Synchrotron radiation in luminescence research: recent advances in the study of single crystals and single crystalline phosphors

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Fundamental differences in the methods and conditions of materials preparation from a high-temperature melt (crystals) and the melt-solution (single-crystalline films) cause significant differences in their luminescent properties. Such differences are caused by various types of intrinsic defects, their concentration, distributions of the dopant ions between cationic sites and the interaction of dopants with defect and dopant centers in the different crystalline forms of the same material.

In the case of oxide crystals growing from high-temperature melt, the contribution of defect centers (oxygen and cation vacancies, antisite defects and their aggregates) in the intrinsic luminescence of matrixes or in the emission of dopants in them may be very significant. This can significantly perturbate the observation of native luminescent properties of oxide hosts and the emission properties of dopants in such materials. Meanwhile, host defect content can be strongly reduced in these oxide films grown using low-temperature liquid-phase epitaxy (LPE) method from melted fluxes. Furthermore, the preferred distribution of dopants between various cation sites may be substantially different in films and crystal phosphors. However, LPE grown films may contain flux components that can also significantly affect the luminescent properties of materials as emission and trapping centers.

Therefore, only a detailed comparison of the luminescent properties of complex oxide compounds prepared in bulk crystal and single crystalline film forms makes it possible to detect a more realistic picture of internal and doped luminescence in these oxides against the background luminescence of defect centers. The use of a combination of optical and EPR spectroscopy together with luminescence spectroscopy under synchrotron radiation excitation with energy in the exciton range and in the range of interband transitions of these compounds opens a unique opportunity to correctly compare the luminescent properties of complex oxides in various crystalline forms.

The aim of this presentation is to show the characteristic examples of comparison of the structure of luminescent centers in crystals and film phosphors based on the Eu^{3+} doped Lu_2O_3 lutetia, Pb^{2+} doped Ga_2O_3 oxide, transition metal doped $MgAl_2O_4$ spinel and Ce^{3+} doped $R_2Si_2O_7$ (R=Lu, La, Gd) pyrosilicates, using the conventional spectral methods as well as the time-resolved luminescent spectroscopy at new VUV stations at P66 line at PETRA3 ring, DESY, Germany.

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