UV generation in silica fibres

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Abstract: The generation of UV light in solid core silica fibres has been achieved using four wave mixing in optical fibre tapers or rare earth doping with Gd^{3+}.

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1. UV generation

The generation of coherent light in the UV has a wide range of potential applications ranging from lithography, biomedical, undersea communications, environmental monitoring and explosives detection [1-5]. Up to now, this has mostly relied on the use of harmonic generation of a near IR laser with the aid of nonlinear crystals, on expensive diodes or on gas lasers based on excited dimers like KrF or XeCl. These methods have various disadvantages, including the need for relatively complicated/lossy free space optics, poor beam shape and relatively low power. Optical fibres on the contrary provide an output beam that is often close to M^2~1, is relatively easy to manipulate and can stand hundreds of Watts without any thermal induced effect. In this paper we presents two lines of investigation that have been pursued for the generation of light: namely, the intermodal four wave mixing (FWM) in optical fibre tapers and the use of rare (in particular Gd^{3+}).

2. FWM

Third harmonic generation has been proposed as an efficient means to convert light from the near IR to short wavelengths [6]; yet, intrinsic surface waves present in all glass materials have proved an unsurmountable limitation to achieve high conversion efficiencies [7]. By exploiting the tailorable waveguide dispersion to compensate for the material dispersion, phase matching be easily achieved in tapered fibres. Simulations with a pulsed source at λ=1.55μm working in conjunction with a periodically poled fibre to generate a second harmonic at λ=0.775μm, indicate that the parametric amplification at λ=0.517μm can be used for an all fiberised FWM process [8] resulting in light at λ~0.38μm and λ~0.31μm being generated. Interestingly, the phase matching diameter was found to be relatively loosely dependent on the diameter, thus avoiding the dephasing limitation associated to surface waves.

3. Rare earth doping

Despite rare earths being frequently used as dopants of silica fibres, their emission results in laser lines which lie mostly in the near IR wavelength region. Emission in the UV at λ~0.31μm and λ~0.28μm has been observed in bulk Gd^{3+} doped samples [9]. Here, two Gd^{3+} doped silica fibres have been fabricated. The first fibre was manufactured by the modified chemical vapour deposition (MCVD) and solution doping resulting in a pure silica cladding and a phosphosilicate core active fibre. A second Gd^{3+}-doped fibre with a pure silica core and a fluorosilicare cladding was manufactured by the rod-in-tube technique using Gd-doped samples fabricated by the sol-gel technique.

4. References

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