Atomic Force Microscope (AFM) Bruker Dimension Edge – ScanAsyst

- The Atomic Force Microscope (AFM) is a high-resolution scanning probe instrument capable of imaging, measuring, and manipulating matter at the nanoscale.
- Bruker's **Dimension Edge (ScanAsyst)** model provides advanced automated imaging, minimal user intervention, and extremely high accuracy for surface topology characterization.
- AFM works by scanning a sharp cantilever tip across the sample surface; the deflection of the tip is recorded to generate 3D nanoscale images.
- ScanAsyst technology automatically optimizes imaging parameters (setpoint, gains, scan rate), ensuring **reproducible and artifact-free measurements**.

Instrument Capabilities

- High-resolution 3D surface topography at **sub-nanometer vertical precision**.
- Automated ScanAsyst mode for consistent imaging without complex parameter tuning.
- Multiple imaging modes possible:
- Peak Force Tapping
- Contact mode
- Tapping mode (AC mode)
- Capable of mapping mechanical, electrical & magnetic properties.
- Suitable for both soft biological samples and hard materials.
- Nano-indentation and force-curve analysis for material mechanics.
- Capable of quantitative nanomechanical mapping (QNM).

Sample Type

- Thin films
- Polymers
- Metals & alloys
- Semiconductors
- Nanomaterials (nanotubes, nanoparticles, graphene, etc.)
- Biological samples (cells, membranes)
- Coatings & surface-treated materials

Sample Preparation

- Samples should be flat, clean, and firmly mounted on AFM sample stubs.
- Remove dust or particles using nitrogen/air blow.
- For soft biological samples, fix and dry properly to avoid motion during imaging.
- Conductive samples may require grounding to avoid charging.
- Ensure sample size fits the AFM sample stage (typically < 10–15 mm).
- Thin films should be uniformly coated and dried.
- Magnetic/electrical property studies may require coated probes.

Applications

- High-resolution surface roughness and texture analysis.
- Thickness and morphology study of thin films.
- Nanomechanical property mapping (modulus, adhesion, stiffness).
- Semiconductor and microelectronics defect inspection.
- Characterization of polymer blend phases, crystallinity, and microstructure.
- Biological surface analysis at the cellular and subcellular level.
- Nanoparticle size and distribution measurement.
- Tribological studies (friction, wear).
- Surface contamination analysis.
- 3D metrology for nanotechnology research.

References

- Bruker AFM Technology Overview
- Dimension Edge ScanAsyst User Manual
- https://www.brukerafm.com

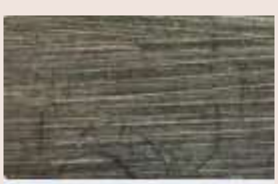
OLYMPUS DSX-100 DIGITAL MICROSCOPE

The Olympus DSX-100 is a high-end, completely motorized digital microscope system engineered to deliver superior image quality and accurate 3D measurement without the need for destructive sample preparation. Its unique features make it an essential tool for material science, quality control, failure analysis, and R&D.

Instrument Capabilities

- **Fully Automated Optical Zoom:** 10X to 7000X magnification range (depending on lens) with seamless, continuous optical and digital zoom.
  BENEFIT: Allows observation from macroscopic overviews to microscopic fine detail without changing lenses.
- **Complete 3D Measurement:** Dedicated software and motorized Z-axis capture elevation data to generate highly accurate 3D models of the sample surface.
  BENEFIT: Enables precise roughness analysis, volume measurement, and profile analysis essential for quality control and failure analysis.
- **Automatic Image Stitching (Panorama):** The system automatically captures and seamlessly merges multiple fields of view into one high-resolution panoramic image. BENEFIT: Allows documentation and measurement of large sample areas (macro-to-micro) while retaining the highest optical resolution.

