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Supporting Information

Ultrastability and Color-tunability $CsPb(Br/I)_3$ Nanocrystals in P-Si-Zn glass for White LEDs

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Experimental Section

Materials.

Cesium carbonate (Cs_2CO_3, 99.9%), lead bromide ($PbBr_2$, 99%), lead iodide (PbI_2, 98%), sodium bromide (NaBr, 99%), sodium iodide (NaI, 99.5%), phosphorus pentoxide (P_2O_5, 98%), and zinc oxide (ZnO, 99%) were purchased from Aladdin. Silicon dioxide (SiO_2, 99%) was obtained from Beichenfangzheng reagent factory. All chemicals were used without further purification.

Synthesis of $CsPbX_3$ (X = Br, I) NCs glasses.

Fig. 1 exhibits the flow diagram of preparing $CsPbBr_xI_{3-x}$ NCs glasses in this work. First of all, the glass matrix of $42P_2O_5$-$43SiO_2$-15ZnO (mol%) raw materials was weighed and ground in an agate thoroughly. Secondly, the perovskite precursors, which were Cs_2CO_3 - PbX_2 - NaX (X = Br, I), were added into the agate and mixed with the glass matrix thoroughly. Where after, the mixture was melted a in an alumina crucible at 1100 ℃ for 15 min under the ambient atmosphere. In molten state, the perovskite precursors (Cs_2CO_3 - PbX_2 - NaX (X = Br, I)) were in the form of ions in the molten glass. Cs^+, Pb^{2+} and X^- were distributed in the molten glass. And the melt portion was poured into a preheated copper mold at 350 ℃, then annealed in a muffle furnace at 350 ℃ for 3h to remove the residual thermal stress, and then naturally cooled down to room temperature. Subsequently, the glass samples were heat-treated at 460 ℃ for 10h. During heat treatment, with the temperature increasing, Cs^+, Pb^{2+} and X^- absorbed energy and reacted spontaneously to form $CsPbX_3$ (X = Br, I) perovskites grain. As time goes on, the $CsPbX_3$ (X = Br, I) perovskites grain gradually grew up, and then the $CsPbX_3$ (X = Br, I) perovskites nanocrystals crystallized from glass matrix and distributed in the glass matrix. Finally, the $CsPbX_3$ NCs glasses were cut and polished into plates for later characterization.

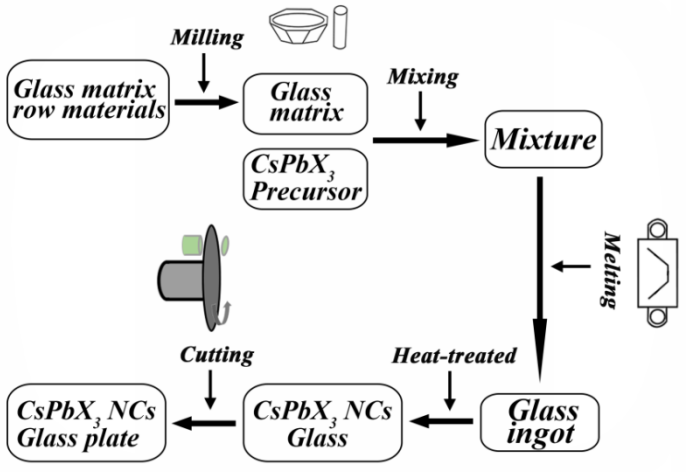

Fig. S1. Schematic of fabrication of the $CsPbX_3$ NCs glasses.

Fabrication of LED device

As shown in Fig. 5a, the LED device was fabricated by combining commercial InGaN blue-emission chips with the $CsPbBr_3$ glass and $CsPbBr_{1.2}I_{1.8}$ glass whose thicknesses were 0.5 mm. The adiaphanous silicone were spread around border of the fluorescent layer to hinder the leakage of blue light. The photoelectric parameters of the product,

such as electroluminescent (EL) spectrum, luminous efficiency(LE), correlated color temperature (CCT), color rendering index(CRI), and Commission Internationale de L’ Eclairage (CIE) chromaticity coordinates, were obtained using an integrating sphere (PMS-50; Everfine, China) at the operatingcurrent of 20 mA. All the measurements were carried out at room temperature.

Characterization

The structure and nanocrystalline phase of the as-prepared $CsPbX_3$(X = Br, I) NCs glasses were measured by X-ray diffraction (XRD, D8 Advance, Bruker, Germany) with Cu Kα radiation operating at 40 kV and 40 mA. The TEM images, the high-resolution transmission electron microscope (HRTEM) images and elemental mapping were recorded on a FEI Tecnai G2 F20 S-TWIN transmission electron microscope operating at an acceleration voltage of 200 kV. UV-vis absorption spectra were collected at room temperature by a PerkinElmer Lambda 750 UV-vis Spectrometer. PL spectra were obtained using an EdinburghInstrument spectrofluorometer(FLS920).