

Microstructured Polymer Optical Fibres: New Opportunities and Challenges

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Microstructured optical fibres were first developed in 1996 and have subsequently generated enormous interest. Important features associated with such fibres are their ability to remain single-moded over a very large frequency range, to be single-moded with a large mode area, and the ability to guide light in air. Modifications of the hole structure have allowed a number of specialty applications to be realized, for example highly birefringent or polarization maintaining fibres. Their dispersion properties have also attracted attention, particularly because of the possibilities they offer for dispersion compensation. By changing the core size of the fibres, it is also possible to make them have either very low or very high optical non-linearity.

The development in 2001 of microstructured *polymer* optical fibres [mPOF] [1] opened up a number of possibilities, particularly for the polymer fibre community. Using this technique is easy to make single mode polymer fibre, which is problematic by conventional methods. Such fibres could have a large number of applications, particularly in sensing, where the ability to make materials sensitive to different stimuli is important. For these applications to be realistic however, the loss of the fibres has to be reduced to more acceptable levels. Over a period of 4 years, the loss for single mode mPOF has been reduced from 32dB/m to 0.7 dB/m. The contributions to this loss will be analyzed and presented.

While there has been considerable development of mPOF applications in which the hole structure is varied [for example: graded index mPOF for large core high bandwidth applications; birefringent fibres; high numerical aperture and dispersion controlled fibres] less attention has been paid to manipulation of the material properties.

A recently developed solution doping technique [2] allows many dopants to be introduced to the polymers after polymerization. This was recently used [3] to develop the first mPOF laser, and is being further developed for applications such as the electro-optic effect. Surface functionality presents other opportunities for applications such as bio-sensing. A more unusual application relates to the inclusion of chiral materials. Circular polarization is associated with important physical phenomena, including Faraday rotation, in which linearly polarized light is rotated by the application of a magnetic field. Many biologically important molecules are optically active. This means that for a variety of important applications relating to sensing, circular birefringence offers the most appropriate optical route. For example optical electrical current sensors employing the Faraday effect may use interferometric approaches based on circularly polarized light. Circular birefringence offers a route to making optical fibres that are *polarization maintaining*, but circularly *polarizing* fibres [which allow only one handedness of light to be transmitted] requires the other handedness to be lost. This may either happen because of circular dichroism, or by the appropriate choice of fibre design. A suitable transparent chiral polymer has been developed [4], and work on producing a chiral mPOF is in progress.

[1] Microstructured Polymer Optical Fibre, van Eijkelenborg, A et al., *Optics Express*, 9(7), 319-327, Sept. 2001.

[2] Solution doping of microstructured polymer optical fibres" Large et al. , *Optics Express* 12 (9) 1966-71 (2004).

[3] A microstructured polymer fibre laser, Argyros et al, *Optics Letters* 29 (16), pp. 1882-1884 (2004).

[4] Transparent chiral polymers for optical applications, Pujari, et al, accepted for *Journal of Applied Polymer Science*