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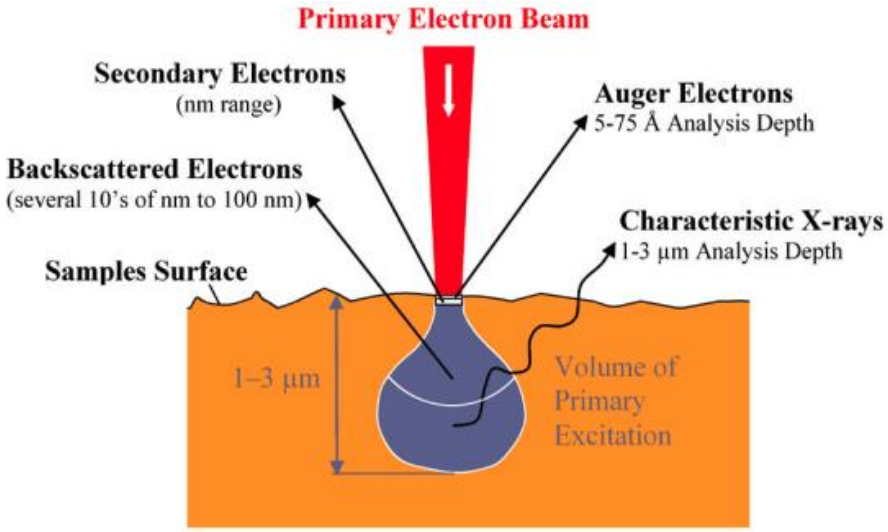
MICROSCOPY AND MICROANALYSIS LAB

SCANNING ELECTRON MICROSCOPY (SEM)

research.hbku.edu.qa

Scanning Electron Microscopy (SEM) provides high-resolution and long-depth-of-field images of the sample surface and near-surface using an energetic beam of electrons. As an e-beam rasters specimen surface, various signals that contain information about the surface topography and composition are produced as a result of the beam–material interaction. Sketch provides different signals produced as a result of this interaction. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image or chemical information across the surface using different produced signals, including secondary and backscattered electrons, X-rays, and photons.



Due to their low energy, 5eV, secondary electrons are very topography-related, providing surface topography images through-beam rastering. The production of backscattered electrons varies directly with the specimen's atomic number providing atomic number contrast across the sample surface. SEM could also be coupled to auxiliary X-ray detector enabling Energy Dispersive X-ray Spectroscopy (EDS) for qualitative and quantitative elemental analysis and elemental distribution and mapping through mapping and line profiling modes. Our systems are versatile, high-performance instrument with three imaging modes (high vacuum, low vacuum and some with environmental ESEM) to accommodate the widest range of samples of any scanning electron microscope (SEM) system. Other imaging modes include Cathodoluminescence, which collects all light emitted by the specimen or could analyze the wavelengths emitted by the specimen and display an emission spectrum or an image of the distribution of Cathodoluminescence emitted by the specimen in real color. Auger signal and technique falls outside the scope of SEM and a stand-alone surface analysis technique.

Core labs render its resources and expertise to industry and academic entities. We value our analysis's quality by reviewing our results and ensuring that our customer's needs are met.

Core Labs house state of the art microscopy facility matching any world-class laboratory. We use these systems to their full potential to get the best results from High Resolution to precise elemental analysis and distributions.

APPLICATIONS

The SEM applications include high-resolution imaging of surfaces, failure analysis, dimensional analysis, process characterization, reverse engineering, and particle identification. SEM application encompasses physical, and life sciences materials and is widely used to imaging all sorts of samples for all types of applications. Examples include:

- High-resolution surface topography images
- Elemental microanalysis and particle characterization
- Examine the structure of devices, including Solar cells.
- Membranes and their x- sections
- Materials Failure Analysis, such as corrosion.
- Nanomaterials analysis and particle size analysis.
- Metals & alloys, oxidation/corrosion, fractures, welds, polished sections, magnetic and superconducting materials
- Ceramics, composites, plastics
- Films/coatings
- Geological sections, minerals
- Soft materials: polymers, pharmaceuticals, filters, gels, tissues, plant material, cells
- Particles, porous materials, fibers
- In situ experiments:
  - Hydration/dehydration
  - Wetting behavior
  - Oxidation/corrosion