- **High Dynamic Range:** Captures multiple images at varying exposure levels and combines them to produce a single image with perfect lighting.
  BENEFIT: Eliminates glare and blocked shadows, ensuring accurate color and detail representation on highly reflective or multi-toned samples (e.g., polished metals, PCBs).
- **Freedom of Observation:** Built-in 6-way lighting options (directional, ring, coaxial, polarized, etc.) and a tilting/rotating sample stage.
  BENEFIT: Eliminates guesswork. Users can freely change observation angle and lighting to find optimal conditions for any surface texture.
- Telecentric Optical System: Unlike traditional microscopes, the DSX-100 maintains constant magnification regardless of the focus distance.
  BENEFIT: Ensures measurement accuracy and repeatability, even on uneven or tilted samples.



Surface Roughness Measurement for Stainless Steel / Micro surface roughness measurement using a laser microscope

Ripple Marks Formed in Die-Casting / 3D shape measurement using a laser microscope

Surface profile evaluation for thermal spraying / Surface roughness measurement using a laser microscope

Detecting flaws in heat-treated aluminum alloy parts / Various microscopy techniques using digital microscopes

Quality management in working with extra-fine tubes / Surface roughness analysis of a micro area using a laser microscope

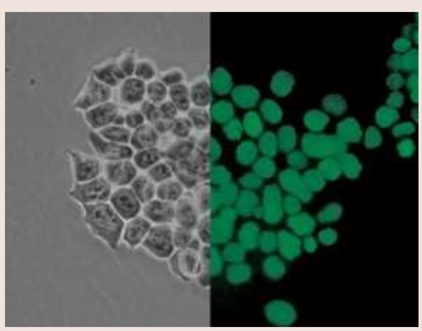
Sample Types & Versatility

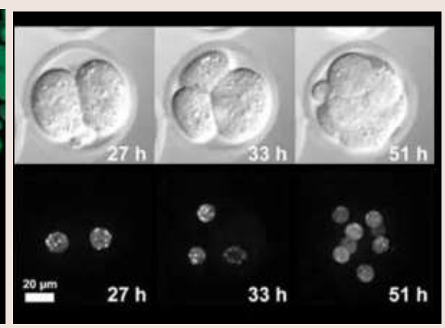
- **Materials Science:**
  SAMPLE TYPES: Metals, Ceramics, Polymers, Composites, Welds, Coatings
  CAPABILITY: Non-contact measurement of surface finish and layer thickness.
- **Electronics & PCBs:**
  SAMPLE TYPES: Semiconductor wafers, Connectors, Solder joints, Micro-electromechanical systems (MEMS)
  CAPABILITY: Precise alignment and inspection of micro-components in 3D.
- **Failure Analysis:**
  SAMPLE TYPES: Fractured surfaces, Corroded parts, Wear marks, Contaminants. CAPABILITY: High-resolution observation of fracture origins and defect morphology.
- **Quality Control:**
  SAMPLE TYPES: Tools, Molds, Stamped parts, Powder metallurgy components
  CAPABILITY: Rapid and reproducible pass/fail criteria for dimensional and surface inspection.

Primary Applications

The DSX-100's combination of high resolution, measurement accuracy, and operational simplicity makes it indispensable for:

- Quantitative 3D Roughness Measurement: Measuring surface parameters (Ra, Rq, Rz, etc.) in a non-contact manner.
- Volumetric Analysis: Calculating the volume of specific features like corrosion pits, cavities, or powder mounds.
- Grain Boundary Analysis: Automated measurement and analysis of grain size in metallurgical samples.
- Profile and Height Measurement: Generating cross-sectional profiles and measuring the height difference between any two points on a surface (e.g., step height).
- Non-Destructive Inspection: Performing root cause analysis on sensitive finished products without cutting or damaging the sample.
- Measurement of Critical Dimensions: Highly accurate measurement of lengths, areas, angles, and pitches on complex geometries.





