Double Cascade Erbium Fiber Laser

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The output power of the erbium laser at 2.7 μm (4I_{11/2} \rightarrow 4I_{13/2}) is enhanced due to simultaneous laser action at 1.7 μm (4S_{3/2} \rightarrow 4I_{13/2}) and 1.6 μm (4I_{11/2} \rightarrow 4I_{15/2}) in an Er^{3+}-doped fluorozirconate fiber. The laser cascade overwhelms the saturation effect for the transition at 2.7 μm by suppressing the laser transition at 850 nm (4S_{3/2} \rightarrow 4I_{13/2}) with lasing at 1.7 μm [1]. The population of the level 4S_{3/2} occurs for pump wavelengths around 800 nm due to strong pump excited state absorption (ESA).

A fluorozirconate fiber (core diameter: 6 μm, N.A.: 0.4, 3000 ppm Er^{3+}, length: 1.1 m) fabricated by Le Verre Fluoré was used for the measurements. The fiber laser set-up was of the Fabry-Perot type. The mirrors used as input and output mirror had reflectivities of 99% at 1.7 μm, 98% at 1.6 μm, 32% at 2.7 μm and approximately 10% at 850 nm. Transmissivity at 792 nm was 84%. It was estimated that 70% of the impinging pump power was launched into the core.

Using the pump wavelength at 792 nm, the laser at 2.7 μm was the first initiated. The transition at 1.7 μm had a higher threshold power at about 300 mW launched pump power. Figure 1 shows the laser spectra for the cascade lasers at 1.6 μm and 1.7 μm. The maxima are located at 1.6 μm and 1.72 μm.

Figure 1: Cascade laser spectra using a pump wavelength at 792 nm

Figure 2: Laser characteristics at 2.7 μm for the cascade with 1.6 μm and 1.7 μm (λ_p = 792 nm)