

Infrared Image Studies of Diode Pumped Yb³⁺, Er³⁺:Glass

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ABSTRACT

Infrared images indicate the fluorescence distribution of Yb³⁺ and Er³⁺ are quite different when pumped with a laser diode. This may result from the spatial cross relaxation of Yb³⁺ and Er³⁺ ions.

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Laser emission at 1535 nm from Er³⁺: glass laser is very useful due to its eye-safe wavelength and high transmission through fiberoptics and the atmosphere. Some applications such as target designation, laser radar, law enforcement, and wind shear detection require higher repetition rates and higher peak power output than can normally be obtained from a conventional flashlamp pumped Er³⁺:glass laser. Diode pumping allows for considerably greater quantum efficiency, dramatically decreasing the thermal design constraints.

Er³⁺:glass operates on a three level lasing scheme when lasing at 1535 nm. In order to achieve reasonable thresholds, it is necessary to minimize the Er³⁺ doping concentration. In addition, because the Er absorption cross-section is relatively weak, Er³⁺: glass is normally sensitized with a high concentration of Yb³⁺ ions to better match the wide spectrum of flashlamp pumping. Recent technological advances in the manufacture of InGaAs laser diode arrays have brought commercial laser diodes, in the wavelength range of 900 - 1 000 m-n, to

market from several manufacturers. This wavelength range matches the strong Yb · F7/2 _2 F5/2 transition, making it an ideal pumping source for Yb³⁺, Er³⁺: glass. In this paper we report the initial results of experimental studies using an infrared image camera to map the Yb³⁺ and Er³⁺ fluorescence in a side pumped, Er³⁺:glass laser configuration.

Two laser diode arrays of 1 cm length have been used in our experiments. The peak wavelength is 947 and 976 m-n with a linewidth of about 6 nm at room temperature. Both of the diode arrays produce about 60W peak power when driven with a 1 00 Amp current pulse. The laser material, QE-7N, has an absorption coefficient of about 5 and 20 cm respectively, at the two wavelengths.

The 1 cm diode bar pumps the polished barrel QE-7N 02 X 10 mm rod from side. A Micronviewer model 7290 video camera with a vidicon tube having a photoconductive target plate with spectra

response range from 400 to 2200 nm was used to monitor the fluorescence and lasing profiles of the laser rod. Filters were employed to separate the Er^{3+} and Yb^{3+} fluorescence.

Figures 1 and 2 illustrate the fluorescence at about 1000 nm from Yb^{3+} and at 1535 nm from Er^{3+} across the rod, when pumped at 946 nm. The exponential intensity of the Yb^{3+} fluorescence was expected; however, the Er^{3+} fluorescence profile has a considerably different distribution indicating the transfer of energy from Yb^{3+} to Er^{3+} is not a linear process.

The energy transfer process in Yb^{3+} , Er^{3+} :glass is indeed quite complicated. The experimental results suggest there may be a strong spatial cross relaxation allowing the pumping energy to be transferred between many Yb^{3+} ions before being transferring to an Er^{3+} ion. Such a migration process could be exploited to homogenize the gain media for future applications. A considerable amount of theoretical and experimental results will be presented.

Figure 1

Fluorescence at 1000 nm (Yb^{3+})

(Fit: $\alpha = 23 \text{ cm}^{-1}$)

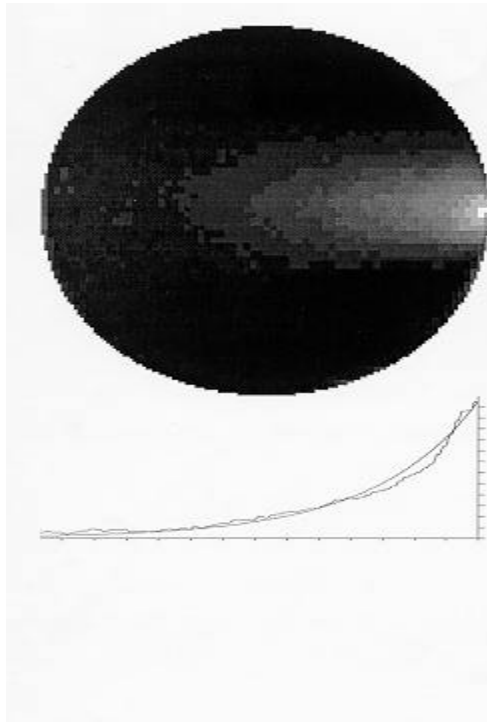


Figure 2

Fluorescence at 1535 nm (Er^{3+})

(Fit: $\alpha = 5 \text{ cm}^{-1}$)