Featured Research Publications Utilizing the DSX Series

This instrument has been crucial in numerous high-impact academic and industrial research projects, demonstrating its reliability and accuracy in advanced material characterization:

1. Forensic and Defect Analysis (Abertay University): The DSX-100's tilting capability and Extended Focal Image (EFI) tool were used to effectively analyze complex forensic samples, including latent fingerprints on metal and detailed observation of logos on pharmaceutical tablets, which were otherwise difficult to distinguish.
2. Abrasive Tool Analysis (Tribology): Research involving the assessment of active surfaces of ceramic grinding wheels utilized the DSX-500 microscope for high-resolution measurements and surface micro-discontinuity analysis, confirming the potential of opto-digital microscopy in detailed material diagnostics.
3. Automotive Component Inspection: The system is widely cited in industrial applications for inspecting critical dimensions and surface defects on parts like pistons and connecting rods, utilizing the auto-stitching and high-magnification objectives to detect subtle burrs and measure metal flow.
4. Glass and Electronics Defect Detection: The DSX series has been employed for non-destructive glass defect analysis (identifying scratches, bubbles, and stress fractures) and for inspecting tiny manufacturing defects on semiconductor wafers and multilayer ceramic condensers with sub-micron accuracy

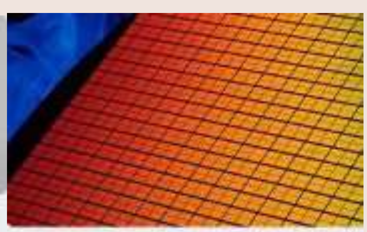
Operating Excellence

The DSX-100 features intuitive, guided software that allows even novice users to achieve expert results quickly. The system ensures the collected data is always highly reliable and repeatable, making it a critical asset for both research and industrial collaboration.

References

- Olympus DSX-100 Product Page: https://evidentscientific.com/en/products/digital/dsx1000
- https://evidentscientific.com/en/applications
- https://evidentscientific.com/en/solutions/life-science-research
- https://evidentscientific.com/en/solutions/clinical
- https://evidentscientific.com/en/solutions/electronics
- https://evidentscientific.com/en/solutions/energy
- https://evidentscientific.com/en/solutions/aerospace
- https://evidentscientific.com/en/solutions/railway

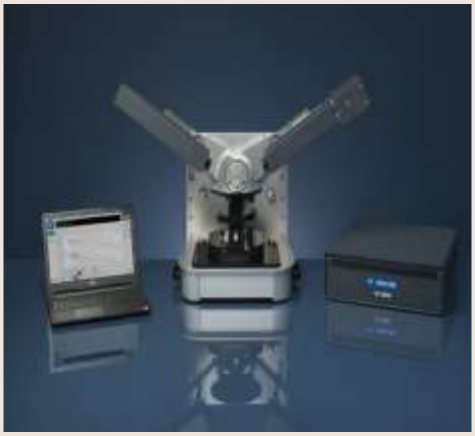
Surface Roughness of Ceramic Parts for Textile Manufacturing Machines / Surface roughness measurement of a micro-sized area using a laser microscope



Microscope Solutions for Semiconductor Manufacturing

Microscope Solutions for PCB Manufacturing

Mix Observation Methods to See More in Your Wafer Defect Inspection



SE-1000 Spectroscopic Ellipsometer (Semilab, Hungary)

- Spectroscopic Ellipsometry is a non-destructive, high-precision optical technique used to determine thin-film thickness, optical constants (n & k) and layer structure with nanometer to sub-nanometer accuracy.
- The SE-1000 from Semilab (Hungary) is a high-performance, research-grade ellipsometer designed for measuring thin films, multi-layer stacks, semiconductor wafers, dielectrics, polymers, nanostructures, and coatings across the UV-Visible-NIR range.
- It is widely used in materials science, semiconductor R&D, photovoltaics, optics, coatings, nanotechnology, and thin-film characterization

Instrument Capabilities

- Measures thin-film thickness from 0.5 nm to several micrometers
- High-accuracy measurement of Psi (Ψ) and Delta (Δ) parameters
- Measures refractive index (n) and extinction coefficient (k)
- Ultra-stable optical design with high wavelength precision
- Supports multi-layer modeling and optical dispersion models
- Measures:
  1. Film thickness
  2. Optical constants
  3. Composition
  4. Roughness
  5. Graded layers
  6. Interfaces
- Fast data acquisition with high signal-to-noise ratio
- Equipped with auto-alignment and beam-tracking technology
- Compatible with mapping stage for wafer-scale uniformity

