

NASA Phase I Project Summary

Firm: Creare Incorporated

Contract Number: NNX12CF09P

Project Title: Miniature Gas Chromatograph Mass Spectrometer for In Situ Resource Utilization

Identification and Significance of Innovation:

NASA's Regolith & Environment Science and Oxygen & Lunar Volatile Extraction (RESOLVE) mission to the Moon will require an instrument to analyze volatile gases. The mission objectives for RESOLVE are to analyze the distribution of volatile compounds on the lunar surface and to demonstrate ISRU. Creare's miniature GC-MS utilizes components already developed for other applications that makes it compact, low mass, and low power compared to other designs. It will provide critical analysis capability to NASA's ISRU missions. It is based, to the largest extent possible, on commercially available components that we are confident will meet the performance specifications and that have strong likelihood of becoming space-qualified. It will be capable of detecting, identifying, and quantifying ppm to 100%-level concentrations of the compounds of interest. In addition, the system will be capable of performing GC-MS and MS only analysis, providing capabilities to separate gas samples of interest, and to analyze isotopic composition of the volatile samples. The specificity, accuracy, and multi-functional capabilities of the Creare miniature GC-MS make it a powerful analysis tool that will be essential in volatile gas analysis for future ISRU missions.

Technical Objectives and Work Plan:

During the Phase I project we tested several MS systems and GC columns and determined their suitability for this application. We selected appropriate GC and MS components based on the desired system specifications and built a Phase I prototype. Based on our Phase I design, size, weight, and power constraints will also be met. We estimate a total system mass of less than 7 kg, total power consumption of less than 75 W (depending on the thermal environment), and size of approximately 25 cm x 25 cm x 13.5 cm.

Technical Accomplishments:

Our GC-MS laboratory prototype met or exceeded nearly all of the critical system specifications, such as dynamic range (5 orders of magnitude), detection limit (100 ppm), detection time (< 90 s for GC), amu range (0 to 70), separation of certain species (N₂ and CO) and mass resolution (< 1 amu). In addition, we operated the prototype in GC-MS mode and in MS only mode. In MS only mode, we successfully separated several isotopes of interest.

NASA Application(s):

The main initial application area for the proposed gas chromatograph mass spectrometer for ISRU plants will be in NASA's future missions to the Moon and Mars, as well as other bodies such as Near Earth Objects (NEOs). Our overall objective is to design, build, and test a fully space-qualifiable miniature GC-MS that can be integrated into baseline ISRU plants currently being designed by NASA, such as the RESOLVE mission. The ability to analyze volatile gas mixtures in these types of plants will be critical in any NASA ISRU mission.

Non-NASA Commercial Application(s):

The primary private sector applications for a miniature GC-MS system is for performing portable chemical analysis, particularly when looking for harmful gases. The sensitive and specific sensor that we propose to develop will not only help ensure the timely generation of data for hazardous gas detection, but will also provide this capability to commercial organizations wishing to perform chemical analysis in the field. For example, the proposed system would be invaluable for supporting first responder personnel who need to determine the safety of areas during cleaning and securing activities for interval testing in different areas. On the commercial front, inexpensive portable mass spectrometers would revolutionize pollution monitoring, process control, and the response to incidents by emergency personnel.

Name and Address of Principal Investigator: (Name, Organization, Street, City, State, Zip)

Paul H. Sorensen
Creare Incorporated
16 Great Hollow Road
Hanover, NH 03755

Name and Address of Offeror: (Firm, Street, City, State, Zip)

Creare Incorporated
16 Great Hollow Road
Hanover, NH 03755