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CONTROLING UPCONVERSION EMISSION OUTCOME IN Yb^{3+}/Er^{3+} SYSTEMS

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Due to their unique property of two NIR photon absorption followed by sequential energy transfer to Ln ions, upconverting nanoparticles (UCNP) generate visible emission. UCNP have been recently playing an important role in biomedicine outweighing other luminescent probes such as organic dyes and quantum dots. High signal-to-noise ratio, deeper NIR penetration depth into tissue and low autofluorescence are the main advantages over conventional fluorophores. One of the main goals is to broaden the possibilities of the applications of upconverting materials by being able to improve emission intensity and tune UC emission in various systems. It can be achieved by designing core/shell nanoparticles, varying concentration of dopants and incorporating additional ions into matrices [1].

In this study, $NaGdF_4$:20% Yb, 2% Er nanoparticles were additionally doped with alkali (K^+) ions and transition metal (Cr^{3+}) ions. XRD measurements revealed that doping up to 40% of K^+ instead of Na^+ and 50% of Cr^{3+} replacing Gd^{3+} no additional phase was formed. In case of K^+, further doping caused formation of cubic phase (or mixture of phases) instead of previously synthesized hexagonal phase nanoparticles. Successful doping into $NaGdF_4$ was confirmed by the shift of XRD patterns comparing to samples of undoped $NaGdF_4$ nanoparticles. Although the position of dopant ions and their role is slightly different, luminescent properties were affected in both cases. The R/G ratio of integrated emission increases resulting in shift towards red region under λ_{exc}=980 nm irradiation when dopant concentrations are increased. Luminescence lifetime measurements were performed in order to investigate the impact on luminescent properties. Temperature dependent measurements of $NaGdF_4$: (20%) Yb, (2%) Er nanoparticles with various doping (K^+ and Cr^{3+}) concentrations were carried out. It turned out that the relative emission intensity from the $^2H_{11/2}$ and $^4F_{9/2}$ levels (Er^{3+}) increase with increasing temperature in the range of 77-500 K. Values of energy distance between $^2H_{11/2}$ and $^4S_{3/2}$ levels of Er^{3+} were calculated and compared. Optimal values for doping K^+ and Cr^{3+} ions will be discussed and proposed.

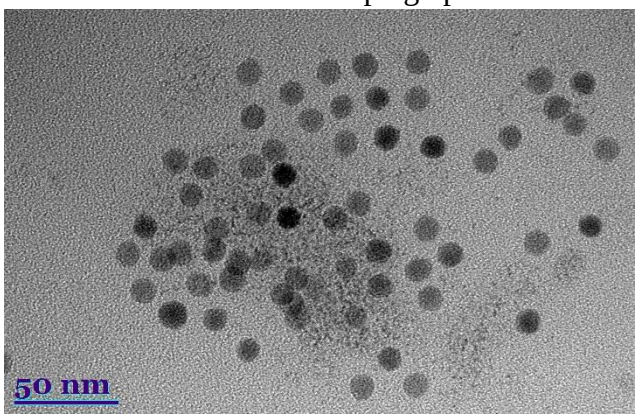

Fig. 1 TEM image of $NaGd_{0.78-}$

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References

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