Sample Type

- Thin Films
- Multi-layer optical coatings
- Semiconductor wafers
- Glass substrates
- Polymer films
- Oxides, nitrides, metals
- Organic & inorganic coatings
- Nanostructured layers

Sample Preparation

Follow these guidelines for best SE-1000 measurements:

- Clean the sample to avoid optical scattering due to dust or contaminants.
- Make sure the **surface is flat and reflective** (SE requires reflected light).
- Avoid fingerprints and moisture—use **IPA and lint-free wipes**.
- Ensure **uniform sample placement** on sample stage.
- For films deposited on transparent substrates:
  - Place an **absorbing backing** if needed.
- Keep the sample dry—no droplets, smudges, or surface roughness.
- Calibrate against a **known reference wafer** before measurements.
- Ensure stable temperature to avoid refractive index fluctuations.
- Ensure that your cuvettes are as clean as possible. If you can, put them through a standard glass washing procedure. At the very least, they should be rinsed with the last used solvent and a rinsing agent, such as acetone, deionized water or IPA.
- Before loading your sample, you should rinse the cuvette with the solvent that your sample is dissolved in. This should help remove any residual solvents left over from cleaning, which could contaminate your measurement.
- Any reference measurement, such as for absorbance spectroscopy, should be taken of the cuvette filled with the diluting solvent. This will ensure that your measurement will account for any optical effects introduced by the quartz cuvette or the solvent.
- Use an appropriate sample concentration. If your sample is too concentrated, the beam will not be able to penetrate through the sample, and no light can be measured by the spectrometer. If your sample is too dilute, light may pass through your sample without interacting with the sample material at all.
- Optimize the path length for your experiment. A cuvette’s path length is the distance that light travels through the sample before it escapes and is measured by the spectrometer. Using a cuvette with a smaller path length can be useful if you cannot reduce your sample concentration without significantly changing your results.
- Additionally, you can use a cuvette with a smaller path length to reduce the volume of sample needed. This can be especially useful if you have a small amount of sample or if your material is expensive.
- Ensure your spectrometer has a sample holder which accommodates your cuvette. The positioning of your cuvette relative to the spectrometer and light source should remain consistent throughout and between experiments. Your sample should also stand "face on" relative to incoming light to reduce any scattering effects. For example, the Ossila Optical Spectroscopy Kit contains a cuvette holder compatible with standard Quartz cuvettes.
- Always ensure that your samples are completely dissolved in your chosen solvent. Wherever possible, filter solutions before using to remove contaminants.

Measurement Range

- **Spectral Range:** ~ **380 nm – 1000 nm** (in visible range)
- **Thickness Range: 0.5 nm to 20 µm**
- **Angle of Incidence: 45°–90°** (motorized)
- **Resolution:** Sub-angstrom level for ultra-thin films
- **Detector System:** High-sensitivity photodiodes + spectrometer

Applications

- Thickness & optical constant measurement of thin films
- Semiconductor dielectric analysis (SiO_2, Si_3N_4, Al_2O_3, HfO_2)
- Optical coatings & multilayer stacks
- Solar cell layer characterization (TCOs, perovskites, amorphous Si)
- Polymer film analysis
- Surface and interface roughness measurement
- Nanostructure optical property extraction
- OLED & display materials
- MEMS/NEMS thin-film verification
- Refractive index dispersion curve generation
- Real-time film monitoring (with in-situ configuration)

Advantages

- Completely **non-contact**, **non-destructive**
- Extremely **high accuracy** and **repeatability**
- Broad spectral range for wide material compatibility
- Industry-standard analysis software (Semilab SEA)
- Works for **conductive & non-conductive** samples
- Excellent for **multi-layer optical modeling**
- Suitable for both **R&D** and **production environments**

References

- Semilab SE-1000 Brochure
- Semilab Technical Application Notes
- Optical Modelling Handbook – Semilab
- Standard ellipsometry textbooks for Ψ-Δ analysis

Fluorescence Spectrophotometer

- Fluorescence Spectrophotometer are powerful tools used in analytics.
- Fluorescence Spectrophotometer measures the emitted light from the excited state
- Versatile, non-destructive, and cost-effective technique that delivers high accuracy and precise measurement.
- UV-Vis-NIR spectrophotometers are able to analyze liquids, solids and thin films with minimal sample preparation.

