Project Introduction

Advanced space suits require lightweight, low-power, durable sensors for monitoring critical life support materials. No current compact sensors have the tolerance for liquid water that is specifically required for portable life support systems (PLSS). Intelligent Optical Systems (IOS) will develop a luminescence-based optical sensor probe to monitor carbon dioxide, oxygen, and humidity, and selected trace contaminants. Our monitor will incorporate robust CO2, O2, and H2O partial pressure sensors interrogated by a compact, low-power optoelectronic unit. The sensors will not only tolerate liquid water but will actually operate while wet, and can be remotely connected to electronic circuitry by an optical fiber cable immune to electromagnetic interference. For space systems, these miniature sensor elements with remote optoelectronics give unmatched design flexibility for measurements in highly constrained volume systems such as PLSS. Our flow-through monitor design includes an optical sensor we have already developed for PLSS humidity monitoring, and an optical oxygen sensor, both of them based on a common IOS technology. In prior projects IOS has demonstrated a CO2 sensor capable of operating while wet that also met PLSS environmental and analytical requirements, but did not meet life requirements. A new generation of CO2 sensors will be developed to advance this sensor technology and fully meet all NASA requirements, including sensor life. The totally novel approach will overcome the limitations of state-of-the-art luminescent sensors for CO2. Additional sensors will be developed to monitor trace contaminants often found in the ventilation loop as result of material off-gassing or crew member metabolism. IOS has established collaboration with UTC Aerospace Systems to produce prototypes for space qualification, and will conduct extensive testing under simulated space conditions, ensuring a smooth path to technology infusion.

Anticipated Benefits

Advanced Extra-Vehicular Activity systems are necessary for the successful support of the International Space Station beyond 2020, for future human space exploration missions, for in-space microgravity EVA, and for planetary surface exploration. In collaboration with NASA personnel, IOS has identified several needs and potential applications of multiparameter probe sensors, particularly for space suits. These include the International Space Station (ISS) Extra-vehicular Mobility Unit (EMU), the Orion-derived Launch Entry Abort (LEA), and future Advanced EMU development. The ISS EMU requirement is the highest priority, because problems have been reported in the CO2 sensor in use under conditions of liquid water condensation, and because solving problems reported in the CO2 scrubber system require a humidity sensor capable of withstanding water condensation. NASA guidance and the participation of UTC Aerospace Systems will ensure that the prototypes resulting from this project are compatible with the ISS EMU PLSS system. The proposed technology will also have application as a monitor for air quality in the pressurized cabins of crewed spacecraft, will significantly improve miniaturization, and has potential

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Compact high-performance gas sensors have a number of aeronautical applications. IOS has already negotiated with Lockheed Martin Aeronautics to integrate the sensor probe to be developed in the proposed project into flight crew air supply systems. Because of its status as both an aircraft system integrator and a leading supplier of avionic and aeronautics subsystems, Lockheed Martin is in an excellent position to bring IOS sensor technology to the aeronautics market.

Primary U.S. Work Locations and Key Partners

<table>
<thead>
<tr>
<th>Organizations Performing Work</th>
<th>Role</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Johnson Space Center (JSC)</td>
<td>Lead Organization</td>
<td>NASA Center</td>
<td>Houston, TX</td>
</tr>
<tr>
<td>Intelligent Optical Systems, Inc.</td>
<td>Supporting Organization</td>
<td>Industry</td>
<td>Torrance, CA</td>
</tr>
<tr>
<td>University of North Texas</td>
<td>Supporting Organization</td>
<td>Academic</td>
<td>Denton, TX</td>
</tr>
</tbody>
</table>

Organizational Responsibility

Responsible Mission Directorate:  
Space Technology Mission Directorate (STMD)

Lead Center / Facility:  
Johnson Space Center (JSC)

Responsible Program:  
SBIR/STTR

Project Management

Program Director:
Jennifer L. Gustetic

Program Manager:
Carlos Torrez

Principal Investigator:
Jesus Delgado Alonso

Technology Maturity (TRL)

Start: 3  
Current: 4  
Estimated End: 4

For more information and an accessible alternative, please visit:  
https://techport.nasa.gov/view/33421
Primary U.S. Work Locations

| California | Texas |

**Closeout Documentation**

Final Summary Chart
(https://techport.nasa.gov/file/27362)

Final Summary Chart Image
(https://techport.nasa.gov/file/26571)

**Images**

[Image of Advanced Gas Sensing Technology for Space Suits, Phase I]

**Briefing Chart Image**
Advanced Gas Sensing Technology for Space Suits, Phase I

**Technology Areas**

**Primary:**

- Human Health, Life Support, and Habitation Systems (TA 6)
- Extravehicular Activity Systems (TA 6.2)
- Portable Life Support System (TA 6.2.2)