LUMINESCENCE AND RADIATION-INDUCED DEFECTS IN GADOLINIUM MOLYBDATE CRYSTALS

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Gadolinium molybdate is a widely studied ferroelectric-ferroelastic material which can be applied in acousto-optical, laser and light-emitting devices. In our research an experimental study of the luminescent properties and radiation-induced phenomena in the β`-$Gd_2(MoO_4)_3$ single crystals was performed. Low temperature photoluminescence (PL) spectra under UV/VUV and XUV excitation were measured at the SUPERLUMI station and BW3 channel (HASYLAB, DESY). At T=90 K PL spectrum was found as a broad band with E_{em}=2.38 eV (FWHM=0.65 eV) when excited into the main excitation peak, E_{exc}=4.4 eV. Excitation into the fundamental absorption edge (E_{exc}=4.0 eV) lead to a shift of the spectrum to E_{em}=2.45 eV. At T=7.5 K the PL band became explicitly split into two subbands 2.21 and 2.45 eV. Complete quenching of PL yield was observed at T_q=140 K, activation energy E_a=0.11 eV. Assumption was made upon considering all data that the PL originated from radiative decay of the self-trapped excitons localized at MoO_4^{2-} tetrahedra.

Energy migration processes between cation and anion sublattices were discovered. They were identified by the presence of three sharp lines in the PL excitation spectra attributed to the $^8S_{7/2} \rightarrow {}^6P_J$ transitions in the Gd^{3+} ions. At T=10 K Gd^{3+} emission from the same levels was observed upon excitation into the Gd 4d core level (E_{exc}=149 eV). Due to the low spectral overlap between Gd^{3+} emission and MoO_4^{2-} absorption, the energy transfer was assumed to take place via electron-hole pairs mechanism. This requires participation of the Gd 4f levels in the formation of the top of the valence band.

Gadolinium molybdate crystals were exposed to the fast electrons beam from the microtron (electron energy E_e=10 MeV, fluence $F=5\cdot10^{16}$ cm^{-2}) in order to investigate possible defects. Radiation-induced defects were detected by the weak yellow coloration of the crystal and slight absorption edge shift. Irradiation by fast electrons did not influence the TSL glow curve. A new PL band at E_{em}=1.92 eV (FWHM=0.38 eV) with selective excitation at E_{exc}=3.92 eV was discovered. Its quenching temperature T_q=220 K was higher than that of the intrinsic PL band, though activation energy E_a=0.12 eV was almost the same. Defect centers with similar properties were previously studied in several molybdates and were ascribed to emission of self-trapped excitons localized near oxygen-deficient MoO_3 tetrahedra.