LUMINESCENCE OF Cu^+ AND Cu^{2+} IONS IN CsBr CRYSTALS

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Cupper ions in the different charge states (usually Cu^+ and Cu^{2+}) create the set of strongly localized states in the ionic compounds [1] that, in principle, may be used for development of the storage phosphors and materials for thermoluminescent (TL) dosimetry [2]. This work is goal to study of nature of the luminescent centers created by the cupper dopant in CsBr crystal using the synchrotron radiation (SR) excitation.

The CsBr:Cu and CsBr:$CuBr_2$ crystals with dominant Cu^+ and Cu^{2+} valence state, respectively [1, 2], were chosen for investigation. Crystals were grown by Bridgman method from the CsBr salt of 5N purity and doped with metallic Cu and $CuBr_2$ bromide in concentration of 0.5 mol.%. The luminescence of these crystals was investigated at 10 and 300 K at the Superlumi station (HASYLAB, DESY) under excitation by SR with energy of 3.7-25 eV.

In CsBr:Cu crystal we found that as opposed to the typical one-component character of Cu^+ emission [3], the luminescence spectrum of Cu^+ ions in CsBr:Cu crystal under excitation at 4.47 and 5.45 eV in the absorption bands related to $^1A_{1g} \rightarrow {}^1T_{2g}$ transition is superposition of the two sub-bands peaked at 2.62 and 2.235 eV. The dominant high-energy emission band corresponds to the $T_{2g} \rightarrow A_{1g}$ radiation transitions of Cu^+ ions in *on-centre* configurations [5]. The possible reasons for the existence of second low-energy emission band are existence of *off-centre* configuration of the relaxed excited state of Cu^+ ions [4, 5] with prevailing mechanism of excitation via charge transfer transition (CTT).

The luminescence spectrum of CsBr:$CuBr_2$ crystal under high-energy excitation consists of the dominant emission band of Cu^{2+} ions peaked at 2.49 eV. The excitation spectrum of the Cu^{2+} luminescence in CsBr transparency range consists of the intensive band peaked at 4.09 eV which coincides with the strong absorption band CsBr:$CuBr_2$ crystal. This band can be related to the formation of Cu^{2+} state via CTT from the ground state of Cu^+ ions to conductive band with following recombination luminescence of Cu^{2+} ions.

In CsBr:Cu and CsBr:$CuBr_2$ crystal under excitation in the exciton range (5.5-6.2 eV) we also found the dominant luminescence of excitons localized around Cu^+ and Cu^{2+} ions in the bands peaked at 3.01 and 2.86 eV, respectively. The energies of formation of such excitons (6.06 and 6.0 eV, respectively) as well as excitons bound with Cu^+ and Cu^{2+} ions (5.83 and 6.0 eV, respectively) were determined as well.

Obtained results reflect the complicated character of formation of the luminescence centers in CsBr crystals due to copper doping which can participate in the storage or TL processes in such phosphors.

References

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