Instrument Capabilities

- The Instrument can measure the steady state fluorescence emission and excitation spectra
- Great sensitivity: Water Raman S/N 16,000:1 RMS method (6,000:1 FSD)

Sample Type

- Solid
- Liquid
- Thin Films

Sample Preparation

- To prepare your samples for solution-state fluorescence spectroscopy, you should consider the following points:
- Ensure that your cuvettes are as clean as possible. If you can, put them through a standard glass washing procedure. At the very least, they should be rinsed with the last used solvent and a rinsing agent, such as acetone, deionized water.
- Before loading your sample, you should rinse the cuvette with the solvent that your sample is dissolved in. This should help remove any residual solvents left over from cleaning, which could contaminate your measurement.
- Use an appropriate sample concentration so as to avoid inner filter effects.
- Optimize the path length for your experiment.
- Ensure your spectrometer has a sample holder which accommodates your cuvette. The positioning of your cuvette relative to the spectrometer and light source should remain consistent throughout and between experiments.
- Always ensure that your samples are completely dissolved in your chosen solvent. Wherever possible, filter solutions before using to remove contaminants.
-

Applications

- Measurement of fluorescence emission and excitation spectra

References

- https://static.horiba.com/fileadmin/Horiba/Products/Scientific/Molecular_and_Microanalysis/FluoroMax/FluoroMax_Series.pdf

FTIR Spectroscopy

Make: PerkinElmer

The PerkinElmer Spectrum Two is a compact, robust FTIR spectrometer designed for high-performance, routine infrared analysis both in the laboratory and in the field. It is widely recognized for its ease of use, reliability, and adaptability across a range of research and industrial settings.
The Universal Attenuated Total Reflectance Accessory (UATR) is an internal reflection accessory, used with a Spectrum Two Series spectrometer, for simplifying the analysis of solids, powders, pastes, gels and liquids. The technique is non-destructive.

Instrument Capabilities

- The Spectrum Two UATR uses a diamond crystal. The diamond crystal is hard, is not easily scratched, is resistant to strong acids and bases, and can withstand high pressures. The diamond UATR has an effective scanning range that matches the full range of the instrument, although sensitivity is somewhat reduced in the approximate range 1900-2700 cm^{-1}
- As the beam does not penetrate deeply into the sample, this technique is ideal for analyzing strong infrared absorbing solutions, such as emulsions or aqueous solutions. The technique can also prove useful in measuring homogenous solid samples, solid surfaces and coatings on solid samples.
- Best resolution of 0.5 cm^{-1}, providing fine spectral details crucial for complex sample analysis
- OpticsGuard™ Technology: Protects optical components from humidity and environmental damage, extending instrument life and maintaining data quality.
- Portability: Weighs approximately 13 kg, making it suitable for remote or field analysis scenarios

Sample Type

- Homogenous solid samples
- Solid samples
- Soil surfaces or coating
- Liquid Samples

Sample Preparation

- As per user requirements

Applications

- Supports research on advanced materials, including nanomaterials, biomaterials, and thin films, by providing detailed molecular fingerprints and enabling the detection of impurities or additives.
- Helps to verify the identity and purity of active pharmaceutical ingredients (APIs), excipients, and finished products.
- Used to detect and quantify pollutants in air, water, soil, and wastewater.
- Includes monitoring industrial emissions, identifying microplastics, analyzing organic contaminants, and characterizing adsorbents

- Identify unknown polymers, study degradation mechanisms, and assess the quality of plastics, rubbers, coatings, and composites.