EQUIPMENT AND TECHNICAL SPECIFICATIONS

- ## JSM-7800F

JSM-7800F is FE-SEM equipped with Schottky field emission gun and the Super Hybrid Lens (strongly-excited conical objective lens combining a magnetic-field lens with an electrostatic lens). The combination of magnetic and electrostatic fields provides a superb effect equivalent to the aberration-correction effect, dramatically improving the SEM resolution, especially at low accelerating voltages. The JSM-7800F has a High Power electron optical system that incorporates an in-lens thermal FEG capable of producing a highly focused electron probe even with a large probe current. Furthermore, since stray magnetic fields at the analysis position are as small as in the case of an out lens, the JSM-7800F facilitates EDS elemental analysis, EBSD crystal-orientation analysis, and other tasks. In addition, the JSM-7800F has a new feature that enables simultaneous, real-time observation of images from up to four detectors.

TECHNICAL SPECIFICATIONS

- Signals Detected: Secondary & backscattered electrons and x-rays, and Electron Beam Induced current (EBIC)
- High Resolution of 0.8 nm at high vacuum
- Retractable BE Detector
- Upper SE Detector
- EBSD: OXFORD AZTECH HKL
- EDS: OXFORD, Advance AZTECH energy package X-MAX80
- Elemental mapping
- Gentle beam mode

JSM-7610F

JSM-7610F is the FE-SEM with Schottky in-lens field emission gun and semi-in-lens type conical objective lens, which enables a highly focused electron beam with a high illumination current. This system is best suitable for high-resolution imaging, EDS, and Cryo-SEM.

TECHNICAL SPECIFICATIONS

- Cryo- SEM
- Signals Detected: Secondary & backscattered electrons and x-rays
- High Resolution of 1.0 nm at High vacuum
- Retractable BE Detector
- EDS: Advance AZTECH energy package X-MAX80
- Elemental mapping
- Gentle beam mode

QUANTA650 FEG

This system is designed with a roomy chamber, enabling the analysis and navigation of large specimens. This allows to perform dynamic experiment's using variable pressure mode combined with either in-situ hot or cold stage (by using Heating and Peltier Stage, covering temperatures from -25°C up to 1000°C) along with EDS analysis. Using ESEM (Environmental SEM) mode we can analyze moist/ wet, hot/ outgassing samples by controlling the humidity and temperature.

Microanalysis under Low vacuum and ESEM conditions is also possible. Charging and drift is minimized using Drift Corrected Frame Integration (DCFI) scanning strategy.

TECHNICAL SPECIFICATIONS

- Electron Optics
  - High resolution Schottky field emission
  - Accelerating voltage: 200 V to 30 kV
  - Probe current: ≤ 200 nA, continuously adjustable
  - Magnification: 6 to 1000000x
- Electron Beam resolution
  - High Vacuum: 1.0 nm* at 30 kV (SE)
  - Low Vacuum: 1.4 nm at 30 kV (SE)
  - ESEM: 1.4 nm at 30 kV (SE)
- Vacuum modes
  - Chamber vacuum (high) < 6e-4 Pa
  - Chamber vacuum (low) < 10 to 200 Pa
  - ESEM vacuum < 10 to 4000 Pa
- Imaging Detectors
  - Everhardt Thornley SED (secondary electron detector)
  - Large Field Low vacuum SED (LFD)
  - Gaseous SED (GSED) (used in ESEM mode)
  - Gaseous analytical BSED (GAD)
  - Gaseous BSED (BSE detection at high ESEM pressures)
  - Directional Backscatter (DBS) detector
  - STEM detector

- Beam Deceleration Mode
- Integrated plasma cleaner for sample and chamber cleaning
- Elemental analysis using Bruker Quantax 400 EDS with X-Flash 6|60 – 129eV
- MAPS- Acquire high resolution images over large areas

