MOCHII FIELD-PORTABLE HIGH RESOLUTION IMAGER AND SPECTROMETER

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Scanning electron microscopes (SEM) are workhorse laboratory tools that serve diverse fields such as materials science, biological science, and engineering. With features of strong optical scattering, high native resolution, large depth of focus, and energy-dispersive X-ray spectroscopy (EDS), SEM provides high magnification down to the nanoscale and simultaneous pinpoint detection of trace chemical elements.

We have developed Mochii, a new SEM-based portable analyizer that brings the traditionally large and expensive laboratory-only SEM capabilities out into the field (Fig 1). As the smallest production SEM in the world, Mochii's portable imaging and spectroscopy capability complements field analyzers such as handheld X-ray Flourescence (XRF) and extends the mapping capability of lab tools such as micro-XRF and SEM into field applications. Mochii has been deployed and tested in a variety of applications and locations, ranging from research labs to home kitchens to investigations at the bottom of the ocean (NEEMO XXIII mission). Recently Mochii completed NASA integration and science requirements verifications and has traveled to the International Space Station (ISS) where it will serve as a National Laboratory research facility serving NASA and the public. [1-3]

The core Mochii concept packages advanced SEM capabilities into a tiny coffee machine-sized form factor small enough to carry in the overhead bin of an airplane. This perspective offered design opportunities that enabled crossing the threshold into true portability while simultaneously improving ease of use and reducing cost. In particular, the electron beam accelerating potential of 10 kV as opposed to the normal 15-30 kV of SEM reduces system size, weight, and cost. At the same time Mochii retains a standard-sized SEM stage that can take samples up to 2 cm with good working distance. An integrated X-ray SDD provides X-ray point spectra and spectrum images without increasing the microscope's footprint (Fig. 2). We have performed semi-quantitive analyses on a number of standards with good accuracy, and are developing new standards suitable for general precision ID at 10 kV.

The entire Mochii optical stack including electron gun, conditioners, and lenses is configured as a single replaceable module, similar to interchangeable lenses in a single-reflex camera. This column module eliminates service complexity enabling a 5-minute replacement of the optical system in the field by users. Replaceable column modules also provide instant reconfiguration of operation, such as higher resolution for imaging and higher current for EDS microanlysis. A small metal coater attachment about the size of a soda can provides for *in-situ* physical vapor deposition of a metallic coating onto samples to increase contrast or enable analysis of non-conductive samples.

References:

[1] Own, et al, Lunar & Planetary Sci. Conf. 2018.
[2] Own, et al, Micros. & Microanal. (2019), https://tinyurl.com/ya3mmowf.
[3] Own, et al, Micros. & Microanal. (2020) (in press).
[4] https://tinyurl.com/yafmovga.
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Figure 1. Mochii portable spectroscopic analyzer is controlled by iPad. Metal coater is attached to right of Mochii.

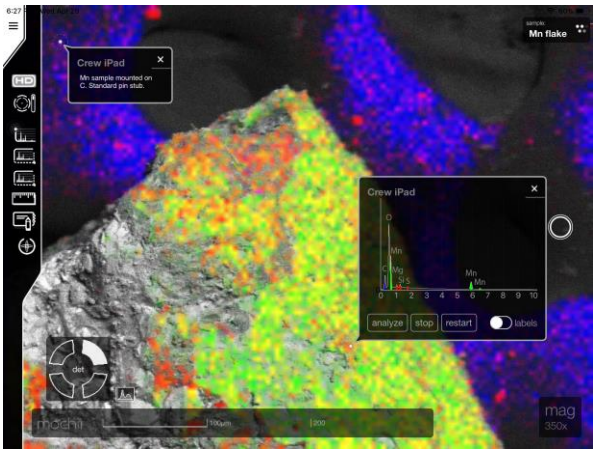

Figure 2. EDS spectrum image and point spectroscopy of a Mn flake. Mg and S impurities are detected in the bulk, fine Si particles are on the C background. Bulk Mn signal is mainly from right face of flake due to detector shadowing.