Layer-by-Layer Films of Upconverting Perovskite Nanosheets

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Inorganic nanosheets are a class of two-dimensional materials obtained by chemical exfoliation of layered oxides, in which the A sites of the host structure can be modified via the doping of various combinations of the lanthanides [1]. These 2D materials have different optical, chemical, catalytic, and electronic properties according to the crystal structure and composition of the layered material [2]. The oxide nanosheets can also be self-assembled to fabricate multilayer films via bottom-up deposition techniques. Layer-by-layer assembly (LBL) method, which is a sequential adsorption driven technique by electrostatic interactions between oppositely charged oxide nanosheets and polycations, forms the nanofilms in a more cost-effective and easy-to-perform way [3]. In this study, upconverting LBL films were fabricated using Er^{+3}/Tm^{+3}, Yb^{+3}/Tm^{+3} and Er^{+3}/Yb^{+3} co-doped perovskite nanosheets. The single nanosheets in colloidal form with thickness in the range of 2-3 nm were obtained by the chemical exfoliation procedure. The UV-vis absorption spectra of LBL films of the exfoliated nanosheets confirmed that the deposition of upconverting nanosheets via the LBL procedure. The LBL films fabricated after 60 sequences of LBL tecnique using the nanosheets exfoliated from three different layered perovskites co-doped with various lanthanide pairs and concentrations have shown a white emission in the CIE diagram. On the other hand, the log-log dependence of the UC emission intensity of the LBL films fabricated after 30 sequences using the nanosheets derived from the 2.5% Er^{3+} + 5% Yb^{3+} co-doped layered perovskites, the two-photon processes were responsible for green and red UC emission due to the $_4F^{9/2} \rightarrow {}_4I^{15/2}$ and $_2H^{11/2}$, $_4S^{3/2} \rightarrow {}_4I^{15/2}$ transitions, respectively.

References

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[2] Gunay B, Sarıyar E, Unal U, Firtina Karagonlar Z, Sağlam Ö., Colloids and Surfaces A: Physicochemical and Engineering Aspects,612 (2021) 126003.
[3] Sasaki T, Ebina Y, Watanabe M, Decher G., Chemical Communications (2000); 2163–2164.

Figures

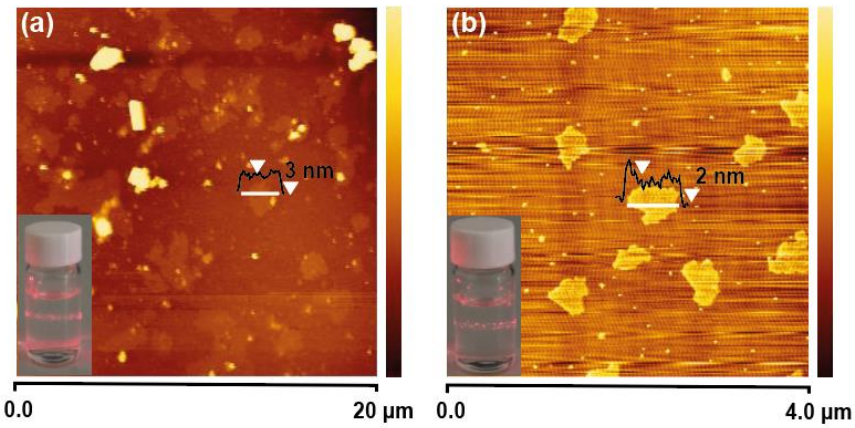

Figure 1 AFM images with height profile of nanosheets delaminated from layered perovskite co-doped with (a) 2.5% Er^{3+} + 5% Yb^{3+} (b) 2.5% Tm^{3+} + 20% Yb^{3+}