NASA PHASE I PROJECT SUMMARY

Firm: Creare Incorporated
Contract Number: NNX13CJ09C
Project Title: Miniaturized Variable-Pressure Scanning Electron Microscope

Identification and Significance of Innovation:

The goal of this project is to develop an easy-to-use miniaturized variable-pressure scanning electron microscope (MVP-SEM) instrument package for use on the International Space Station (ISS) (and other planetary and interplanetary missions). The MVP-SEM will support current ISS customers and engage new customers by improving the available ISS support structure and greatly reducing the need to ship samples to Earth for analysis. The MVP-SEM will support ISS research in biology and biotechnology, Earth and space science, physical science, human research, and technology development, as well as assessing the health of ISS structures. We will achieve our goals by leveraging key developments achieved by Creare in the area of vacuum technology for space flight, by Applied Physics Technologies Incorporated (APTech) in the area of electron emitters, and from the Marshall Space Flight Center (MSFC) lunar mini-SEM including MSFC's electron gun control system, electron focusing column design, and scanning and imaging systems. This development project will result in a MVP-SEM design that is ready for flight qualification for installation on board the ISS.

Technical Objectives and Work Plan:

The overall goal of this project was to produce an MVP-SEM instrument package for use on the ISS and for other planetary and interplanetary missions. Our approach was to develop a flexible SEM system that greatly reduces the size, weight, and power requirements of the overall design and auxiliary systems and simplifies system maintenance. The work plan covered the following tasks: (1) determine the MVP-SEM measurement requirements, (2) design electron gun and focusing column, and (3) design sample chamber and vacuum system, and (4) Develop conceptual system design.

Technical Accomplishments:

During this Phase I project, we completed a detailed design of the MVP-SEM. We detailed a high-brightness, long-lifetime electron gun design based on APTech's proven design. We designed a compact, electrostatically actuated beam steering column, and we detailed a complete compact vacuum system based on Creare's space-qualified high-vacuum turbomolecular/molecular drag pumps. We further designed a sample chamber including sample holder and stage and selected detectors and electronics for both electron and X ray imaging. Finally, we developed a concept assembly that will ensure that the MVP-SEM can be integrated into a ISS standard mid-deck locker and meet ISS power requirements.

NASA Application(s):

An MVP-SEM will provide the ISS with an additional on-orbit analytical tool that will allow for increased capacity of on-orbit analysis, thereby reducing the number of samples that must be returned to Earth. For Mars exploration, a variable-pressure SEM will allow for the simultaneous study of organisms and the geological substrates they might live on, provide shape and size-scale information, and impart context for other studies that provide detailed chemical information. Morphological and chemical characterization of lunar regolith in laboratories on Earth has been routinely accomplished using a SEM and Energy Dispersive X ray Spectroscopy (EDS). Our SEM would allow similar analysis in situ.

Non-NASA Commercial Application(s):

SEMs are one of the most indispensable laboratory tools for making analytical measurements. The market for electron microscopes is expected to exceed $4 billion by 2017, and the clear trend in the market is a shift to smaller, lighter, and more portable units. Our miniature variable-pressure SEM will be uniquely positioned to benefit from growth in this segment of the market due to its small size, low power, small mass, and excellent measurement capabilities. The fact that our system will facilitate measurements in support of biology and biotechnology, Earth science, physical science, human research, technology development, and will also facilitate assessment of the health of materials and structures, suggests that potential commercial applications for the technology are wide and deep.

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