Double glass transitions in phase-separated glasses containing perovskite nanocrystals

Li, Zhencai; Yue, Yuanzheng

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

Double glass transitions in phase-separated glasses containing perovskite nanocrystals

Zhencai Li[1], Yuanzheng Yue [1]
[1]Department of Chemistry and Bioscience, Aalborg University, Aalborg, Denmark, 9220
Email: zhli@bio.aau.dk

Abstract: Perovskite ($CsPbX_3$, X = Cl, Br, and I) nanocrystal-bearing borosilicate glasses exhibit tunable bandgaps, and bright narrow-band photoluminescence (PL), and hence, can be used for light-emitting diode (LED) applications [1]. However, the precipitation of perovskite nanocrystals from glass matrix is an initial and essential step for the applications. By subjecting the precursor glass to heat treatment (HT) above the glass transition temperature (T_g), perovskite nanocrystals were precipitated from the glass matrix [2]. However, the effect of the crystallization of $CsPbX_3$ on the structural network connectivity still needs to be investigated. In this study, we prepared a series of melt-quenching derived borosilicate glasses and found the occurrence of two glass transition events after HT. The first glass transition with a T_g value of 473 °C occurs in the primary glass phase, while the second glass transition with a T_g value of around 410 °C appears in the second phase. The second glass transition becomes more pronounced with increasing HT temperature and its T_g increases, finally reaching the T_g of the first glass transition [3, 4]. This HT process led to the formation of $CsPbBr_3$ nanocrystals. To investigate the double glass transitions in the phase-separated glasses, we characterized the thermodynamic, microstructural, and crystalline characteristics of the samples by performing differential scanning calorimetry, X-ray diffraction, scanning electron microscopy, high-resolution transmission electron microscopy, and solid-state nuclear magnetic resonance measurements. Finally, the derived samples show high PL quantum yields, and thus, they are a potential candidate for fabricating high-performance LED devices.

Keywords: Double glass transitions; Phase separation; Crystallization; Perovskite nanocrystals

References:

[1] SUN K, TAN DZ, FANG XY, et al. Science, 2022, 375(6875): 307-310.

[2] LIN JD, LU YX, LI XY, et al. ACS Energy Lett, 2021, 6(2): 519-528.

[3] LIU H, YOUNGMAN RE, KAPOOR S, et al. Phys. Chem. Chem. Phys, 2018, 20(23): 15707-15717.

[4] TIAN KV, YANG B, YUE YZ, et al. Nat. Commun, 2015, 6(1): 8631.