OPERATION OF YTTERBIUM-DOPED SILICA FIBRE LASERS AT SPECIFIC WAVELENGTHS USING FIBRE GRATINGS

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Yb-doped fibre lasers have been previously reported as versatile, efficient laser sources in the 1 μm spectral region. The very broad Stark splitting of Yb energy levels in silica results in wide pump (830 - 1064 nm) and emission (975 - 1160 nm) bands [1,2]. The emission band includes a number of wavelengths of interest for specific uses; examples include 1020 nm, the optimum pump wavelength for the Pr:ZBLAN amplifier and upconversion laser [3], and 1128 nm, which has been utilised to pump a Tm:ZBLAN upconversion laser [2].

An attractive approach to achieve efficient laser operation at any wavelength within the emission band is to incorporate fibre gratings into the laser cavity [4]. In this work we report the performance of Yb-doped silica lasers operating at 1020 nm and 1128 nm. Gratings having reflectivities up to 99% at 1020 nm and 1128 nm were fabricated in silica fibre using a technique described elsewhere [5]. These gratings were fusion-spliced to silica fibre doped with 700 ppm of Yb. Laser performance has been compared to predictions from a small-signal computer model which predicts laser thresholds, and the amount of selectivity required to suppress oscillation at free-running wavelengths.

Laser action occurred at 1020 nm when pumped at 840 nm using a Titanium Sapphire laser. For a 10 m length of fibre, gratings having reflectivities of 95% and 30% at 1020 nm were spliced to the input and output ends of the Yb:SiO_2 respectively to suppress the free-running wavelength of 1050 nm. The output consisted of 260 mW at 1020 nm, and 50 mW of unabsorbed pump light for 660 mW launched pump. Angle-polishing of the fibre input end was found to be beneficial in suppressing the free-running wavelength. The relative output at the two wavelengths could be varied by changing the length of doped fibre.

Laser action has also been demonstrated at 1128 nm in Yb:SiO_2, pumped at 1064 nm by a pulsed NdYAG laser (5ms pulse duration). Due to very weak absorption of the pump, a fibre length of ~100 m was used, and the laser cavity consisted of a mirror (99% reflectivity at 1128 nm) butted to the input end of the doped fibre and a grating (50% reflectivity at 1128 nm) spliced at the output end. This configuration suppressed the free-running wavelength (1115 nm) and constrained laser oscillation to 1128 nm. 1.4 W peak power was achieved for an incident power of 10.6 W, and this output was then employed to obtain upconversion laser action at 480 nm from a Tm-doped ZBLAN fibre laser.

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