Europa Luminescence Microscope

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The Europa Luminescence Microscope (ELM) is an automated fluorescence and bright-field microscope designed to meet key objectives defined in the 2016 NASA Europa Lander Study Report, including the identification and characterization of morphological biosignatures. ELM's heritage stems from a 2U cubesat fluorescence microscope, the Fluorescence Analysis for In-situ Research (FLAIR) imager, designed and built at NASA Ames Research Center, for the autonomous study of microbial biology in low Earth orbit. For the ELM implementation, a sample is autonomously manipulated with a microfluidic system using in-line filter sets to capture successively smaller particles on 10, 1.0, and 0.1 μm pore-size filters for imaging. For bright-field imaging, ELM uses ultraviolet and visible light to image organic and inorganic structures with submicron resolution. The ability to detect structural and chemical biosignatures as small as 0.2 μm in size is achieved by imaging native fluorescence and using fluorescence microscopy stains to identify key molecular and structural indicators of microbial life (proteins, lipids, nucleic acids). To excite fluorescence, ELM uses LEDs with wavelengths centered near 265, 370, 470, and 530 nm and five emission bands. The use of multiple excitation and emission wavelengths for native fluorescence imaging not only enables the detection of different molecular species, but also their rough classification. Excitation at 265 nm allows for the detection of smaller polyaromatic hydrocarbons (PAHs; 1-5 rings), aromatic amino acids, and proteins with little to no interference from mineral fluorescence, given proper emission band selection. 370 and 470 nm light excites increasingly larger PAH structures (e.g., coronene) and larger aromatic biomolecules that may be present (e.g., protective pigments). Similarly, inorganic fluorescence can be characterized and separated from organic fluorescence, allowing the recognition and in some cases classification, of minerals and other abiotic particles. ELM is based upon work supported by the NASA COLDTech and ICEE-2 programs.