References

- PerkinElmer Spectrum Two Overview
- Universal Attenuated Total Reflectance Accessory Manual

Pilot Scale Bioreactor (Make: FERMEX)

- Pilot-scale bioreactors typically have working volumes 20 liters and serve as a bridge between lab-scale and industrial-scale production.
- Dual-vessel setup — one main bioreactor vessel and one media/seed vessel.
- Sensors: Integrated pH, DO (Dissolved Oxygen), temperature, and foam sensors for real-time monitoring.
- Pressure Gauge & Safety Valves: Ensures safe operation under pressurized conditions.
- Peristaltic Pumps: For controlled addition of acid, base, antifoam, and nutrients.

Instrument Capabilities

- Suitable for batch, fed-batch, and continuous fermentation processes.
- Can cultivate bacteria, yeast, fungi, and mammalian cells under controlled conditions.
- Enables precise control of temperature, pH, DO, agitation, and aeration.
- Supports scale-up studies from lab to pilot scale.
- Facilitates optimization of bioprocess parameters for product yield improvement.

Sample Type

- Ethanol
- Microbial metabolites
- Pharmaceutical products
- Protein and enzymes

Sample Preparation

- As per user requirements

Applications

- Used in research, biopharmaceutical production, enzyme and metabolite synthesis, and wastewater studies
- Microbial fermentation – production of enzymes, organic acids, ethanol, antibiotics, and other metabolites.
- Biopolymer production – synthesis of PHAs, bioplastics, or polysaccharides.
- Bioremediation studies – degradation of pollutants using microbial consortia.

References

- Tripathi, N. M., Aseri, G. K. A. K., Sharma, D., & Singh, D. (2025). Comparative ethanol production by *Saccharomyces cerevisiae* and *Saccharomyces bayanus* using apple juice concentrate. *Microbial Biosystems*, *10*(2).
- Abutu, D., Aderemi, B. O., Ameh, A. O., Yussof, H. W., Gbonhinbor, J., Money, B.,& Agi, A. (2025, August). Optimization of ethanol fermentation in a bubble column bioreactor using response surface methodology with ferric oxide nanoparticle-modified supports. In *SPE Nigeria*
- *Annual International Conference and Exhibition* (p. D021S008R004). SPE.

High-Performance Liquid Chromatography (HPLC) (Make: THERMO)

- The Thermo Scientific Vanquish HPLC system is an advanced analytical instrument used for the separation, identification, and quantification of chemical compounds in complex mixtures.
- It consists of two detector- RI and UV-Visible which detect separated compounds based on their absorbance or spectral properties.
- Pump Module: Delivers mobile phase at constant flow and high pressure; supports binary or quaternary gradient elution.
- Column Compartment (Oven): Maintains a stable temperature for consistent retention and peak shape.

Instrument Capabilities

- Pressure Range: Supports up to 1500 bar (≈22,000 psi), allowing use of sub-2 µm particle columns.
- Flow Range: Typically, 0.001–8.0 mL/min, depending on configuration.
- Column- C18 and Amino
- Software: Controlled via Thermo Scientific Chromeleon™ Chromatography Data System (CDS) software.

Sample Type

- Protein and enzymes
- Microbial metabolites
- Pharmaceutical products

Sample Preparation

- As per user requirements

Applications

- Enables separation, identification, and quantification of complex mixtures.
- Pharmaceutical analysis – quantification of active ingredients, impurities, and degradation products.
- Metabolomics and lipidomics – profiling of metabolites, lipids, and small biomolecules.
- Food and beverage testing – analysis of vitamins, additives, preservatives, and contaminants.
- Polymer and material science – characterization of polymers, additives, and degradation products.

References

- Boros, K., Nagy, B. E., Tomoiagă, R. B., Tőtős, R., Toșa, M. I., Paizs, C., & Bencze, L. C. (2025). Fine tuning enzyme activity assays for monitoring the enzymatic hydrolysis of PET. *Scientific Reports*, *15*(1), 1877.
- Beech, J. L., Clare, R., Kincannon, W. M., Erickson, E., McGeehan, J. E., Beckham, G. T., & DuBois, J. L. (2022). A flexible kinetic assay efficiently sorts prospective biocatalysts for PET plastic subunit hydrolysis. *RSC advances*, *12*(13), 8119-8130.

