Heavy ion induced luminescence studies of $YAlO_3$: Tb^{3+}, Tm^{3+} single crystals

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Ionoluminescence (IL), photoluminescence (PL) and thermoluminescence (TL) studies of $YAlO_3$:Tb^{3+}, Tm^{3+} (1 at %) single crystals are carried out using 100 MeV Si^{7+} ions for the fluence 3.91×10^{12} ions cm^{-2}. IL peaks are recorded in the range 385–450, 493, 544, 585 and 624 nm in Tb^{3+}- and 353, 459, 523, 651 and 763 nm in Tm^{3+}-doped $YAlO_3$ single crystals, respectively. PL studies also show similar characteristic emission peaks. The variation of IL intensity is studied in a $YAlO_3$:Tb^{3+} crystal for a wide fluence range of 3.91×10^{12} – 17.57×10^{12} ions cm^{-2}. The IL intensity is found to be higher in lower ion fluences, and it decreases with the increase of ion fluence. Thermoluminescence (TL) studies are carried out for ion fluence– (3.91×10^{12} ions cm^{-2}) and UV-exposed (05–60 min) single crystals. A single well-resolved glow peak at 242 °C, along with a shouldered peak at 272 °C, is recorded in the Tm^{3+}-doped sample. In the Tb^{3+}-doped samples, a well-resolved glow peak at 218 °C, along with a shouldered peak at 147 °C, is recorded at the lower temperature side. In the UV-exposed crystals, two glow peaks at 168 °C and 223 °C are recorded. The glow peaks are found to be shifted towards the lower temperature side with an increase in UV exposure time. Good linearity over a large span of UV exposure time and a single glow peak with a simple trap distribution are observed in $YAlO_3$:Tb^{3+} single crystals, which makes them suitable as a dosimeter for UV-rays. The kinetic parameters (E, b, s) are estimated using the glow peak shape method for both ion and UV-exposed crystals, and the results are discussed in detail.

Keywords: ionoluminescence, thermoluminescence, photoluminescence, ion irradiation, single crystals