RARE-EARTH DOPED MATERIALS: TIME RESOLVED LUMINESCENCE SPECTROSCOPY INDUCED BY SHORT PULSE LASER EXCITATION

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The mechanism of energy transfer in Yb-Er and Tm-Ho in ZBLAN and Tm-Ho in Tellurite glasses and $LiYF_4$ crystal were investigated using a time resolved luminescence spectroscopy under short laser excitation. Efficiencies of the Yb→Er and Tm→Ho energy transfer were investigated as a function of donor and acceptor concentrations. Luminescence decay curves were analyzed by monitoring the Er-emission at 2.7 μm and Ho-luminescence at 2 μm. Best fittings were obtained using the acceptor luminescence expression derived from the Inokuti-Hirayama model. The results showed that a fast excitation migration among donors modifies the mean distance between donors (excited) and acceptors, increasing the transfer rate by 15-25 times. A localized donor-to-acceptor interaction takes place after the fast excitation migration, leading to an exponential decay of donors in competition with the Inokuti Hirayama type decay. Fractions of each process were obtained from the best fitting of the experimental acceptor luminescence transient with the proposed models. Therefore, a concentration ratio between donor and acceptor can be optimized.
The investigation of the multiphoton excitation process of the $4f^2 5d$ configuration in $LiYF_4$ and $LiLuF_4$ crystals doped with Nd^{3+} ion were performed using a short laser excitation in the visible range and a VUV monochromator.

The excitation spectrum of fast UV luminescence exhibited different structures depending on the excitation geometry with respect to the c axis of the crystal. We observed two emissions from the first state of $4f^2 5d$ configuration with peaks at 535 and 595 nm modifying the luminescence branching ratio of the bottom of the $4f^2 5d$ configuration around 55000 cm^{-1}. The equivalent cross section of three and two excitation processes was estimated at 510 nm by solving the rate equations of the system under short laser excitation, which shows that is possible to have laser action under pulsed laser pumping with intensity below the crystal damage threshold.

The observed broad band emissions with peaks at 185, 230 and 262 nm with a lifetime of 35ns follow a four level system and can be used for laser actiont.

Yb:Tm:YLF LASER EMITTING AT 2.3 MICROMETERS PUMPED BY A 960 NM DIODE BAR

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The 2.3 μm laser is used for sensing carbon monoxide [1] or hydrocarbon gases in combustion experiments and LIDAR applications. In situ absorption measurements of CO concentration in combustion experiments have shown a minimum detectivity of less than 10 ppm using 2.3 μm radiation. Operation of the cw Yb:Tm:YLF laser, pumped at 975 nm with a 3 W fiber coupled diode laser, has been demonstrated and produced 450 mW of output power at 2.3 μm [2]. The Yb:Tm:YLF crystals were grown in our crystal growth facility with a nominal concentration of 10 mol% of Yb and 1mol% of Tm in the melt. The pump scheme used in our experiment included a fast axis collimated diode bar emitting up to 20 W at 960 nm. Using a series of cylindrical lenses and a beamshaper we achieved a pump intensity of 17 kW/cm^2 and a M2 quality factor of 43x83 (horizontal x vertical) at the crystal position. Pump spot size was 240 x 400 mm^2. Due to losses in the beamshaper and the mirror M1, the maximum pump power was 13 W. The Brewster cut crystal had a length of 4.6 mm and absorbed 96% of the pump radiation. The laser cavity length was 2.3 cm using a 10 cm radius-of-curvature input mirror and a flat, 99.3% reflective output coupler. This cavity generates a TEMoo mode of 360 m diameter at the crystal position. The laser was operated in a qcw mode with pump pulse durations ranging from 1 ms to 10 ms and repetition frequencies of up to 75 Hz. Maximum peak output power was 520 mW and the slope efficiency was 5% (FIG.1). This is to our best knowledge the highest output power achieved with Yb:Tm:YLF at 2.3 μm.

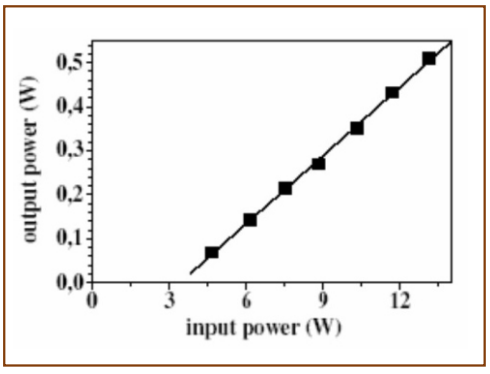

FIGURE 1