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POPULATION KINETICS IN ERBIUM DOPED LASER CRYSTALS PRODUCED BY EXCITATION WITH AN Er: GLASS LASER AT 1.53 MICRONS

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It is well-known that upconversion limits the performance of Er:crystal lasers at 1.6 μ (4I_{13/2} → 4I_{15/2}). The ion-ion interaction consists of Er(13/2) + Er(13/2) → Er(9/2) + Er(15/2). Thus each upconversion event leads to a loss of inversion by three. The following crystals were irradiated with the focused light output of an Er:glass laser at 1.53 μ which provided a spiked output for about 1 ms and total energy about 200 mJ: Er(0.1, 0.2, 0.5, 1, 2, 4%):YAG, Er(5%):YALO, Er(10%):YLF, Er(25%):YSGG, and Er(10%):YSO. In all cases, absorption of the 1.53 μ radiation produced "bleaching", namely, reduced absorption resulting from depletion of the ground level of Er, which becomes saturated (maximum transmission of 1.53 μ light).

The division of population between the ground levels of the 4I_{15/2} manifold and the 4I_{13/2} manifold was calculated from the changes in absorption coefficient induced by depletion of the ground state. Using the Boltzmann distribution, we computed the populations in the sublevels of the 15/2 and the 13/2 manifolds and found that a very large inversion was produced between the lowest sublevel of the 13/2 manifold and the highest lying sublevel of the 15/2 manifold. The length or thickness of our crystal samples (0.1 to 1 cm) together with the computed inversion showed that there was ample gain to sustain laser action. Experiments are in progress to demonstrate laser action with the 1.53 μ Er:glass laser pump.

Green light (560 nm) and infrared (980 nm) fluorescence was observed for all the crystals under 1.53 μ excitation. These measurements will be used to obtain the upconversion coefficients and to determine the deleterious effects of upconversion on Er:crystal lasers. The focus of these studies is the determination of the potential utility of Er:crystals for development of an efficient room temperature Er:crystal laser at 1.6 μ.

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