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High power cladding-pumped tunable Er-Yb fiber laser

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Abstract: We report a high-power erbium-ytterbium co-doped fiber laser, cladding-pumped at 940nm by two beam-shaped diode-stacks, with up to 29W of output power at 1568nm and with operating wavelength tunable from 1561 to 1627nm.

Summary: High power solid-state lasers sources operating in the eye-safe wavelength regime around 1.55μm have applications in a number of areas (e.g. LIDAR and remote monitoring). For many of these applications, the requirement for high output power is also accompanied by the need for high efficiency and good beam quality, which are often difficult to achieve in conventional solid-state lasers. Cladding-pumping of Er,Yb-doped fiber lasers offers alternative route to output in the 1.5-1.6μm spectral regime with the attraction of a geometry that allows scaling to high power levels without decreasing efficiency or degrading beam quality. Moreover, the broad emission linewidths that are typical in glass hosts allows for flexibility in the operating wavelength. Here we report a tunable Er,Yb double-clad fiber laser (EYDFL), pumped by two beam-shaped diode-stacks at 940nm, with up to 29W of output at 1568nm and with lasing wavelength tunable from 1561nm to 1627nm.

The fiber used in our experiments had an Er,Yb-doped phosphosilicate core of 24μm diameter and 0.21NA, surrounded by a pure silica D-shaped inner-cladding of 400μm diameter and 0.49NA, with a low refractive index polymer outer-cladding. A relatively simple cavity configuration was employed (see fig.1) with feedback for laser oscillation provided the 3.6% Fresnel reflection from a perpendicularly-cleaved fiber end and by an external cavity at the opposite fiber end comprising a collimating lens and a diffraction grating aligned in the Littrow configuration to provide the means for tuning the lasing wavelength. The fiber end facet nearest the grating was angle-polished to suppress parasitic lasing between the two fiber end facets. Pump light at 940nm from two beam-shaped diode-stacks was launched into opposite ends of the EYDF with the aid of dichroic mirrors with high reflectivity at the pump wavelength at 45° and high transmission at 1.5-1.6μm. A rather long length of fiber (~18m) was selected for efficient pump absorption (~83% of the launched pump power) and hence to minimise the risk of damage to opposing diodes from unabsorbed pump light.

Using this resonator configuration, we obtained a maximum output power of 29W at 1568nm for ~100W of launched pump power, and by adjusting the angle of the grating the lasing wavelength could be tuned over 66nm from 1561 to 1627nm (see fig.2). The slope efficiency with respect to absorbed pump power was determined to be ~39%. At any given operating wavelength the laser spectrum (see inset of fig.1) was found to consist of multiple lines of width <0..02nm spread over 0.6nm. The M^2 value of the output beam was measured to be 2.9, but it was found that, by introducing a aperture to reduce the beam size inside the external cavity and hence the amount of light launched into the inner-cladding, it was possible to decrease this value to ~1.8, with a corresponding power loss of only 10 %. The prospects for a further increase in output power, improvement in beam quality and extension of the wavelength tuning range will be discussed.

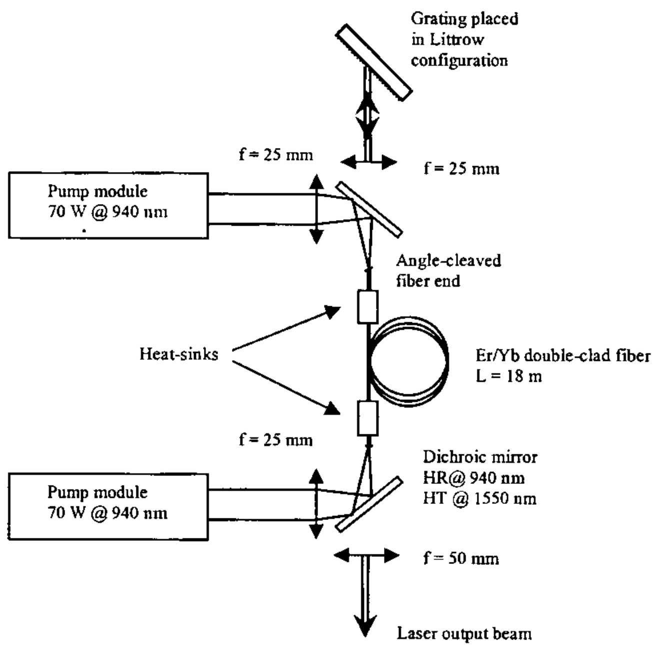

Fig.1: Tunable Er,Yb-doped fiber laser configurtaion

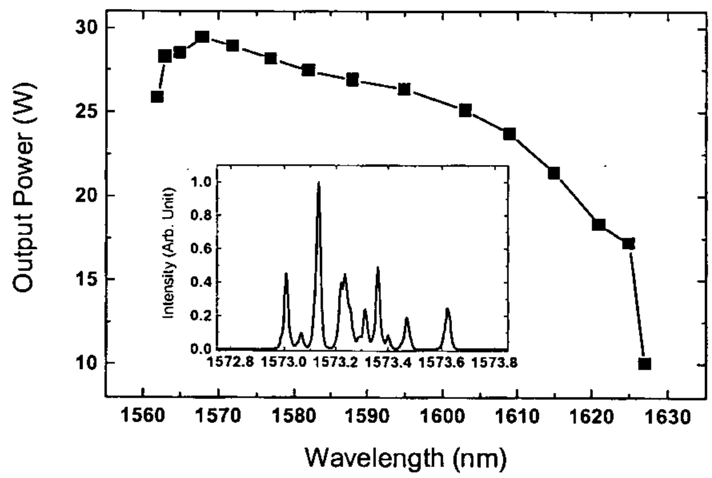

Fig.2: Er,Yb fiber laser output power vs lasing wavelength.