Scanning Electron Microscopy (SEM) , Make: Zeiss

- **Scanning Electron Microscopy (SEM)** is a powerful imaging technique used to observe the surface structure and composition of materials at very high magnifications.
- SEM is widely used in materials science, biology, geology, forensics, semiconductor research, and many other fields.
- SEM works by using an electron source, typically a heated tungsten filament or a field emission gun, to produce a beam of electrons.
- The primary electron beam is directed onto the sample's surface. When the beam interacts with the sample, several types of interactions occur, including scattering, absorption, and emission of secondary electrons.

Instrument Capabilities

- SEMs provide high-magnification, high-resolution images of sample surfaces.
- SEM produces detailed 3D-like images of surfaces. Useful of Studying-Fracture surfaces, Particulates, Biological structures, Micro and Nano fabricated devices.
- SEM include additional detectors for chemical analysis. It Provides: Spot analysis, Line scans, Elemental maps.
- SEM is equipped to determine grain orientation**,** phase identification**,** and texture**.**
- It has large Range of Magnification From ~10× to 100000×. It covers macro, micro, and near-nano scales.

Sample Type

- **Conductive Samples:** These are the easiest to image, as they naturally dissipate the electron beam's charge. Examples Metals (Al, Cu, Fe, Au, etc.) Metal alloys Conductive ceramics Carbon-based materials (graphite).
- **Non-Conductive Samples:** Insulators accumulate charge under the electron beam, causing image distortion. Examples Polymers and plastics, Glass, Most minerals and ceramics, Biological specimens (once dried).
- **Biological Samples:** Soft, hydrated samples must be prepared carefully. Examples Cells, tissues, microorganisms, Plant material, Insects.
- **Powdered Samples:** Loose particulate materials. Examples Soil or clay powders, Pharmaceutical powders, Nanoparticles, Metal or ceramic powders
- **Thin Films and Coatings:** Used to study surface morphology and layer thickness. Examples Semiconductor films, Metallic coatings, Oxide layers, Polymer coatings.
- It can also be used for surface and fracture analysis of Geological Samples and many Industrial and Engineering Materials (Manufactured materials for failure analysis or quality control).

Sample Preparation

- **Conductive Samples:** Usually minimal: cleaning and mounting.
- **Non-Conductive Samples:** Often require conductive coating (e.g., Au, Pt, Pd, carbon), Drying or dehydration before imaging
- **Biological Samples:** Fixation, dehydration, drying, Conductive coating.
- **Powdered Samples:** Dispersed on carbon tape or a stub, Sometimes require coating.
- **Thin Films and Coatings:** Mounted directly; cross-sectioning if interior layers need imaging.
- For others samples required sectioning, mounting, or coating as needed.

Applications

- Microstructure analysis of metals, ceramics, polymers, and composites.
- Failure analysis (fracture surfaces, corrosion, wear)
- Phase identification and grain-size measurements
- Surface analysis of coating and thin-films.
- Inspecting microchips, circuits, and nanostructures.
- Identifying defects, contamination, lithography issues.
- Imaging cells, tissues, microorganisms in high detail.
- Studying surface morphology of plants, insects, and biological structures.
- Visualizing nanoparticles, nanotubes, nanowires.
- Characterizing nano-scale surfaces and interfaces
- Surface defect inspection and analysis of wear, machining marks, coatings.
- Studying particulates, aerosols, dust, micro plastics.
- Characterization of implants, biomaterials studying enamel, dentin, and bone microstructure.

References

- Goldstein, J. I., et al. Scanning Electron Microscopy and X-ray Microanalysis.
- Reimer, L. Scanning Electron Microscopy: Physics of Image Formation and Microanalysis.
- Watt, I. The Principles and Practice of Electron Microscopy.
- Newbury, D. E. “Misconceptions in the SEM and EPMA Communities.” Microscopy and Microanalysis, 2016.
- Boyde, A. “Practical Problems and Solutions in Sample Preparation for SEM.” In: SEM Practical Handbook.

