

The luminescent and kinetic characteristics of CsPbBr₃ nanocrystals dispersed in CsCdBr₃ matrix

*S.V.Myagkota, Z.A.Khapko, I.S.Novosad,
I.V.Stefanskii, I.V.Garapyn*

I.Franko Lviv National University,
8 Kirila i Mefodiya St., 79005 Lviv, Ukraine

The luminescence spectral and kinetic characteristics of CsPbBr₃ nanocrystals dispersed in a CsCdBr₃ matrix have been studied under excitation in the transparency region ($E < 4$ eV). The luminescence spectrum structure of CsPbBr₃ nanocrystals is explained assuming the formation of planar type nanocrystals differing in thickness. The luminescence decay kinetics of the CsPbBr₃ nanocrystals with $\lambda_{max} = 523$ nm is characterized by an exponent with a main decay time $\tau_f \leq 0.5$ ns. Besides this exponent, the slow component detectable as the CsPbBr₃ nanocrystal emission band overlapped with CsCdBr₃ matrix emission is present, too.

Проведены исследования люминесцентно-кинетических особенностей нанокристаллов CsPbBr₃, диспергированных в матрице CsCdBr₃, при возбуждении в области прозрачности ($E < 4$ эВ). Структура спектра люминесценции нанокристаллов CsPbBr₃ разъясняется на основе предположения о формировании нанокристаллов планарного типа разной толщины. Кинетика затухания люминесценции нанокристаллов CsPbBr₃ с $\lambda_{max} = 523$ нм характеризуется экспонентой с основным временем затухания $\tau_f \leq 0,5$ нс. Кроме этой экспоненты присутствует также медленная компонента, которая регистрируется вследствие спектрального наложения полосы излучения нанокристалла CsPbBr₃ с излучением матрицы CsCdBr₃.

Along with well-known semiconducting nanocrystals of CdS, CdSe, CuCl, PbI₂ type, the ionic lead-containing nanocrystals of CsPbX₃ type (X = Cl, Br) are extensively studied in the last years. These nanocrystals are produced in crystals of CsX–Pb (X = Cl, Br), CsBCl₃–Pb (B = Sr, Mg, Ca) ($C_{Pb} = 0.05 \div 5.0$ mol. %) or PbX₂–Cs (X = Cl, Br), RbPbCl₃–Cs ($C_{Cs} = 0.05 \div 5.0$ % mol.) in the course of their prolonged (from 10 up to 100 h) high-temperature (150 to 250 °C) annealing [1–7].

The particular interest in research of these compounds is explained by possibility to study in this way the influence of the quantum-size effect on spectral and luminescence properties of those nanocrystals as well as by a feasible application of the mentioned nanocrystals as fast-acting convert-

ers of high-energy radiation into visible range one. Such nanocrystals are characterized both by intense luminescence comparable with intensity of free exciton luminescence of CsPbX₃ (X = Cl, Br) single crystal with a decay time (tens of picoseconds) shorter than that of CsPbX₃ (X = Cl, Br) (the main decay time for CsPbCl₃ bulk is $\tau_f \leq 0.5$ ns, and for CsPbBr₃ bulk, $\tau_f \leq 1.3$ ns) [8, 9].

Related investigations [6, 7] have shown that in CsSrCl₃–Pb, CsCaCl₃–Pb, CsMgCl₃–Pb, and CsCl–Pb crystals, not all Pb²⁺–V_c[–] single centers are aggregated in the course of their prolonged high-temperature annealing, i. e. Pb²⁺–V_c[–] single centers, complex lead centers and CsPbCl₃-like nanocrystals coexist in the corresponding matrices. The emission of Pb²⁺–V_c[–] single centers and