Laboratory Instruments Available to Support Space Station Researchers at Marshall Space Flight Center

by Dr. Binayak Panda and Dr. Sridhar Gorti
Materials and Processes Laboratory, NASA Marshall Space Flight Center

Abstract

A number of research instruments are available at NASA’s Marshall Space Flight Center (MSFC) to support ISS researchers and their investigations. These modern analytical tools yield valuable and sometimes new information resulting from sample characterization, including structural, compositional, and textural analysis. These instruments include transmission electron microscopy equipped with field emission guns providing analytical capabilities that include nanoscale imaging resolution and quantification of chemical composition and microstructure. Additional instruments include scanning electron microscopy equipped with energy dispersive x-ray spectroscopy for elemental analysis and x-ray diffraction for phase identification. Other analytical capabilities at MSFC include X-ray photoelectron spectroscopy (XPS) for surface analysis, and atomic force microscopy for imaging and chemical analysis of nanoscale features. These instruments provide a comprehensive suite of tools for investigating materials and processes relevant to space applications.

Conventional Transmission Electron Microscopy (TEM) for observing internal microstructures at very high magnifications and the Electron Probe Microanalyzer (EPMA) for very precise microanalysis are available on request by the researcher. Space Station researchers are invited to work with MSFC to analyze their samples using these techniques.

JEOL Superprobe (JXA-8900R): Scanning Microprobe allows for precise chemical analysis down to ppm levels using x-rays. Uses four spectrometers, with a large chamber size that can accommodate either fractured or flat samples.

Field Emission-SEM (FEI Quanta 600): Provides very high resolution and depth of field. It is equipped with X-ray microanalysis and EDS, and samples can be 3D imaged in 4K. The EBSD can be used for grain orientations, texture analysis, and phase identification. It is equipped with a large chamber size that can accommodate either fractured or flat samples.

Microprobe Analysis of An Amalgam Composite

ESCA- Auger System (Kratos AXIS Ultra): Instrument uses both white and characteristic x-rays for chemical analysis of thin surface layers. Can identify elements and their chemical compositions and oxidation states. Applications include imaging and identification of compounds, films, and polymers.

Secondary Ion Mass Spectrometry (SIMS, Cameca MS-50): Uses four spectrometers with a large chamber size that can accommodate either fractured or flat samples. It is sensitive to all elements and can perform quantitative analysis. Can map locations of all elements, including hydrogenic, inorganic, and organic substances. Requires flat polished samples and very high vacuum.

EBSD Images for A Partially Recrystallized Aluminum Alloy

Perform Qualitative and Quantitative Chemical Analysis of Slag Cross Sections

Identify precise quantitative chemical composition of slag features, using electron microprobe.

Image quality with superimposed grain boundary (RDF) map:

Pole figure (PF) map:

Inverse pole figure (IPF) map:

High resolution x-ray mapping of patterned sample.

ESCA Gallaries

Secondary Ion Mass Spectrometry (SIMS, Cameca MS-50):

X-ray photoelectron microscopy (XPS) with x-ray mapping.

Identify elemental distributions in slag using scanning electron microscope (SEM) with x-ray mapping.

Identify precise quantitative chemical composition of slag features, using electron microprobe.