COLA '03

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Laser operation of a low loss (0.1 dB/cm) Nd:$Gd_3Ga_5O_{12}$ thick-film (40 μm) waveguide grown by pulsed laser deposition

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Waveguiding films of Nd:GGG with a thickness up to 60 μm have been fabricated by pulsed-laser deposition on YAG (100) substrates. Laser performance at 1060 nm has been investigated for a 40 μm thick and 4.1 mm long film. The laser cavity was formed by butt-coupling high reflectivity mirrors to the end faces of the waveguide and pumping was achieved using a Ti:sapphire laser emitting at 808 nm, and a spherical coupling lens with a focal length of 5 cm. A laser threshold of 35 mW of absorbed power was observed. Lasing action was observed at 1060.6 nm at pumping powers close to the lasing threshold, and at both 1059 and 1060.6 nm at pumping levels above 100 mW.

Waveguide propagation losses have been investigated using the Findley-Clay method. Figure 1 shows the absorbed pump power threshold for lasing action versus logarithm of output coupler reflectivity for 1060.6 nm laser operation. The x-axis intercept values for this plot correspond to a propagation loss of 0.1dB/cm, which to the best of our knowledge is the lowest loss reported for any pulsed laser deposited waveguide. Figure 2 shows the output power as a function of the absorbed power for two different output couplers of 2.5% and 4.5% transmission respectively. The slope efficiencies derived for these couplers were 5.4% and 7.5% respectively. The low efficiencies are thought to be due to the bad overlap of the multimode laser output and the transmitted pump beam.

Further work is in progress towards the development of multi-layer garnet waveguides, for which such thickness is essential, as the planar analogues of the large-mode-area (LMA) and cladding-pumped LMA waveguide designs previously used in optical fibres. The aim is to produce high-power diode-end-pumped laser sources of near-diffraction-limited beam quality at high powers (>10 W).

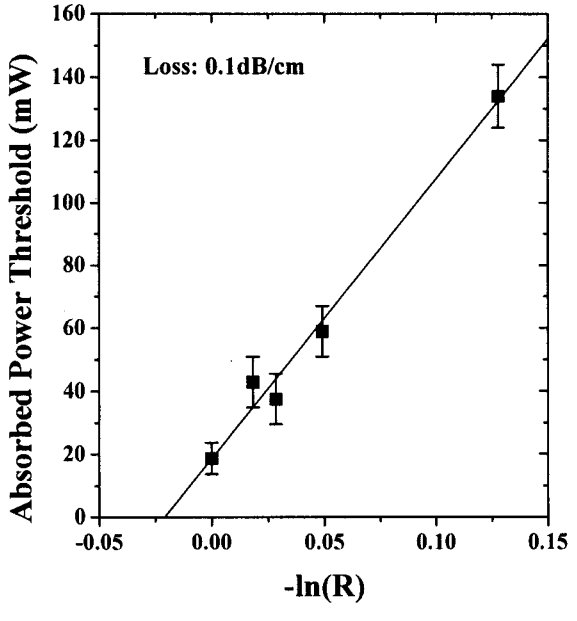

Figure 1: Absorbed power threshold for lasing as a function of output coupler reflectivity for the 1060.6 nm laser operation.

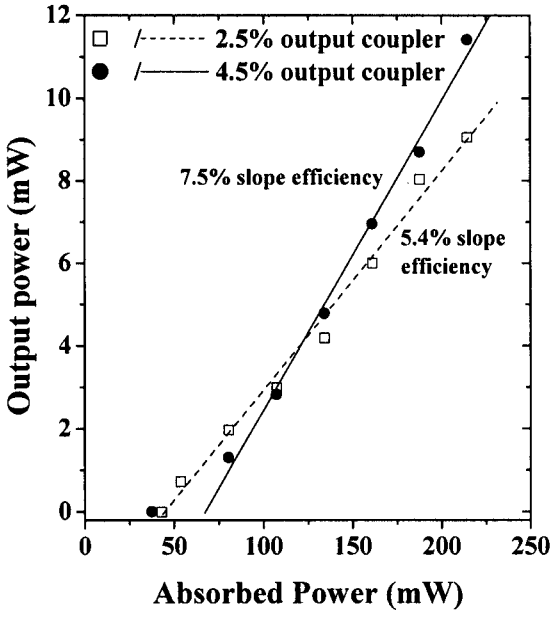

Figure 2: Dependence of the output power on the absorbed power for two output couplers with: (□) 2.5% and (●) 4.5% transmission respectively.

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