Oxide Nanosheets Structured Upconverting Nanofilms

Özge Sağlam
İzmir University of Economics, Faculty of Engineering, Sakarya Cad. 156, İzmir, Turkey
ozge.saglam@ieu.edu.tr

The lanthanide-doped upconversion nanomaterials have a nonlinear optical process involving sequential absorption of two or more photons leading to the emission of higher energy photons. These nanomaterials, because of their intriguing luminescent properties cover diverse applications such as solar cells [1], tissue engineering [2], safety inks [3] and display devices [4]. Single crystalline inorganic nanosheets, a class of 2D materials, are synthesized by chemical exfoliation of layered oxide materials. They are obtained from one-to-several nanometers thick depending on the composition of host layers of bulk materials. In this study, $K_2Ln_2Ti_3O_{10}$ (Ln: lanthanide), the Ruddlesden-Popper type perovskite, were doped with la Yb^{3+}/Er^{3+}, Yb^{3+}/Tm^{3+}, and Tm^{3+}/Er^{3+} ion pairs and then exfoliated to produce upconversion crytallines. These nanosheets were deposited by the layer-by-layer method to fabricate upconverting nanofilms having ~50 nm thickness. These nanofilms show emission in different parts of the visible region by upconversion depending on the amount of doping with lanthanides and the annealing temperature of the layered materials. The characterization of the layered materials, nanosheets and nanofilms were performed using Atomic Force Microscopy, X-ray Diffraction Spectroscopy, Scanning Electron Microscopy-EDX and UV/VIS/NIR Spectroscopy techniques.

References

[1] Zou, W., Visser, C., Maduro, J. A., Pshenichnikov, M. S., Hummelen, J. C. (2012). Broadband dye-sensitized upconversion of near-infrared light. Nature Photonics, 6(8), 560.
[2] Chen, G., Shen, J., Ohulchanskyy, T. Y., Patel, N. J., Kutikov, A., Li, Z., Song, J., Pandey, R. K., Ågren, H., Prasad, R. K., Han, G. (2012). (α-$NaYbF_4$: Tm^{3+})/CaF_2 core/shell nanoparticles with efficient near-infrared to near-infrared upconversion for high-contrast deep tissue bioimaging. ACS Nano, 6(9), 8280-8287.
[3] Zhao, J., Jin, D., Schartner, E. P., Lu, Y., Liu, Y., Zvyagin, A. V., Zhang, L., Dawes, J.M., Xi, P., Piper, J. A., Goldys, E. M., Monro, T.M. (2013). Single-nanocrystal sensitivity achieved by enhanced upconversion luminescence. Nature Nanotechnology, 8(10), 729.
[4] He, M., Li, Z., Ge, Y., Liu, Z. (2016). Portable upconversion nanoparticles-based paper device for field testing of drug abuse. Analytical Chemistry, 88(3), 1530-1534.

Acknowledgments

This work was supported by The Scientific and Technological Research Council of Turkey (TÜBİTAK) (No. 117M512).