NASA Phase II Project Summary

NONPROPRIETARY

Firm: Creare Incorporated
Contract Number: NNX09CA64C
Project Title: Very Low-Cost, Rugged, High-Vacuum System for Mass Spectrometers

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

The overall goal of this Phase II project and enhancement was to develop and test complete high vacuum systems of very small size, mass, and power consumption that are optimized for supporting portable analytical instruments. The two principal targeted applications are (1) for use on Mars and astrobiology probes and (2) for man-portable applications on Earth. To achieve this overall goal, in Phase II we constructed two versions of an extremely miniaturized high vacuum pump and fabricated another high vacuum pump during the enhancement. One version includes a pure molecular drag pump and the other two incorporate a hybrid turbomolecular/molecular drag pump. The pumps were also tested to verify their operation. In addition, we developed a very high-speed motor design that demonstrated equivalent life to previous motors that were built, but that include substantial changes to make the motors more tolerant to environmental extremes, as could be expected to be found on Mars.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

During this Phase II enhancement project, we: further developed a design for a miniature, high-speed motor that incorporates changes to increase the tolerance of the motor to environmental effects (such as vibration and temperature excursions); demonstrated that the high-speed motor has equivalent lifetime to our past motor designs; designed a hybrid turbomolecular/molecular drag pump that incorporates the features of the new motor design; fabricated the new hybrid turbomolecular/molecular drag pump design; and tested the performance of the pump in a typical application.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

The results we obtained confirmed our hypothesis that we could develop a hybrid turbomolecular/molecular drag pump that achieves a vacuum level of 1e-8 torr and has sufficient pumping capability to meet the needs of a typical mass spectrometer used in astrobiology missions. Our life test of the improved motor design also demonstrated that our new motor design meets or exceeds the lifetime requirements of a typical Mars mission. Finally, we demonstrated a new technique for sealing the pump stators that will allow lower pressure operation than has been heretofore possible in such a small pump package.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

A number of current NASA initiatives seek to reduce the size and power requirement of scientific instruments. Success in these efforts will lead to new generations of sensors that can be deployed on smaller, less expensive platforms, including Unmanned Aerial Vehicles (UAVs), balloons, microspacecraft, and miniature interplanetary probes. Our minitature, rugged vacuum system directly supports these goals by reducing the size, mass, and power consumption of vacuum systems required to run these instruments.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Numerous commercial applications exist for the proposed rugged, low-cost vacuum system, primarily to support portable analytical instruments such as mass spectrometers and leak detectors. Current-generation devices are limited by the size and mass of their high vacuum and rough pumps, or else use less capable absorption pumps. Building a small, lightweight, rugged, low-cost, and low-power high

vacuum system whose performance is tuned to the needs of miniature detectors is expected to greatly expand the market for such devices.

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