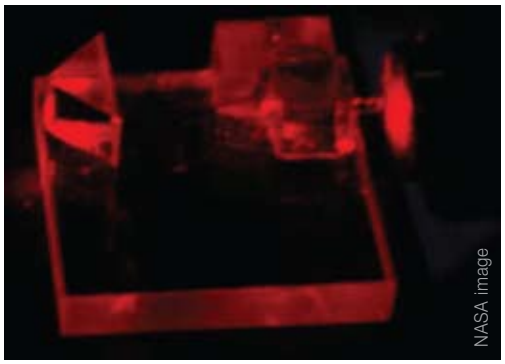
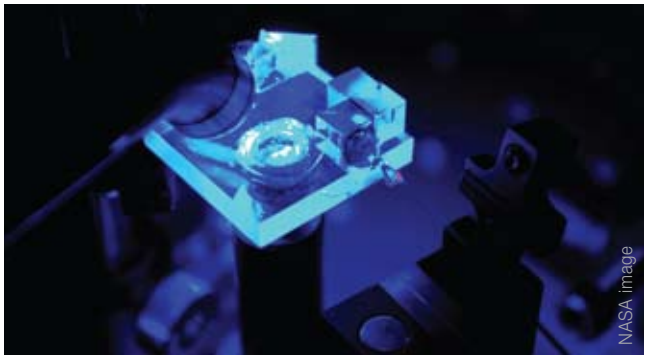
National Aeronautics and Space Administration

Sensors Technology

Compact Sensor for In-Situ Gas Species Determination and Measurement

For real-time optical monitoring of gas density, temperature, type, and concentration


NASA image


NASA image

Researchers at NASA's Marshall Space Flight Center have developed a compact, lightweight, integrated gas sensor capable of monitoring and detecting leaks in real time. The fiber-optic, laser-based leak detector uses an array of interferometric and spectroscopic techniques to measure gas density, temperature, species determination, and species concentrations. It is constructed from solid optics, compact enough to be used in the smallest of recesses, and consumes very little power. This technology can be used in space-based applications as well as numerous commercial industries, including automotive manufacturing, aerospace, natural gas, semiconductors, electronics, refrigeration, fuel cells, and distributed power.

Benefits

- **Compact:** Fits in small areas where larger and more fragile mass spectrometers cannot
- **Lightweight:** Can be deployed without adding excessive bulk or weight to an assembly
- **Versatile:** Operates in cryogenic environments, pressurized or vacuum conditions, and hazardous locations
- **Durable:** Offers solid state design, ensuring that the sensor is rugged
- **Efficient:** Each sensor consumes less than 100 mW
- **Low cost:** Serves price-sensitive markets through use of inexpensive optics
- **Safe:** Does not introduce an ignition source, so it can be used safely with explosive gases
- **Real-time:** Response rate is 10 ms
- **Precise:** Allows operators of large systems to pinpoint exact leak locations and species via multiple sensors networked together on a single fiber

technology opportunity

Images on front: (top left) Sensor in use with a helium-neon laser light source (top right) Sensor under assembly, illuminated by an ultraviolet light to cure epoxy

For More Information

If you would like more information about this technology, please contact:

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The Technology

NASA's gas sensor was originally developed for the storage of volatile liquids and high-pressure gases in outer space in order to facilitate space travel. The innovation has a diverse array of applications beyond aerospace, including cryogenic environments, pressurized or vacuum conditions, and hazardous locations.

How it works

The sensor system is composed of 1) a fiber-coupled laser light source, 2) a fiber-coupled photodiode detector, and 3) an optical interferometer. The non-intrusive sensor employs a number of optical techniques to measure gas density, temperature, type of species present, and concentration of various species. When the sensor is placed in the area where a gas leak may be present, gas density is detected and recorded as a result of changes in light transmission through the fiber. Changes in the density of gas in the test region cause corresponding changes in the intensity output onto a photodiode detector. This process provides a real-time, temporal history of a leak. Gas temperature is determined by placing an optical fiber along the length of a structure for in-situ measurements. The type of gas species present can be determined by using optical line emission spectrometry. The light-based sensor uses these interferometric and spectroscopic techniques to obtain real-time, in-situ measurements that have been successfully tested in environments with a pressure range of 20 mtorr to 760 mtorr.

Why it is better

Commercially available gas detection methods are limited in several ways. Vacuum gauges can detect only certain gases, and they have a limited operational range. Mass spectrometer systems are able to perform well, but their size, bulk, and use of high voltage, which can potentially cause arcing and ignition of combustible propellants, severely limit their usefulness. NASA's compact gas detection sensor has numerous advantages over other state-of-the-art detection techniques. Because the sensor is rugged, compact, and lightweight, it can be used in small, remote areas where other devices will not fit. It has no electronic ignition device, making the system suitable for use in explosive or hazardous environments. The system measures gas density, temperature, type, and concentration in real time, providing critical information on both the severity and location of the leak, all while consuming minimal power at very low cost.

Patents

Patent Number: 8,330,961

Potential Applications

- Industrial manufacturing facilities
- Industrial storage facilities
- Distributed power for small-scale or utility-scale fuel cells
- Semiconductor and electronics processing
- Facilities or processing involving or housing toxic, hazardous, or explosive gases

Licensing & Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for the Compact Sensor for In-Situ Measurements of Gas Leaks technology (MFS-32797-1 and MFS-32584-1) for further development and commercial applications.

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Fuentek is a contractor to NASA's Innovative Partnerships Program, providing support for the access and transfer of technology.