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## Hollow-Core Fibre–Enhanced Raman Spectroscopy of High-Pressure Gases

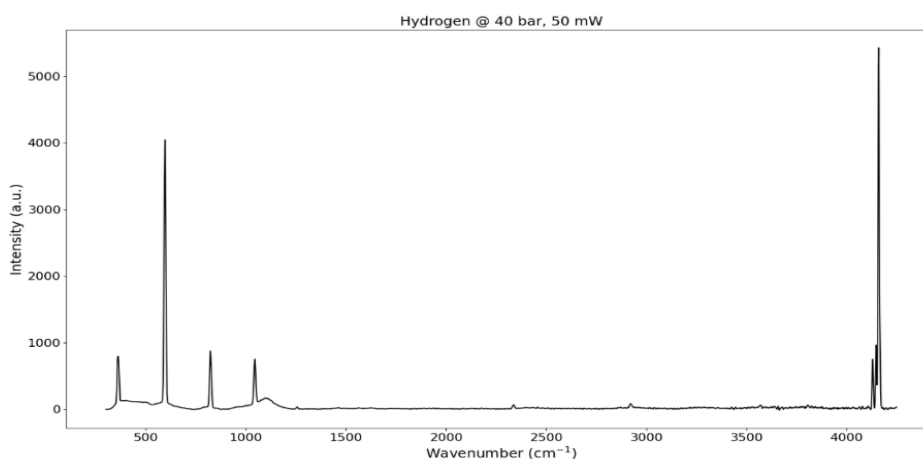
ISI have been working in collaboration with the Optoelectronics Research Centre (ORC) at the University of Southampton to develop a flexible on-line gas detection instrument with high specificity and sensitivity that can measure several gas species simultaneously. The Raman spectroscopy-based system uses a state-of-the-art hollow core fibre (HCF), a micro-structured silica fibre with a tubular hollow core which can be filled with the sample gas. The HCF facilitates an extended interaction path length between the excitation laser and the confined gas thereby enhancing gas measurement sensitivity, using just microliters of sample.

For the past two years, ISI has been focused on developing their gas Raman technology into a high-pressure rack mounted analysis tool. Now rated to analyse gases at pressures up to 45 barg, the instrument limit of detection has substantially improved, with the hydrogen LoD now being estimated at ~600 ppb, an example spectrum is shown in Figure 1.

To allow for high pressure gas samples to flow through the instrument, custom gas cells have been designed to integrate the HCF and the gas interfacing system. At the first cell, the gas enters the system and flows through the HCF where it interacts with the excitation laser. The HCF acts as both the vessel for the sample and a light guide for the laser and Raman. At the second cell, the gas exits the instrument and the Raman is collected via a custom dispersive spectrometer.

The observed linearity across all tested gases confirms the theoretical expectation that Raman scattering intensity scales proportionally with molecular number density, which increases linearly with pressure at constant temperature. The high coefficients of determination ( $R^2$ ) validate the suitability of HCFs for precision, high-pressure Raman gas sensing. A study is currently being conducted to build a database and to determine the response across the pressure range (1-45barg), the results will be presented.

### Figures



**Figure 1:** Hydrogen Raman spectrum, 1s integration, 532nm @ 50 mW