Abstract

A number of research instruments are available at NASA’s Marshall Space Flight Center (MSFC) to support SS researchers and their investigations. These modern analytical tools yield valuable and sometimes new information resulting from sample characterization. Instruments include modern scanning electron microscopes equipped with field emission guns providing analytical capabilities that include nanogram-level image resolution of dry, wet, and biological samples. These microscopes are also equipped with silicon drift X-ray spectrometry (EDS) for quantitative elemental mapping of samples, as well as an electron backscatter diffraction (EBSD) unit to map grain orientations in crystalline alloys. Sample chambers admit large samples, providing latitude pressures for wet samples, and quantitative analysis software to determine elemental compositions.

Advances in solid-state electronics have also facilitated improvements for surface chemical analysis that are amenable to analysis of materials and alloys, concrete, rocks, and organic materials. Another analytical capability of MSFC is a magnetic sector Secondary Ion Mass Spectrometer (SIMS) that quantitatively determines and maps light elements such as hydrogen, lithium, nitrogen, and carbon along with their isotopes. EDS and other methods available at MSFC include X-ray photoelectron spectroscopy (XPS) that can determine oxidation state of elements as well as identify surfactants and measures the thicknesses of coated materials. Scanning Auger electron spectroscopy (SAM) which combines surface sensitivity, spatial lateral resolution (25 nm), and depth profiling capabilities to inverse elemental compositions in near surface regions and even the chemical state of analyzed atoms.


Conventional Transmission Electron Microscopy (TEM) for observing internal microstructures at very high magnifications and the Electron Probe Micro-analyzer (EPMA) for very precise microanalysis are available as needed 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.

Microprobe Analysis of An Amalgam Composite

ESCA Galliums

Secondary Ion Mass Spectrometry (SIMS, Cameca MS-60): A mass spectrometer from sample surface to identify and quantify elements and their isotopes. It is sensitive to all elements and compounds at ppm levels. Can map locations of all elements, including boron, carbon, germanium, selenium, sulfur, and oxygen. Quantitative analysis 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 elemental distributions in slag using scanning electron microscope (SEM) with x-ray mapping.

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