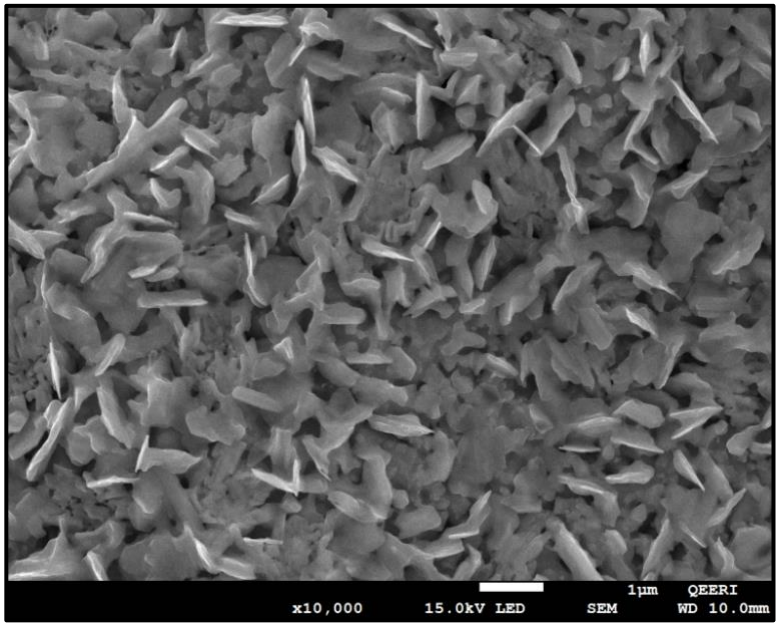
QUANTA250 FEG

Similar to Quanta 650 FEG, this system contains the same imaging modes including the Low-Vacuum mode. This system is dedicated for imaging and Cathodoluminescence(CL) analysis.

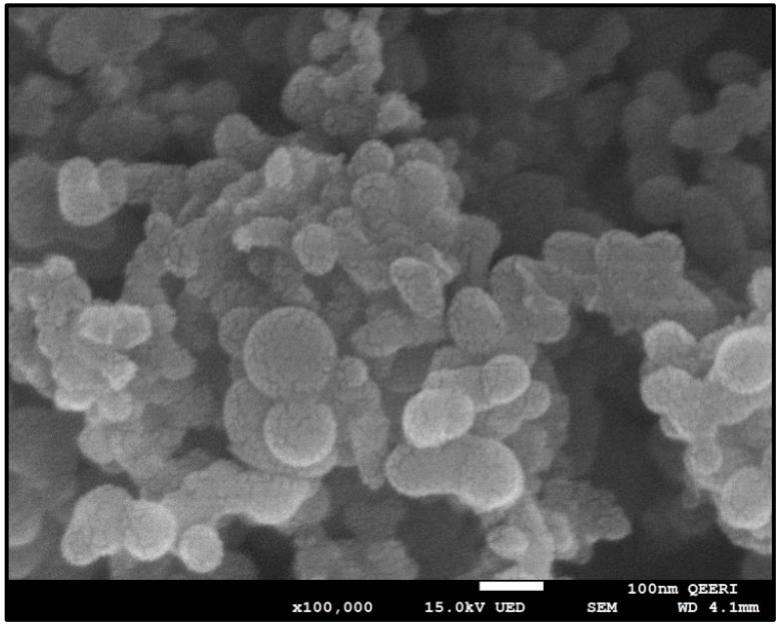
TECHNICAL SPECIFICATIONS

- Electron Optics
  - High resolution Schottky field emission
  - Accelerating voltage: 200 V to 30 kV
  - Probe current: ≤ 200 nA, continuously adjustable
  - Magnification: 6 to 1000000x
- Electron Beam resolution
  - High Vacuum: 1.0 nm* at 30 kV (SE)
  - Low Vacuum: 1.4 nm at 30 kV (SE)
- Vacuum modes
  - Chamber vacuum (high) < 6e-4 Pa
  - Chamber vacuum (low) < 10 to 200 Pa
- Imaging Detectors
  - Everhardt Thornley SED (secondary electron detector)
  - Large Field Low vacuum SED (LFD)
- Beam Deceleration Mode
- Gatan- Cathodoluminescence (Mono CL4)
- Integrated plasma cleaner for sample and chamber cleaning

