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Novel low-loss high-temperature stable strong fibre Bragg gratings

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Abstract – A novel strong index change is generated within low loss fibre Bragg gratings that survive extended periods at temperatures >400°C. The new approach circumvents many of the limitations of other techniques, making these gratings ideal for more advanced distributed sensing applications in the oil, gas and other energy industries.

Next generation fibre Bragg grating (FBG) high temperature point sensors require both long term stability at elevated temperatures T>400°C and complex low-loss reflectivity profiles. Regenerated FBGs [1,2] are the most stable gratings known and is complemented by superior spectral characteristics, but are too weak for many applications. Type-II gratings [3] can also handle very high temperatures, but high-end spectral reflectivity profiles are difficult to achieve and the gratings are prone to large scattering losses due to micro-cracks [4]. Other methods include advanced laser and thermal processing techniques such as hypersensitisation [3]. In this contribution, we present a systematic evaluation of various material processing recipes to develop a new approach that circumvents many of the limitations of each of these. We have, as a result, been able to generate strong index change within gratings that survive 400°C whilst retaining low losses, making them ideal for more advanced distributed sensing applications in the oil, gas and other energy industries.

Accelerated ageing studies were carried out using isochronal annealing to estimate the expected lifetime of these new stable high-temperature resilient FBGs. The grating under test was exposed to ambient temperatures ranging from 100-600°C in steps of 100°C for the duration of an hour each. The resulting transmission spectra were measured using an erbium doped optical fibre amplifier as source and an optical spectrum analyzer. The maximum FBG induced rejection was measured continuously and is shown in Figure 1 as a function of time. The vertical lines in the graph mark the different temperature zones. As is evident from the results, the FBG experiences insignificant reduction in strength up to a temperature of 600°C. There was no observable change in either reflectivity or spectral profile, suggesting that these FBGs are very promising candidates for future high-performance FBGs in high temperature environments.

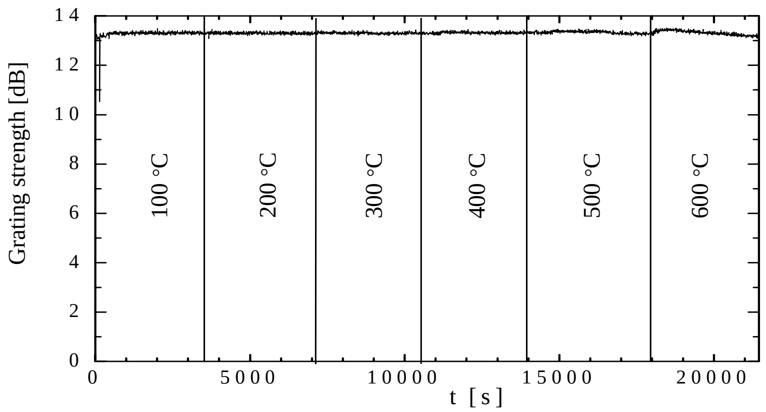

Figure 1: Accelerated ageing studies of FBG using isochronal annealing.

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