

Fabrication of $\text{YVO}_4:\text{Eu}^{3+}$ Nanoparticles by Laser ablation in Liquid

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Introduction

During the past decade, dramatic efforts have been dedicated to exploring rare-earth doped nanoparticles, whose optical properties and low cytotoxicity are promising for biological application¹. Yttrium orthovanadate (YVO_4), which crystallizes in a zircon-type structure, has received considerable interest due to its suitable lattice structure for doping with rare earth elements. $\text{YVO}_4:\text{Eu}^{3+}$ is an important red emitting phosphor while it was used widely in color television, high-pressure mercury lamp. In particular, $\text{YVO}_4:\text{Eu}^{3+}$ nanocrystal is promising material for biological applications.

In this study, $\text{YVO}_4:\text{Eu}^{3+}$ colloidal nanoparticles are prepared by laser ablation in DI water² and surfactant solution such as sodium dodecyl sulfate (SDS)³ and cetrimonium bromide (CTAB). Interestingly, we found that the nanoparticles with different size and morphology were obtained at different surfactant solution.

Experimental

Target for laser ablation was prepared by pressing commercial $\text{YVO}_4:\text{Eu}^{3+}$ powders. The obtained target was irradiated in DI water by a Q-switched Nd:YAG pulsed laser providing a 13ns pulse at 532nm wavelength with a repetition rate of 10Hz. The properties of phase, morphology and luminescence are characterized by X-ray diffractometer (XRD), scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and photoluminescence spectrophotometry (PL). Elemental analysis of point-mode and area-mode are performed by energy-dispersive X-ray spectroscopy (EDS).

Results

Structure and crystallinity analysis of the nanoparticles obtained in DI water were analyzed by XRD. All diffraction peaks for both target and nanoparticles can be indexed as tetragonal phase of YVO_4 (JCPDS, No.17-0341), indicating that all the particles possess highly crystalline structures without any impurity phases. The nanocrystallite size estimated from the full width at half maximum (FWHM) of the (200) peak according to the Debye-Scherrer formula revealed that the average crystallite size of $\text{YVO}_4:\text{Eu}^{3+}$ were around 8nm in diameter. Fig. 1 shows the SEM image of the nanoparticles obtained from DI water and SDS solution. As clearly be seen, the ovoid-like nanoparticles obtained in DI water have diameter of 70-110 nm, which are composed of numerous nanocrystallites deduced from XRD result, while the nearly spherical nanoparticles with an average diameter of 50 nm were synthesized in SDS solution.

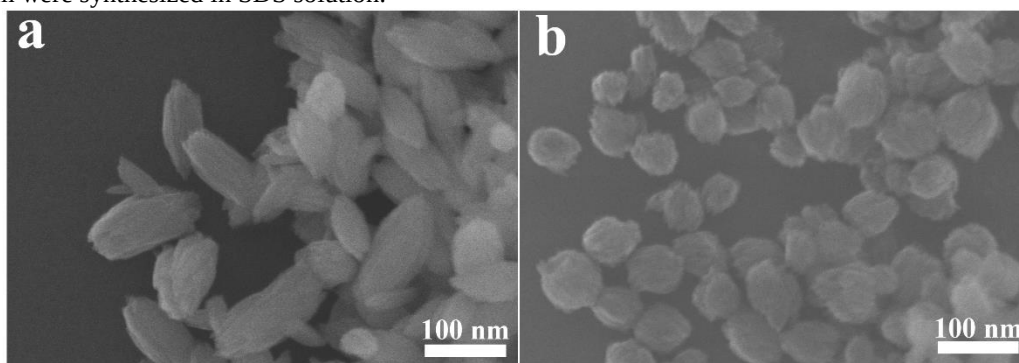


Figure 1. a) Ovoid-like nanoparticles obtained by laser ablation in DI water and B) SDS solution.

References

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