Direct UV writing of channel waveguides and Bragg grating structures

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Direct UV writing is a dynamic planar lightwave circuit fabrication technique offering great potential as a means of rapid prototyping and small/medium batch fabrication. The technique is based on the refractive index increase of photosensitive glasses through exposure to ultraviolet light. In this case, a beam is tightly focused to create a writing spot in the order of microns and is translated relative to the sample. It is this translation over a 2-d plane that defines the channel waveguide structures; there is no need for a photolithographic mask or subsequent processing. This process has previously been shown to be a versatile system producing good quality, low loss waveguides compatible with existing silica based telecom fibres [1].

Traditionally, planar Bragg grating structures are defined in a similar manner regardless of the channel definition technique applied, that is, the location and superimposition of the grating modulation on top of the existing channel structure. This two step process is time intensive, normally resulting in non-optimal grating contrast and a variation of the strength of the channel waveguides with and without grating structures. As an alternative, we have developed a Direct Grating Writing technique (DGW), retaining all the advantages of Direct UV writing, allowing the definition of s-bends, y-splitters and couplers, whilst adding the ability to define Bragg grating structures within the channel waveguide in the same process [2].

The DGW technique retains a single micron-order writing spot, but now created through intersecting two focussed coherent beams (figure 1). The resultant spot is near circular with an inherent linear interference pattern that allows the simultaneous definition of both channel waveguide and grating structure. Bragg gratings are defined by modulating the intensity of the writing spot as the sample is translated. During this modulation, a 'snap-shot' of the interference pattern is exposed, the width of the channel waveguide. With each exposure the grating and channel structure is extended one plane at a time until the required grating length has been written. Subsequent translation with constant power averages out the effect of the interference pattern, defining standard channel waveguides.

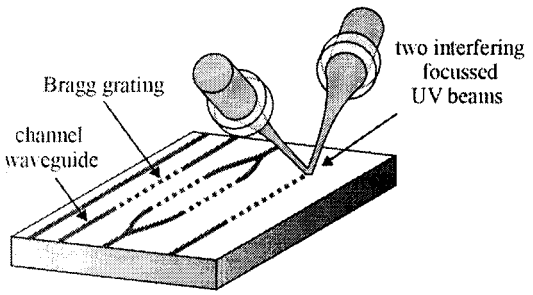

Figure 1: Direct Grating Writing technique allowing the simultaneous definition of Bragg grating and channel structure

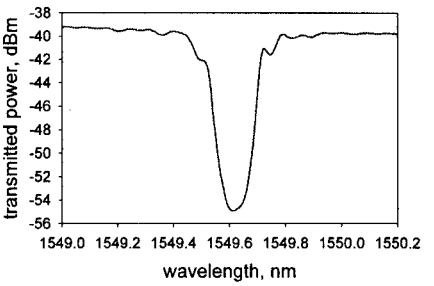

Figure 2: Example grating transmission spectra of a channel waveguide and grating defined simultaneously using the DGW technique

There are several advantages associated with this technique when compared to the traditional two-step approach. As both the grating and waveguide structures are defined entirely in software; there is a high degree of flexibility in the design and development of any structure written as there is only one fabrication step between design and device. The lack of a phase mask, and the unparalleled small spot, permits a very large range of detuning (the process of defining gratings with periods different to that of the interference pattern), hence a wide range of gratings can be written with a fixed intersection angle. This technique offers a rapid and powerful insight into the understanding of the writing conditions of different materials. Since both the channel waveguide and grating structure are defined in the same process, interrogation of the grating structures yields direct information on the properties of the channel waveguide itself.

[1] Zauner *et.al.* 'Directly UV-written silica-on-silicon planar waveguides with low insertion loss', *Electron. Lett.*, 1998, **34** (16), pp. 1582-1584
[2] Emmerson *et.al.* 'Fabrication of directly UV-written channel waveguides with simultaneously defined integral Bragg gratings', *Electron. Lett.*, 2002, **38**(24), pp. 1531-1532