PROPERTIES AND APPLICATIONS OF POLED GLASS

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When glass fibres were first proposed for optical communications in the late 1960's, one attractive selling point was their extreme insensitivity (if not complete immunity) to electromagnetic interference, which - in addition to a much larger bandwidth - gave them considerable advantages over co-axial cable. Early research concentrated on reducing the optical absorption to the lowest possible levels, eventually achieving values <0.1 dB/km in the main communications windows at 1.3 and 1.5 μm. At this point there seemed no reason to suppose that germanium-doped silica glass of extremely high purity should be anything other than an almost perfect optical transmission medium. Ambitious, however, to extend the capabilities of optical fibres, researchers went on to study whether more complex functions such as amplification, modulation, wavelength conversion and lasing could be incorporated, the idea being to avoid the need for optical-electronic-optical repeaters and modulators. This effort has resulted in the successful demonstration of all-optical diode-laser-pumped *in-fibre* lasing and amplification by incorporation of rare-earth dopants in the core glass. These developments are already revolutionising communications system design.

Components still missing from the list of practical all-fibre devices include effective linear electro-optical modulators and parametric frequency convertors, both of which require a second order optical nonlinearity - a $\chi^{(2)}$. This returns us to the issue of immunity to electromagnetic disturbance, for this property depends on the *absence* of a $\chi^{(2)}$ in glass, which in turn depends on glass being centro-symmetric on the scale of the optical wavelength.

In recent years a number of groups around the world have been exploring, with some success, the use of various poling techniques to break this centro-symmetry and induce substantial second order nonlinearities in glasses. Levels of $\chi^{(2)}$ of order 1 pm/V have been achieved, with some indications that even higher values may be possible. Considering that metre-long interaction lengths are feasible in optical fibre (compared to a few cm in ferroelectric crystals), that the optical damage threshold is very high, and that the dispersion of refractive index with wavelength is weak, nonlinearities of this order place glass in the unexpected position of a serious potential rival to such important nonlinear crystals such as lithium niobate, potassium titanyl phosphate (KTP) and lithium triborate (LBO). In the talk, recent developments in glass poling will be reviewed, and the prospects and potential applications for poled optical fibre discussed.