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Advanced Grating Laser Designs for Microwave Generation

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Fibre Bragg gratings have over a relatively short evolutionary process matured from prototypes in laboratory environments to commercial products in real world applications. This short process has been driven by a combined effort from many research groups throughout the scientific communities in the development and refinement of grating fabrication techniques as well as a number of potential applications. One field that has attracted attention from many obvious applications of Bragg gratings is that of microwave photonics, where optical devices and systems are employed to generate, transport and process RF, microwave and millimetre wave signals.

Bragg grating lasers and in particular the distributed-feedback (DFB) fibre-laser exhibit many attractive features including narrow (kHz) line width and being based on and around a fibre Bragg grating, they exhibit the robustness in performance offered by these together with inherent fibre compatibility. In light of this and with a number of applications in mind, we have developed a DFB-fibre laser source operating CW on two frequency channels separated by 15GHz, 25GHz, 50GHz and 100GHz respectively with output powers up to 1mW/channel. The laser consists of a superstructure Bragg grating with multiple phase-shifts written into a rare-earth doped fibre, where the periodicity of the phase-shifts determines the frequency separation of the generated channels. Additionally, the fibre-lasers are designed to operate with single sided output to optimise output-power. Furthermore, they can be made to operate in both single and dual polarisation mode configuration on both channels by controlling the polarisation of the grating writing-beam.

In this talk we will give a detailed description of the various design issues related to this device and will in addition give an airing of the Bragg grating fabrication technique used to manufacture the lasers. This technique can not just make devices like the one described here, but a wide range of Bragg grating devices with interest in microwave photonics. Among these are metre-long chirped Bragg gratings for phase-array antennas with beam-steering applications and superstructure Bragg gratings for pulse shaping and manipulation. We will highlight how our grating manufacturing technique provides sublime control of all the important parameters in a Bragg grating. We will also discuss the results of a sensor to simultaneously measure strain and temperature independently that has been constructed using our fibre-laser. This shows an increase in resolution of an order of magnitude over devices previously used to measure similar quantities.