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Novel synthetic approach to $YbPO_4:Eu^{3+}$ and luminescence of light-emitting $YbPO_4$: $Eu^{3+}@SiO_2$ hybrid nanostructure

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$YbPO_4:Eu^{3+}$ and $YbPO_4:Eu^{3+}@SiO_2$ are developed to investigate Yb^{3+} sensitized up-/down-conversion luminescence of Eu3+ ions. New tetragonal light-emitting photonic materials $YbPO_4:Eu^{3+}$ were synthesized for the first time via sol-gel route. Optical properties of as obtained $YbPO_4:Eu^{3+}$ and $YbPO_4:Eu^{3+}@SiO_2$ hybrid nanomaterials were investigated by varying the dopant concentration. The structural examination of $YbPO_4$ revealed single phase tetragonal, I41/amd, zircon type structure. XRD data showed uniform morphology and extremely high crystallinity of all synthesized samples with an average particle size around 21.5 nm. Emission spectra showed intense typical transitions of Eu^{3+} ions. Emission spectra recorded under 320 nm; excitation demonstrated dominant $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, $^5D_0 \rightarrow {}^7F_4$ Eu^{3+} transitions, which indicate that Eu^{3+} is not at a site with a center of symmetry. With increasing of Eu^{3+} doping concentration emission intensity increased. Emission spectra recorded less than 978 nm; excitation exhibited an increase of dominant emissions with doping concentration and possibility of color tuning. These insights are highly important in emerging applications of $YbPO_4:Eu^{3+}$ doped nanocrystals. All emission spectra displayed high energy transitions in the 450-570 nm region characteristic of Eu^{3+} ions which are rarely observed. This unusual result shows that the phonon energies are low enough to lead to the observation of high energy lines in this region, which are comparable with fluoride, germanate and tellurite glasses. The influence of SiO_2 shell on up-/down-conversion emission of $YbPO_4:Eu^{3+}$ showed significant suppression of the UC/DC emission with SiO_2 protection due to light-scattering effect caused by the amorphous silica layer. The presence of free silanol groups on the surface not only results in high solubility in water, but also allows further conjugation with various biomolecules, which opens the possibility of distinct bio-applications. We obtained novel up-/down shifting material which, among distinct applications should enhance the rational design of rare-earth spectral converters.

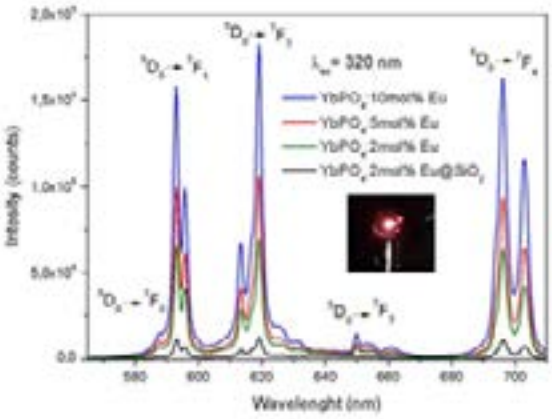

Figure 1: Down-conversion spectra of Eu^{3+} (2, 5, 10 mol%) doped $YbPO_4$ and $YbPO_4$:2mol%$Eu^{3+}@SiO_2$ samples.

Recent Publication

1. T V Gavrilović, D J Jovanović, V Lojpur and M D Dramićanin (2014) Multifuctional Eu^{3+} and Er^{3+}/Yb^{3+}-doped $GdVO_4$ nanoparticles synthesized by reverse micelle method. Scientific Reports 4:4209-4217.
2. Tamara V Gavrilović, Dragana J Jovanović, Krisjanis Smits and Miroslav D Dramićanin (2016) Multicolor upconversion luminescence of $GdVO_4$:Ln^{3+}/Yb^{3+} (Ln^{3+} = Ho^{3+}, Er^{3+}, Tm^{3+}, $Ho^{3+}/Er^{3+}/Tm^{3+}$) nanorods. Dyes and Pigments 126:1–7.
3. Tamara Gavrilović, Jovana Periša, Jelena Papa, Katarina Vuković, Krisjanis Smits, Dragana J Jovanović and Miroslav D Dramićanin (2018) Particle size effects on the structure and emission of Eu^{3+}:$LaPO_4$ and $EuPO_4$ phosphors. Journal of Luminescence 195:420–429.
4. Tamara V Gavrilović, Dragana J Jovanović, Lidija V Trandafilović and Miroslav D Dramićanin (2015) Effects of Ho^{3+} and Yb^{3+} doping concentrations and Li+ co-doping on the luminescence of $GdVO_4$ powders. Optical Materials 45:76–81.
5. Tamara Gavrilović, Katrīna Laganovska, Aleksejs Zolotarjovs, Krisjanis Smits, Dragana J Jovanović and Miroslav D Dramićanin (2018) High resolution luminescence spectroscopy and thermoluminescence of different size $LaPO_4$:Eu^{3+} nanoparticles. Optical Materials 82:39–46

Biography

Tamara Gavrilović has completed her PhD from Belgrade University, Serbia. She is the Lead Researcher of the Department of Institute of Solid State Physics, University of Latvia, a premier research organization. She has published more than 10 papers in reputed journals, book chapter and has been serving as an outstanding review member. She is the winner of Individual Marie Sklodowska-Curie postdoc fellowship. She has an expertise in synthetic chemistry of innovative optical materials, examination and enhancement of their properties.

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