## Low-Power, Chip-Scale, Carbon Dioxide Gas Sensors for Spacesuit Monitoring

Asha Rani<sup>1</sup>, Chen Shi,<sup>2</sup> Brian Thomson,<sup>3</sup> Ratan Debnath,<sup>4</sup> Boamei Wen<sup>5</sup>, Abhishek Motayed<sup>6</sup> N5 Sensors, Inc. Rockville, MD 20850

and

Cinda Chullen<sup>7</sup> NASA Johnson Space Center, Houston, Texas, 77058

N5 Sensors, Inc. through a Small Business Technology Transfer (STTR) contract award has been developing ultra-small, low-power carbon dioxide (CO<sub>2</sub>) gas sensors, suited for monitoring CO<sub>2</sub> levels inside NASA spacesuits. Due to the unique environmental conditions within the spacesuits, such as high humidity, large temperature swings, and operating pressure swings, measurement of key gases relevant to astronaut's safety and health such as(CO<sub>2</sub>), is quite challenging. Conventional non-dispersive infrared absorption based CO<sub>2</sub> sensors present challenges inside the spacesuits due to size, weight, and power constraints, along with the ability to sense CO<sub>2</sub> in a high humidity environment. Unique chip-scale, nanoengineered chemiresistive gassensing architecture has been developed for this application, which can be operated in a typical space-suite environmental conditions. Unique design combining the selective adsorption properties of the nanophotocatalytic clusters of metal-oxides and metals, provides selective detection of CO<sub>2</sub> in high relative humidity conditions. All electronic design provides a compact and low-power solution, which can be implemented for multipoint detection of CO<sub>2</sub> inside the spacesuits. This paper will describe the sensor architecture, development of new photocatalytic material for better sensor response, and advanced structure for better sensitivity and shorter response times.

<sup>&</sup>lt;sup>1</sup> Senior Process Engineer, N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>2</sup> Senior Process Engineer, N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>3</sup> Test and Development Engineer, N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>4</sup> Director of Research and Dev., N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>5</sup> Senior Process Engineer, N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>6</sup> Chief Technology Officer, N5 Sensors, 9610 Medical Center Dr. Suite 200, Rockville, MD 20852

<sup>&</sup>lt;sup>7</sup> Project Engineer, Space Suit and Crew Survival Systems Branch, Crew and Thermal Systems Division, 2101 NASA Parkway/EC5.