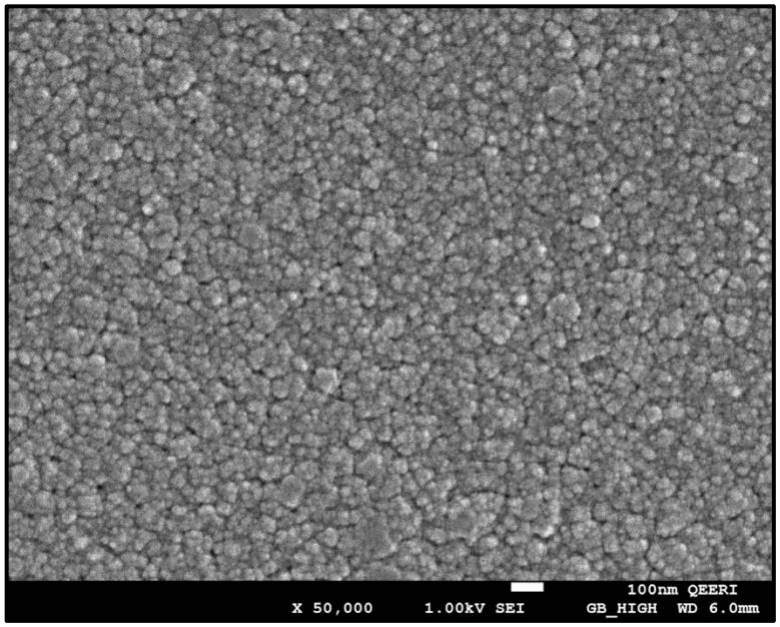
EXAMPLES OF WORK DONE



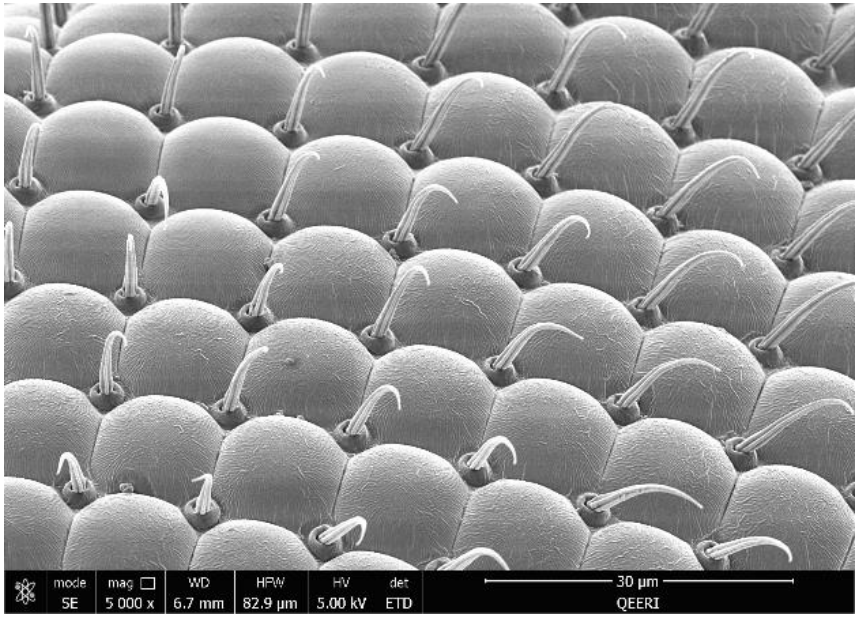
SEM image of perovskite material showing the morphological structure of aged perovskite



