An integrated optical fibre device for harsh environment refractometry at indices above silica for monitoring hydrocarbon fuels

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Integrated Optical Fibre (IOF) allows for robust planar integration and seamless monolithic coupling. Fabrication is achieved through an adapted Flame Hydrolysis Deposition (FHD) technique, which forms a ruggedized glass alloy between the fibre and planar substrate. It has been previously demonstrated as a low linewidth external cavity lasers diode and a hot-wire anemometer, inherently suitable for harsh environments.

This work looks at implementing the platform for harsh environment refractometry, in particular monitoring hydrocarbon fuels in the C_{14} to C_{20} range (e.g. Jet A1 and diesel). The platform uses SMF-28 fibre and direct UV written Bragg gratings to infer refractive index and thus the quality of the fuel. A challenge arises as the refractive index of these fuels are typically greater than the refractive index of the waveguide. Therefore, the guided mode operation of FBG refractometers is unsuitable. This work uniquely reports leaky mode operation and a regression analysis, inferring propagation loss through changes in amplitude of successive gratings. In effect, the proposed methodology utilises the imaginary part of the effective index as opposed to the real part, typically used by such sensors.

Initial results have shown a 350 (dB/cm)/riu sensitivity is achievable above a refractive index of 1.45. This was measured for a SMF-28 fibre wet etched to 30 µm and planarized. Considering a 0.01 dB/cm propagation loss resolution, refractive index changes of the order 10^{-5} can be approached.

Work will be presented on the fabrication of an IOF platform for refractometers as well as metrics for survivability in harsh environments.