National Aeronautics and Space Administration

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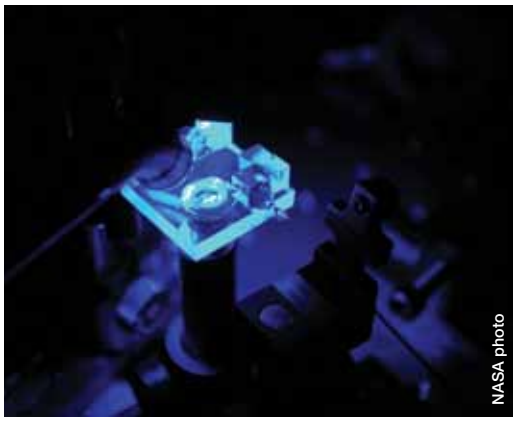
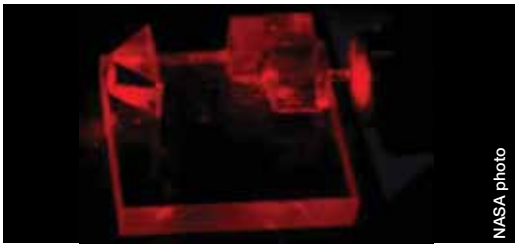
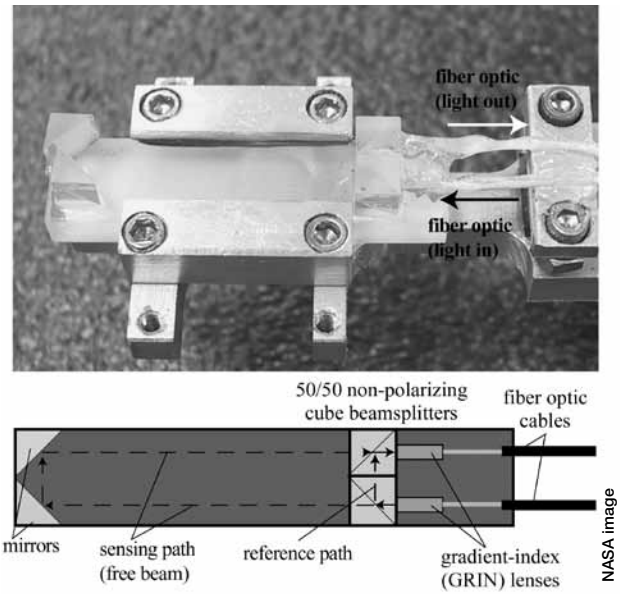
Materials Technology

Optical System and Method for Gas Detection and Monitoring

For safe monitoring of pressurized systems, including cryogenic applications







The above image and diagram show the basic configuration of Marshall's gas sensor for pressurized systems.

Innovators at NASA's Marshall Space Flight Center have designed a gas sensor that utilizes optical properties to monitor and detect leaks in pressurized systems, such as cryogenic tanks and distribution systems, and in vacuum conditions such as in space. The sensor optically measures even low-level gas leaks in a vacuum using principles of optical refraction. It is straightforward to implement, with minimal power requirements, and offers lowered project risk and the ability to operate in hazardous conditions. The innovation is an enabling technology for leak detection in space-based applications and also can be used for gas systems health monitoring (cryogenic or otherwise) in industrial manufacturing and storage facilities.

Benefits

- **Effective**: Provides highly accurate sensing of even low-level gas leaks, and can provide a time-history of leaks to determine severity (with time-accuracy demonstrated to 10 ns), lowering project risk
- **Sensitive**: Provides resolution to 10 mtorr (13 micro-atmospheres) with a development path to obtain resolution to 10 microtorr (13 billionths of an atmosphere)
- **Versatile**: Operates in vacuum conditions, cryogenic environments, and hazardous locations
- **Efficient**: Requires a minimal level of power (about 100 mW per detector) for the light source and offers straightforward implementation
- **Streamlined**: Offers a smaller overall system (about the size of a deck of cards) while improving detection capabilities compared to other gas sensor systems

technology opportunity

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The Technology

Marshall's gas sensor innovation extends existing sensor methods to make them applicable to specialized needs, including low-level pressure environments and hazardous locations.

How it works

The gas sensor employs a light source that is fiber-coupled to an optical interferometer (comprised of a low-power laser and a detector) using a single-mode optical fiber and placed in a region of interest (an area prone to gas leaks). The output light is guided to the optical detector and a history of the output light is recorded. The technology senses the presence of gases by measuring the shift in the interference pattern of the optical interferometer across a small gap. A system with multiple sensors can monitor multiple points of interest or gas-leak vulnerability simultaneously, and the data set can be analyzed manually or in automated schemes to evaluate the presence of gas in a given environment. Prototype systems have been successfully tested in environments over a pressure range of 20 mtorr to 760 mtorr.

Why it is better

While several methods to detect gas in a vacuum are available, there are no off-the-shelf instruments that are particularly effective for detecting leaks in a spatially or time-accurate manner and determining their severity and the resulting pressure level in the vicinity of the gas leak. Ion gauges, for example, offer high accuracy at low pressures but are fragile and can be damaged at higher pressures or during prolonged operation. Other instruments such as mass spectrometers are large and difficult to position in space-limited or remote locations and often require high voltage, which can be dangerous near tanks containing liquid hydrogen or oxygen. Further, existing techniques to meter liquid levels in cryogen tanks have exhibited poor resolution, and their sensitivity is not low enough to detect small leaks and identify leak locations. In contrast with these methods and devices, Marshall's gas sensor offers accurate detection of even small gas leaks at a variety of temperatures and pressures, and enables identification of both the severity and location of the leak, yielding high sensitivity while consuming minimal power and offering ease of implementation.

Patents

Marshall has applied for patent protection for its Optical System and Method for Gas Detection and Monitoring technology.

Commercial Applications

- Industrial manufacturing facilities
- Industrial storage facilities
- Facilities or processing involving or housing toxic, hazardous, or explosive gases

For More Information

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

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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 Marshall's Optical System and Method for Gas Detection and Monitoring technology (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.