UNIVERSITY OF LIVERPOOL

Department of Earth, Ocean and Ecological Sciences

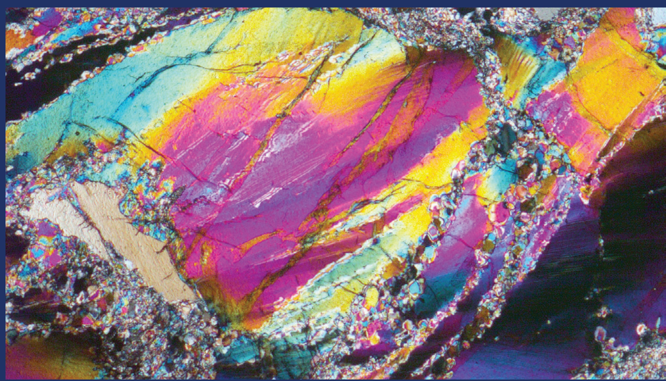
SCANNING ELECTRON MICROSCOPY SHARED RESEARCH FACILITY

Research Theme

Understanding the structure and chemistry of materials at a range of scales (from hand specimens to atoms) is a crucial process for delivering solutions for global engineering and environmental challenges.

Our research at the Scanning Electron Microscopy Shared Research Facility (SEM SRF) tackles these challenges through advanced characterisation of materials important for society's decarbonisation efforts, and for the energy transition to cleaner and renewable resources. Our researchers also examine materials that contribute to society's resilience against engineering, environmental, and health hazards.

The University of Liverpool's investment in Shared Research Facilities provides a unique platform for cutting-edge research supported by excellent facilities. We work with external organisations on a variety of collaborative projects in engineering, physical sciences, Earth and environmental sciences, and health and biosciences.



Research Team

Our researchers are leading experts in their respective fields.

- **Dr Elisabetta Mariani**, Director of the SEM SRF, is an expert in Earth materials microstructure and mineralogy research. She has over 20 years of experience in quantitative microscopy using electron backscatter diffraction that she applies to the study of structure-process relationships in critical materials research.
- **Dr David McNamara**, Deputy Director of the SEM SRF, has a specific research focus on hydrothermal alteration and vein mineralogy that is applicable to understanding the mineralisation processes in geothermal resources, carbon sequestration and mineral processes controlling critical materials development.
- **Dr Heath Bagshaw**, Facility Manager and Electron Microscopy Specialist with over 20 years analytical experience in a variety of techniques working alongside both university and industry stakeholders.

Contact:

Dr Elisabetta Mariani

mariani@liverpool.ac.uk

Facilities and Expertise

- In the SEM SRF we provide guidance on advanced research techniques and best research strategies, along with personalised training.

  We offer our clients access to a range of electron microscopes that are optimised for the multiscale measurement of crystal structures and their chemistry, using high-resolution secondary and backscatter imaging, electron backscatter diffraction (EBSD), quantitative energy dispersive spectroscopy (EDS), and cathodoluminescence (CL).

Microscopes

- Zeiss GeminiSEM 450
- JEOL JSM 7001F FEG-SEM
- JEOL JSM 6610 SEM

Techniques

- **Electron backscatter diffraction (EBSD)**

  A high-resolution, high-speed technique, which enables the mapping of crystallographic orientations in any crystalline material.

Energy dispersive spectroscopy (EDS)

- A technique used for both qualitative mapping and/or quantitative analysis of the chemistry of materials.
- **Cathodoluminescence (CL)**

  A qualitative imaging technique used to provide unique contrasts in luminescent materials, highlighting the distribution of trace elements and crystal defects.

Data analysis

- Aztec Crystal for EBSD and EDS data interpretation
- CrossCourt Rapide for stress and strain analysis by high-angular resolution (HR) EBSD
- Mountains for 3D image rendering and quantification of surface topography
- Crystal Maker for crystal and molecular structure visualisation and modelling

Sample preparation

We offer access to a full suite of cutting, coring, mechanical grinding, mounting, polishing, conductive coating and plasma cleaning equipment across the School of Engineering and the School of Environmental Sciences.

Case Study:

Developing cheap, reliable sensors to detect arsenic groundwater contamination

In partnership with:
ICT ltd (UK), Caminos de Agua (Mexico NGO)

Challenge

Arsenic pollution in groundwater affects millions of people globally leading to increased risk of cancer, skin lesions, mental disabilities and diabetes. Regular monitoring of arsenic in groundwater wells is essential, and the development of cheap, reliable methods of arsenic detection is an important step for securing the health and wellbeing of people at risk of arsenic groundwater contamination.

Solution

Gold wire electrodes have been developed that can detect the presence of arsenic in groundwater by an electrochemical technique called stripping voltammetry. In the SEM SRF high-resolution images of the electrode surface were collected before and after trial testing. The post-test electrodes exhibited drastic changes in surface morphology, which may impede electrode sensitivity. Observed variance in arsenic detection in the field may be attributable to these changes in surface morphology.

Impact

Understanding the evolution of gold electrode surfaces during exposure to arsenic-contaminated groundwater will help improve the development of reliable arsenic testing, contributing to the health and wellbeing of hundreds of millions of people around the world.

Contact:

Dr Elisabetta Mariani
mariani@liverpool.ac.uk