Advanced Multispectral Infrared Microimager (AMIM) for Ocean Worlds

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Microscopic imaging has long been an essential tool for field geologists and in the robotic exploration of planetary surfaces. Spatially correlated microscale texture and composition are essential for properly identifying rocks and soils in situ and interpreting their geologic histories. The Europa Lander strawman payload includes a Microscope for Life Detection (MLD) to provide microscale images of collected samples for characterizing textural and structural properties of collected material, and searching for cells and other biosignatures.

In support of determining the habitability and search for potential biosignatures on Europa and other ocean worlds such as Enceladus and Titan, we have developed the Advanced Multispectral Infrared Microimager (AMIM). AMIM combines microscopic imaging with visible-infrared microspectroscopy to enable the non-destructive first-reconnaissance of collected samples in situ. AMIM generates a visible-infrared spectrum at each pixel to provide spatially-correlated composition of minerals and ices within microtexture at the microscale. In addition, it can detect the presence of organics via UV fluorescence.

Under NASA PICASSO funding, we have developed an AMIM prototype that features compact illumination system composed of low-power multispectral LED arrays coated with micro-filters (> 25 wavelengths with FWHM ≤ 50 nm), an adjustable focus mechanism that provides in-focus images (spatial resolution ≤ 10 μm/pixel) with z-stacking, and a visible-infrared camera capable of imaging from the visible to the infrared (VIS-IR, 0.4 to 2.6 μm). Within this wavelength range, AMIM provides imaging/ spectroscopic measurements to detect minerals, salts and other biominerals, characterize the crystallinity and grain size of ice, and search for potential organic biosignatures (Figure 1).

The DPU merges multiple frames of each image to remediate radiation-induced noise, coregisters images from different bands, calibrates data onboard, and uses onboard processing to reduce image cubes to a few "summary products" that measure key absorptions and are downlinked to provide a context for samples analyzed with other onboard instruments.

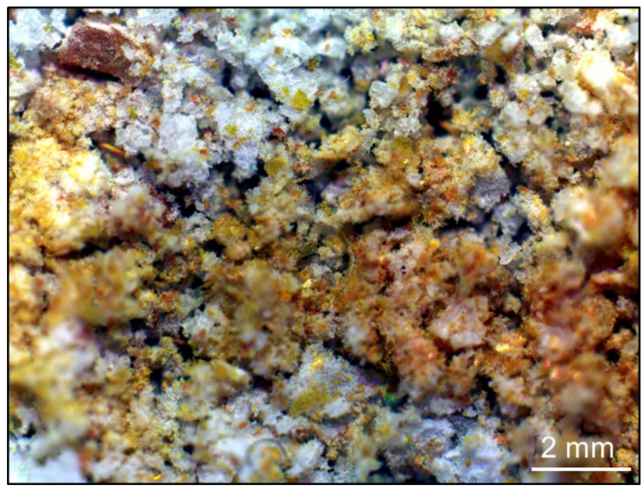

Fig. 1. Tholin-water ice mixture, applicable to ocean worlds, illuminated with AMIM's LED bands R=935 nm, G=770 nm, B=455 nm respectively. Image Field-of-View (FOV) is 14.1 mm x 10.5 mm with a spatial resolution of 6 μm/pixel. The two tholin samples, each made with 5% and 10% methane respectively, while indistinguishable in the visible (not shown), are clearly distinguishable in the false-color image, with orange and yellow colors respectively. Tholin samples credit: Dr. Sarah Hörst, Johns Hopkins University.