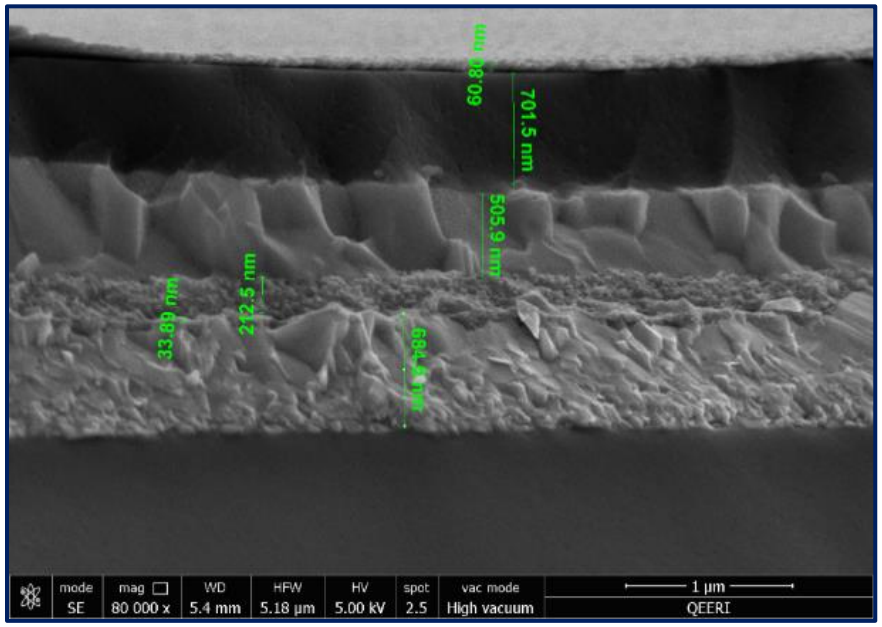
SEM image of Ni-NP showing the morphology and size of these nanoparticles



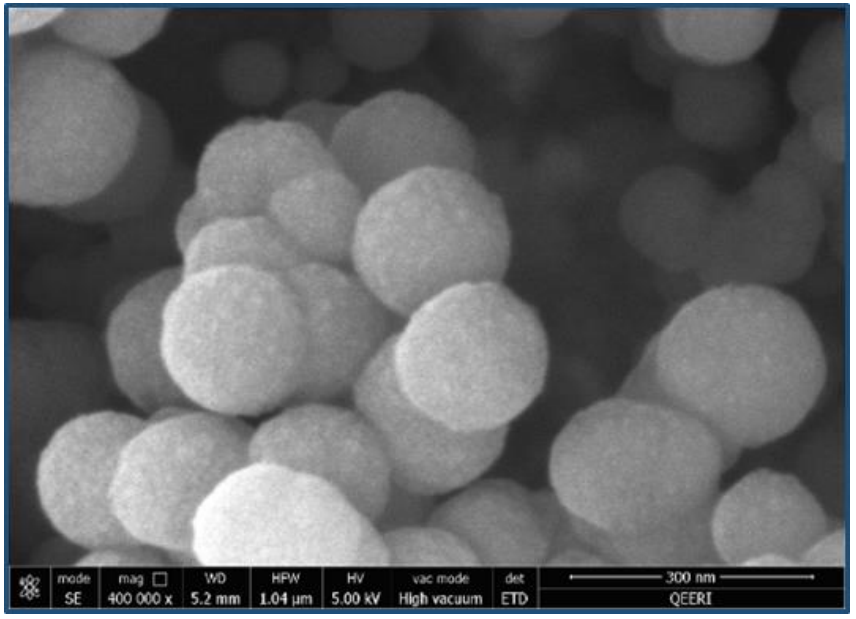
SiOx on a glass substrate. The SEM image was taken at 1 Kv to show The top thin layer of SiOx



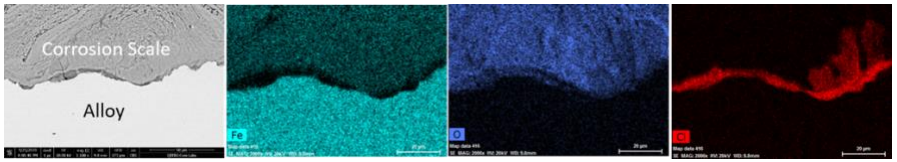
Fruit Fly's Eye Imaged without damaging the tissues



