Docket #: S23-271

Rapid Optical Sensing of Hydrogen Concentration

Hydrogen is becoming increasingly important as a clean energy fuel source. Accurate measurement of hydrogen concentration is essential, as it impacts fuel pricing and ensures safety during production, refinement, and transportation. However, existing technologies struggle to provide reliable and cost-effective solutions. Stanford researchers have developed a novel optical method for the rapid and precise measurement of hydrogen concentrations in gas mixtures using low-cost optical elements. This approach is particularly important in supporting the expanding hydrogen infrastructure, which is receiving significant attention in the US and globally.

The new method leverages Collision Induced Absorption (CIA) of high-pressure gas to overcome the infrared inactivity of homonuclear molecules, making traditionally non-observable gas molecules, such as hydrogen, nitrogen, and oxygen, visible in standard infrared absorption spectroscopy.

Key advantages of this sensor include high accuracy, fast measurement rates (sub-second), and low cost. It can measure multiple gas components simultaneously without degrading over time and can be used directly in pipelines. The new sensor is seen as a promising solution for the accurate monitoring of hydrogen-rich fuel streams, with applications also extending to natural gas extraction, process control, and flammability sensing.

Stage of Development: Prototype; planning to test at pilot scale demonstration.

Applications

- **Sensing and monitoring hydrogen-rich fuel streams**
- **Applicable as nitrogen and oxygen sensors**
- **Sensors for natural gas extraction, process control, flammability**

Advantages

- **Fast measurement rates (sub second measurements)**
- **Very low cost: $100-$1000 in components**
- **High accuracy**
- **Multiple gas components can be measured at once**
- **Sensor resilience: would not degrade/desensitize over timever time**

Publications

- Wei, C., Klingberg, A., Strand, C. L., and Hanson, R. K., "Measurement of Hydrogen and Nitrogen via Collision-Induced Infrared Absorption," *International Journal of Hydrogen Energy,* Vol. 93, 2024, pp. 364–373.

Patents

- Published Application: WO2025240565

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