

Borbála Tegze: Upconverting nanoparticles and their composite coatings

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Upconverting nanomaterials are able to convert multiple photons of lower energy (higher wavelength) into a photon of higher energy (lower wavelength), and due to this property they are promising in many applications. One possibility is to increase the efficiency of solar cells and photocatalyst systems by means of upconversion and dye-sensitization, which allow for a broader wavelength spectrum of solar light to be utilized [1,2]. In a typical example, upconverting nanoparticles (UCNPs) convert near infrared light into visible light, which is absorbed by dye molecules, and then this energy is transferred to a semiconductor material, e.g. TiO₂. Our aim was to investigate these interactions in a thin film model system.

Upconverting NaYF₄: Yb, Tm/Er particles (Figure 1) with different compositions were synthesized by solvothermal method, and their properties (shape, size distribution, crystal structure, upconversion emission) were studied. LaF₃: Yb, Tm/Er nanoparticles synthesized with co-precipitation method were also investigated after different heat-treatments. Composite coatings of the UCNPs were prepared on glass substrates with spin-coating method: the chosen matrix materials were SiO₂, TiO₂ and chitosan; single- and multilayered structures were tried. After excitation with 980 nm light, the composite coatings showed emission in the visible and ultraviolet range. The samples were immersed in aqueous solutions of rhodamine 6G dye molecules, and the energy transfer processes between the UCNPs, dye and TiO₂ were investigated by measuring the absorbance and emission spectra during 980 nm irradiation.

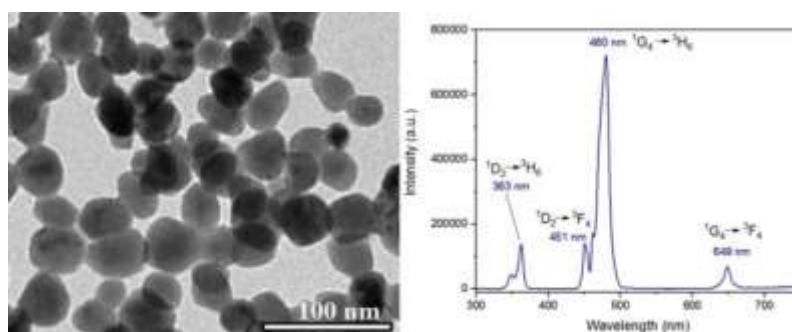


Figure 1. TEM image and upconversion emission of NaYF₄: 20% Yb, 0.5% Tm nanoparticles.

References:

- [1] W. Yang, X. Li, D. Chi, H. Zhang, X. Liu, *Nanotechnology* 25 482001 (2014)
- [2] R. Rajeswari, N. Islavath, M. Raghavender, L. Giribabu, *The Chemical Record* 20(2) 65-88 (2020)



Borbála Tegze (tegze.borbala@vbk.bme.hu) did her PhD course as a student of George Oláh PhD school, under the supervision of Prof. Dr. Zoltán Hórvölgyi, and she currently works as an associate research fellow while also finishing her PhD thesis at the Centre for Colloid Chemistry research group at the Budapest University of Technology and Economics in Budapest, Hungary. Her research work includes nanoparticles and sol-gel coatings with photoactive and photoresponsive properties, for example self-cleaning titania surfaces, upconverting nanoparticles and their composites.