Observation of Increasing Upconversion Luminescence in Yb^{3+}/Er^{3+} Co-doped $PbO-GeO_2-Ga_2O_3$ Glasses in a Presence of Higher Ytterbium Concentrations

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Er^{3+} doped glasses have attracted much interest due to their important optical properties for use in lasers, photonic devices and other communications devices. Since the spectral region of the $^2F_{7/2} \rightarrow ^2F_{5/2}$ transition of the Yb^{3+} ion overlaps that of the $^4I_{15/2} \rightarrow ^4I_{11/2}$ transition of the Er^{3+} ion, it becomes possible to achieve an effective Yb to Er transfer mechanism of the excitation energy.

In addition, the up-conversion luminescence from Er^{3+} doped glass has attracted attention for the purpose of developing infrared laser pumped solid state up-conversion lasers. An efficient up-conversion laser at 540 nm when pumped with a laser diode at 800 nm has been realized and has shown a higher efficiency than harmonic generation techniques.

To the basic glass composition (PGG) $72.8PbO-17.0GeO_2-10.2Ga_2O_3$ (in wt%), 0.5 wt% of Er_2O_3 and concentrations from 1 to 5 wt% of Yb_2O_3 were added and prepared by a conventional melting and quenching method. Batches of 7.0 g of high purity (99.999%) compounds were fully mixed in a platinum crucible and melted at 1200 °C for 1h. The melts were then poured into pre-heated brass molds, in air, and annealed at 392 °C for 1h. Finally the glasses were cooled to room temperature inside the furnace. After cooling, samples were polished to acquire a good quality surface for optical measurements. Transparent and homogeneous glasses were produced.

The samples were pumped at 980 nm by a diode laser and we saw that the intensity of the frequency upconversion luminescence is enhanced by the presence of the sensitizer Yb^{3+}. The incorporation of Yb^{3+} causes the increase of the green emissions because Yb^{3+} ion is an extremely effective absorber for 980 nm light. The relative integral intensities of the red (657 nm) and green emissions (545 nm) for 5.0 wt% of Yb_2O_3 increase approximately 40 and 4 times, respectively, when the concentration changes from 1.0 to 5.0 wt% of Yb_2O_3 in the sample. As a result we have samples which can emits red photons more intense than green ones in a presence of higher Yb^{3+} concentrations.