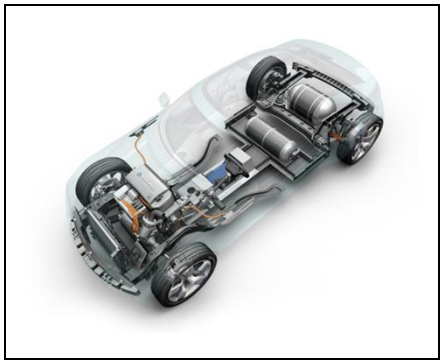
Fuel Cell Hydrogen Purity Analysis

Products: HALO 3, LaserTrace 3, Prismatic, VROOM

Tiger Optics Overview

Tiger Optics introduced the world's first commercial "Continuous Wave Cavity Ring-Down Spectroscopy" (CW-CRDS) analyzer in 2001. Today, our instruments monitor thousands of critical points for industrial and scientific applications. They also serve the world's national metrology institutes, where they function as transfer standards for the qualification of calibration and zero gases, as well as research tools for such critical issues as global warming and urban air quality.



CW-CRDS is ideally suited to laboratory applications where factors such as accuracy, sensitivity, low detection limits, speed of response, long-term stability, low maintenance, and low gas throughput are all essential when the efficient analysis of multiple samples is required. This report details the use of our CW-CRDS analyzers for fuel cell hydrogen purity analysis.

Hydrogen Purity Standards

Fuel cell technology is poised to have a significant impact in both the vehicle and portable power markets. In anticipation, standards bodies, such as ASTM and ISO, are preparing standards for hydrogen purity to maintain optimal performance of fuel cell devices. The proton exchange membranes in fuel cells are susceptible to contamination from multiple impurities typically found in hydrogen, which must be minimized to maintain efficiency. Concentrations as low as single figure ppb (parts per billion) for total sulfur, for example, can be a major issue. Contaminants, such as hydrogen sulfide and other sulphur-containing species, have a permanent effect on fuel cell efficiency. It is critical to monitor the concentration of these contaminants in fuel cell hydrogen during the production phase through to the point of delivery.

In Europe, the UK's National Physical Laboratory (NPL) has supported the drafting of ISO standards for fuel cell hydrogen purity.

NPL's collaboration with Air Products resulted in the validation of our LaserTrace instrument for measurement of trace water vapor in fuel cell grade hydrogen. CW-CRDS is now listed as a candidate analytical method in ISO 14687-2:2012.

The NPL report states that the LaserTrace far exceeded the required specification for water measurement. In addition to recommending CW-CRDS for water vapor, it is also listed as a candidate technique for the measurement of other key contaminants, including oxygen, methane, carbon dioxide, carbon monoxide, formaldehyde, formic acid, hydrogen sulfide, and ammonia.

CW-CRDS for Fuel Cell Hydrogen Purity Analysis

Tiger Optics manufactures a range of instruments for hydrogen purity analysis applications. The HALO 3 is ideally suited to ensure fuel cell hydrogen meets the necessary water specification, while lower levels of other impurities call for the power and sensitivity of the LaserTrace 3. Multi-component applications are also addressed by both our innovative Prismatic platform and our multi-species mirror-based analyzer, the VROOM.

HALO 3 and LaserTrace 3

Prismatic and VROOM

All Tiger Optics instruments are based on Continuous Wave Cavity Ring-Down Spectroscopy (CW CRDS). The key components of the CW-CRDS system are shown in Figure 1 below.

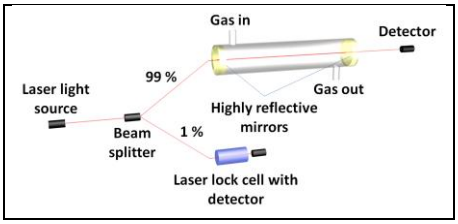


Figure 1. Schematic of CW-CRDS Analyzer

CW-CRDS works by tuning light rays to a unique molecular fingerprint of the sample species. By measuring the time it takes the light to fade or "ring-down", you receive an accurate molecular count in milliseconds.

The time of light decay, in essence, provides an exact, non-invasive, and rapid means to detect contaminants. Figure 2 below shows the linear response of the LaserTrace 3 when measuring formaldehyde from ppb to ppm (parts per million) level.

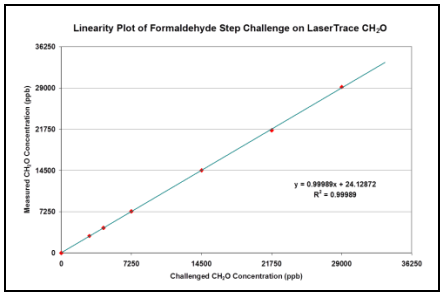


Figure 2. Linear response to formaldehyde

The LaserTrace 3 offers detection limits for water and oxygen at ppt (parts per trillion) level, with other components in the low ppb range. Up to four independent sensor modules can be connected to the PC driven electronics module, providing a standard MS Windows environment controlled via an integrated touch-screen.

Both the Prismatic and VROOM provide a similar package and user interface, offering the possibility of measuring up to four components in a single gas stream from ppb up to high ppm.

The HALO 3 features a touch-screen interface, including integrated trending features, plus on-board data logging – five days @ 15 second logging interval, three weeks @ 1 minute logging interval – provides additional benefits for operation at remote locations. Data is retrievable via an RS232 or Ethernet interface. Real-time data collection to an external data logger or PC is available via the same two options, or the 4-20 mA signal output.

Tiger Optics CW-CRDS analyzers bring powerful benefits to purity analysis applications, including:

- Accuracy traceable to the world's major national reference labs
- Sub-ppb detection capability
- No zero or span required
- No periodic sensor replacement/maintenance
- Nano-second speed of response
- Wide dynamic range

The maintenance-free and calibration-free properties of CW-CRDS also mean low cost-of-ownership and allow users to operate with confidence and ease in field and laboratory alike.

Tiger Optics LLC, 250 Titus Ave, Warrington. PA 18976-2426, U.S.A ▪ Tel: +1-215-343-6600 ▪ Fax: +1-215-343-4194 ▪ sales@tigeroptics.com