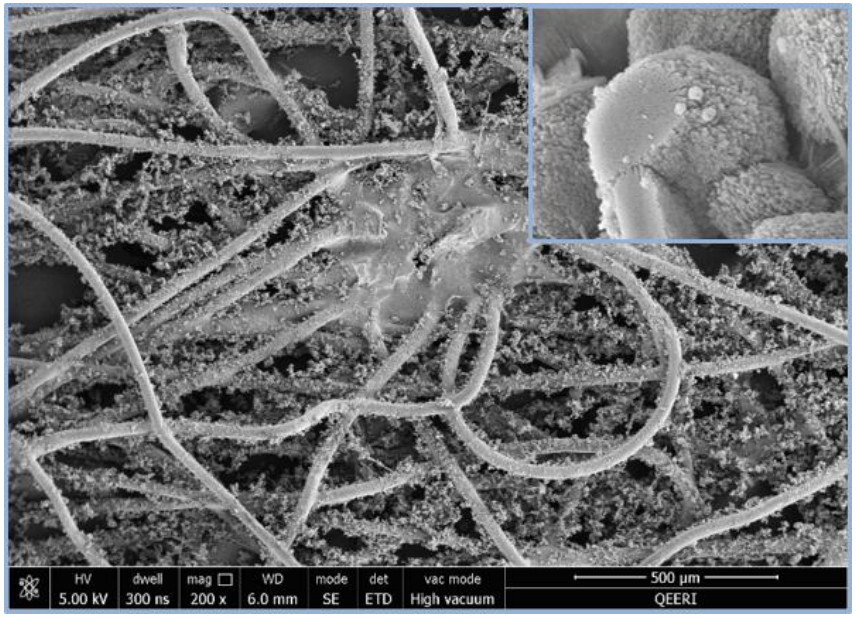
Cross Section of a Perovskite Solar Cell



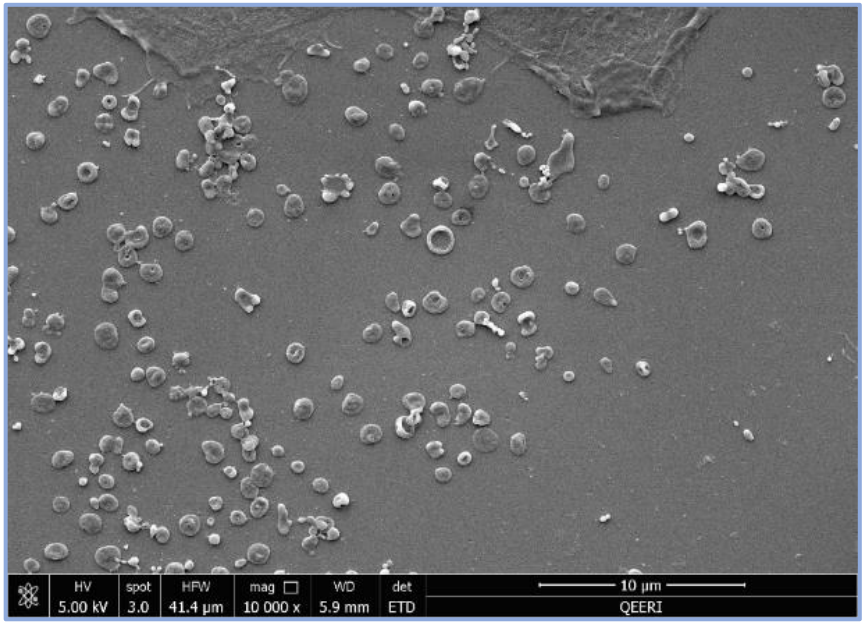
Chitosan Lignin Spheres Imaged at Low KV



