H4.06 Low-Power Multi-Gas Sensor for Spacesuits

Scope Title
Spacesuit Gas Sensors

Scope Description
As the design for the new Exploration Extravehicular Mobility Unit (xEMU) is developed, technology gaps have been identified for the gas sensors employed in the portable life support system (PLSS). These gaps need to be fulfilled to meet the new exploration requirements.

To ensure the safe operation of the spacesuit there is a need to measure the following major constituents in the gas stream across a total pressure range of 3.5 to 23.5 psi and temperature range of 35 to 125°F: $O_2 = 20$ to 100%; $CO_2 = 0$ to 30 torr over 3.5 to 23.5 psi; $H_2O = 5$ to 90% relative humidity (RH). During ground testing these measurements can be made by ancillary equipment, however, the current design of the PLSS only includes nondispersive infrared (NDIR) sensors for $CO_2$. For reference, the outer mold line for these sensors is approximately 2.3 x 2.2 x 6.1 inches.

Since these sensors are continuously powered during an extravehicular activity (EVA) their power consumption is a direct driver of spacesuit battery capacity and in consequence spacesuit mass. It is, therefore, desirable to have a sensor power consumption below 2.5 W. The current $CO_2$ sensors consume 2 W during operation.

The intended use case for these sensors in the PLSS is to provide general situational awareness of the major constituents, in contrast to highly accurate measurements. The required accuracy of the sensors is therefore 1% or better for $O_2$ concentration and RH and 0.3 torr for $CO_2$ partial pressure.

Expected TRL or TRL Range at completion of the Project
3 to 5

Primary Technology Taxonomy

Level 1
TX 06 Human Health, Life Support, and Habitation Systems

Level 2
TX 06.2 Extravehicular Activity Systems
Desired Deliverables of Phase I and Phase II

- Prototype

Desired Deliverables Description

Phase I products: By the end of Phase I, it would be beneficial to have a concept design for infusion into the xEMU. Testing of the concept is desired at this Phase.

Phase II products: By the end of Phase II, a prototype ready for system-level testing in the xEMU or in a representative loop of the PLSS is desired.

State of the Art and Critical Gaps

As the design for the new xEMU is developed, there are obvious gaps in technologies that need to be fulfilled to meet the new exploration requirements. The currently employed gas sensors are functionally limited, draw significant power, and require new, innovative ideas. This solicitation is an attempt to seek new technologies for low-power multi-gas sensors. NASA has plans to go to the Moon and as the mission extends further out of low Earth orbit, the additional information provided by such sensors will be indispensable for the situational awareness of astronauts in space, as well as flight controllers on the ground.

Relevance / Science Traceability

It is relevant to the new xEMU, International Space Station (ISS), as well as commercial space companies. As the xEMU is being designed, built, integrated, and tested at Johnson Space Center, solutions will have a direct infusion path as the xEMU is matured to meet the design and performance goals.

References

https://www.nasa.gov/image-feature/exploration-extravehicular-mobility-unit-xemu

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