	**UV- VIS-NIR Spectrophotometer** • Ultraviolet-visible-near-infrared (UV-Vis-NIR) spectrophotometers are powerful tools used in analytics. • UV-Vis-NIR spectroscopy measures the amount of light transmitted or reflected when a sample is irradiated with light. From these data, we can obtain information such as concentration, colour, and optical characteristics. • Versatile, non-destructive, and cost-effective technique that delivers high accuracy and precise measurement. • UV-Vis-NIR spectrophotometers are able to analyze liquids, solids and thin films with minimal sample preparation.

Instrument Capabilities

- The Instrument can measure the absorbance with highest sensitivity in class with three detectors
- High resolution, Ultra-Low stray light, and wide measurement wavelength range

Sample Type

- Solid
- Liquid
- Thin Films

Sample Preparation

- To prepare your samples for solution-state UV-Vis spectroscopy, you should consider the following points:
- Ensure that your cuvettes are as clean as possible. If you can, put them through a standard glass washing procedure. At the very least, they should be rinsed with the last used solvent and a rinsing agent, such as acetone, deionized water or IPA.
- Before loading your sample, you should rinse the cuvette with the solvent that your sample is dissolved in. This should help remove any residual solvents left over from cleaning, which could contaminate your measurement.
- Any reference measurement, such as for absorbance spectroscopy, should be taken of the cuvette filled with the diluting solvent. This will ensure that your measurement will account for any optical effects introduced by the quartz cuvette or the solvent.
- Use an appropriate sample concentration. If your sample is too concentrated, the beam will not be able to penetrate through the sample, and no light can be measured by the spectrometer. If your sample is too dilute, light may pass through your sample without interacting with the sample material at all.
- Optimize the path length for your experiment. A cuvette's path length is the distance that light travels through the sample before it escapes and is measured by the spectrometer. Using a cuvette with a smaller path length can be useful if you cannot reduce your sample concentration without significantly changing your results.

- Additionally, you can use a cuvette with a smaller path length to reduce the volume of sample needed. This can be especially useful if you have a small amount of sample or if your material is expensive.

- Ensure your spectrometer has a sample holder which accommodates your cuvette. The positioning of your cuvette relative to the spectrometer and light source should remain consistent throughout and between experiments. Your sample should also stand "face on" relative to incoming light to reduce any scattering effects. For example, the Ossila Optical Spectroscopy Kit contains a cuvette holder compatible with standard Quartz cuvettes.
- Always ensure that your samples are completely dissolved in your chosen solvent. Wherever possible, filter solutions before using to remove contaminants.
-

Applications

- High-absorbance measurement of polarizing films
- UV-Vis-NIR spectrophotometers are frequently used across a wide range of industries including pharmaceuticals, environmental science, food safety, and materials research.
- Reflection measurement of multilayer films
- Absolute reflectance measurement of highly reflective mirrors
- Spectral characteristic measurement of beam splitters
- Relative emission measurement of LEDs
- Transmittance measurement of quartz plates
- Absolute reflectance measurement of anti-reflection coatings
- Transmittance measurement of functional films
- Diffuse reflectance measurement and band gap measurement of semiconductor materials
- Transmittance measurement of solar cell cover glass, etc.BB
- Cosmetic color measurement and ultraviolet screening measurement
- Measurement of drugs containing crystallization water
- Measurement of moisture in plants
- Measurement of various amino acids
- Quantitation of proteins and nucleic acids
- Near-infrared measurement of pharmaceutical components
- Transmittance and color measurements of plastic materials
- Reflectance measurement of silica-based white powered materials
- Thickness measurement of thin films
- Near-infrared measurement of organic solvents
- Haze measurement of plastics

References

- https://www.shimadzu.com/an/products/molecular-spectroscopy/uv-vis/uv-vis-nir-spectroscopy/index.html
- https://www.shimadzu.com/an/sites/shimadzu.com.an/files/pim/pim_document_file/brochures/10404/c101-e171.pdf