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"NOVEL GLASSES FOR MINIATURE LASERS AND AMPLIFIERS"

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Waveguide lasers and amplifiers possess the very powerful advantage that the gain medium is contained within a narrow waveguide. The close overlap between the lasing ions and pump and signal radiation leads to high intensities and good transverse mode control. Combined with excellent thermal stability these features provide high efficiency, cw operation and low threshold at room temperature with diode-pumping. Further, doped glass fibres are small, robust, flexible and relatively cheap.

Glass is a versatile medium providing a wide variety of environments for dopant ions. Even small structural changes can alter spectral characteristics, such as the emission linewidth - an important feature in optical network amplifiers.

Silica is often the preferred host because of its robustness and compatibility with telecommunication fibres. The limited solubility of rare-earths in SiO_2 is alleviated by adding alumina. Further, the addition of, for example, P_2O_5 changes the lattice structure, slightly increasing the phonon energy so changing the radiative probability of electronic transitions. These features have been combined to produce a highly efficient Er^{3+}/Yb^{3+} energy transfer fibre in which 1.5μm emission is generated from a 1064nm source.

Thus the host glass phonon energy can be tailored to provide the optimum lasing conditions, giving fully radiative metastable emission combined with rapid decay from intermediate bands. Considerable research is underway on silicate, phosphate, germanate, chalcogenide and fluoride glasses to extend the range of emission wavelengths, to develop visible emission via infra-red pumping and to provide tuneable parametric sources.

Impressive results have been achieved with fibre lasers and amplifiers. The laser range now extends from the blue (~470nm) to 2.7μm with tuning ranges up to 200nm. Other developments include 30fs solitons at rates up to 200Gbits^{-1}, 4W cw fibre lasers, 1kW Q-switched pulses and a visible white-light laser, whilst high gains (54dB) with quantum-limited noise have been demonstrated in the erbium fibre amplifier as well as 95% quantum pumping efficiency, 110kW output pulses and teraHertz bandwidths. Recent work on planar glass waveguides also shows promise. Combined with the ability to "write" components directly into the core, a new technology "Integrated Fibre Optics" is emerging.