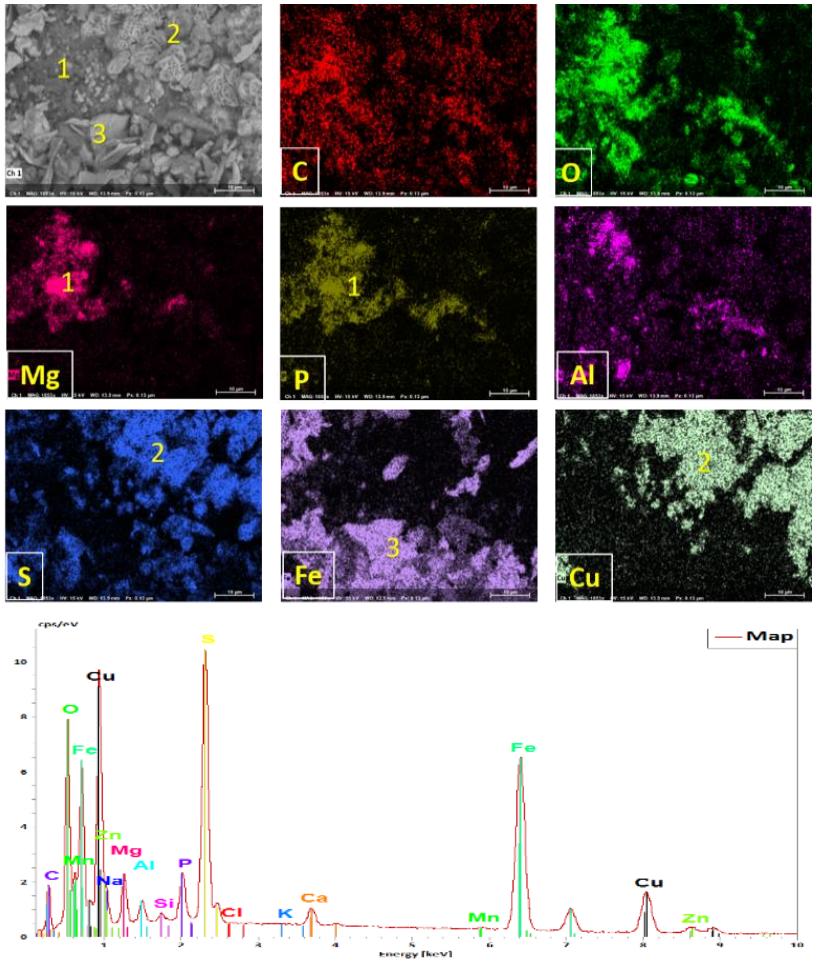
Root Cause Failure Analysis in Steel Pipes



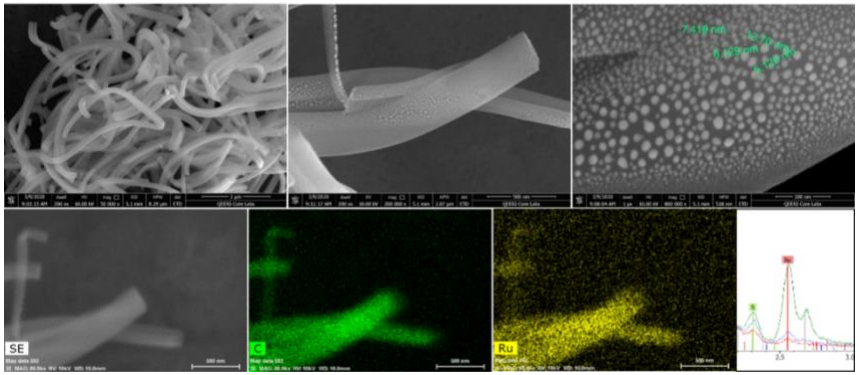
Study of Particulates in AC Duct Filters



Breast Cells Imaged using SEM



Study of different phases using EDS mapping on corroded steel pipe



Characterization of RuO2 Sprayed on Polymer Fibers for Gas Sensing Applications

PICTURES OF EQUIPMENT

JSM-7800F FE-SEM

JSM-7610F FE-SEM

Quanta650 FEG

Quanta250 FEG