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SPECTRAL BEAM COMBINING OF CLADDING-PUMPED TM-DOPED FIBRE LASERS

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Tm-doped silica fibre lasers offer excellent potential for power-scaling owing to a very broad linewidth (>300nm) and relatively high lasing efficiencies. Output powers from fibre lasers are however ultimately limited by damage to the core due to its small size. There is limited scope for increasing the core size whilst maintaining good output beam quality and immunity from thermal effects. One attractive solution is to use multiple fibres and wavelength-combine their outputs using an intracavity diffraction grating [1]. Here we present preliminary results for a wavelength-combined Tm-doped fibre laser with 14W output power in the 2μm spectral region.

Our set-up (Fig.1) used four double-clad Tm-doped fibres, each ~4m in length with a Tm-doped alumino-silicate core of diameter 20μm and 0.12NA, and a non-circular silica inner-cladding of outer dimension 200μm coated with a low-index polymer outer-cladding. Each fibre was butted to a mirror with high reflectivity at ~1.8-2.1μm and high-transmission (>94%) at the pump wavelength. The opposite ends of the fibres were cleaved and arranged adjacently in a linear array with core-to-core separation of ~600μm. Each fibre was pumped by a beam-shaped diode-bar at ~790-797nm. The outputs from the fibres were collimated with a single 25mm focal length lens and then incident with slightly different angles of incidence on a diffraction grating with 600 lines/mm, positioned 25mm from the lens. The first-order diffracted beam was then incident on a plane output coupler of reflectivity ~20% from ~1.8-2.1μm to provide feedback for laser oscillation. Without grating feedback, the four lasers, using only the Fresnel reflections for feedback produced a combined output power of 23.6W for a total launched pump power of ~85W. With grating feedback, a maximum combined output power of 14W was achieved on four lines at wavelengths, 1926nm, 1956nm, 1981nm and 2001nm. The power reflected from the grating in zero order was ~1.8W, indicating that a grating with higher first-order reflectivity would allow higher output power. By adjusting the grating angle, the centre wavelength could be tuned over a range of 200nm from 1900nm to 2100nm. With a longer focal length collimating lens and a larger aperture grating, the wavelength separation of the fibre lasers can be reduced, allowing more lasers to be wavelength-combined. With these relatively simple modifications this fibre laser scheme offers the potential for scaling to power levels in excess of a hundred watts in a single high quality beam.

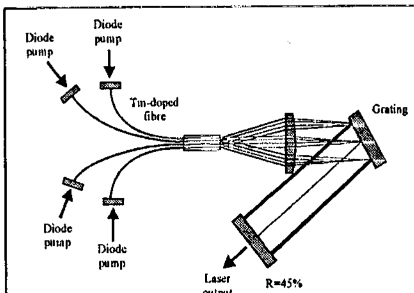

Fig.1 Wavelength-combined Tm-doped silica fibre

Reference

1. C. C. Cook and T. Y. Fan, in Trends in Optics and Photonics, Advanced Solid-State Lasers, vol. 26, (Optical Society of America, Washington, D.C.), 163-166 (1999).