ABSTRACT

We report on the optical properties of Ho doped KPb2Cl5 (Ho: KPC) for potential applications as an infrared (IR) solid-state gain medium. The investigated crystal was synthesized from commercial starting materials of PbCl2, KCl, and HoCl3 followed by several purification steps including directional freezing, zone-refinement, and chlorination. The Ho: KPC crystal was subsequently grown by Bridgman technique. Following optical excitation at 885 nm, several IR emission bands were observed at room-temperature with average wavelengths at 1.07, 1.18, 1.35, 1.65, 2.00, 2.89, and 3.96 mm. The emission at 3.96 mm originated from the 5I5 ® 5I6 transitions of Ho3+ and was further evaluated for possible applications in mid-IR lasers. The decay time of the 5I5 excited state was measured to be 5.0 ms at room-temperature. The long 5I5 lifetime is favorable for laser applications and indicates that non-radiative multi-phonon relaxations are small in Ho: KPC. Based on a Judd-Ofelt analysis, the emission quantum efficiency was determined to be near unity resulting in a peak emission cross-section of 0.62x10-20 cm2 at 3.96 mm. A drawback for laser applications is the long decay time of the lower 5I6 state with a value of 4.8 ms. Since the 3.96 mm transition terminates in the 5I6 level, its long lifetime will lead to population bottlenecks, which limits possible mid-IR lasing to pulsed and quasi-cw operation.