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Ce^{3+} doped $LiYF_4$ nanoparticles fabrication by laser ablation

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Abstract. Here we report on laser ablation approach to produce dielectric crystalline nanoparticles $Ce:LiYF_4$ inspired by method for metal nanoparticles fabrication in aqueous solutions. The obtained water solution has shown tangible presence of compound we believe to be agglomerates of $Ce:LiYF_4$ nanocrystals. The obtained powder has shown luminescence with peaks at 310 nm and 325 nm which is characteristic for the scheelite structured fluoride and luminescence decay quenching characteristic for Ce-doped nanoparticles.

1 Introduction

Fluoride crystalline materials are popular for luminescent applications due to their low-energy phonons and transparency in wide spectral range. These advantages are transferred also to nanomaterials applications e.i. upconversion and quantum cutting materials for bioimaging, sensibilization, phosphors and so on [1,2]. The compound of $LiYF_4$ is of specific interest due to isomorphic character of substitution for most of rare-earth ions (Yb, Tm, Gd, Eu, Tb, Er). There are works on propositions of $LiYF_4$ nanocrystals doped with Yb, Tm and Ce ions as efficient upconverters to UV spectral range [3]. One of the problems for $LiYF_4$ nanoparticles is complexity of synthesis procedure. Namely solvothermal method or thermal decomposition which is mostly implemented supposes high temperature exposure in autoclave or noble gas flow [1-3]. This could be costly when trying to transfer the method to large volumes of production.

Here we report on laser ablation approach to produce dielectric crystalline nanoparticles $Ce:LiYF_4$ inspired by method for metal nanoparticles fabrication [4].

2 Experiment details

The laser beam of 532 nm wavelength from Nd:YAG: laser was focused onto the surface of $Ce:LiYF_4$ crystal under the layer of distilled water as a target. The Nd:YAG laser operated in Q-switch regime with 10 ns pulses and 10 Hz repetition rate. Energy density of laser beam at the surface of the crystal was about 15 J/cm^2. After one hour of exposition the water from above the target crystal was collected. Part of the obtained sample was investigated by means

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of dynamic light scattering technique (DLS), another part was dried and the acquired powder was tested by spectroscopic methods.

3 Results

The DLS investigation have shown presence of particles with the hydrodynamic radius of about 180 nm. The dried powder was luminescent under 289 nm excitation giving spectrum of Ce:$LiYF_4$ crystal. In the Figure 1A luminescence spectra of the Ce:$LiYF_4$ target and resulting powder are shown.

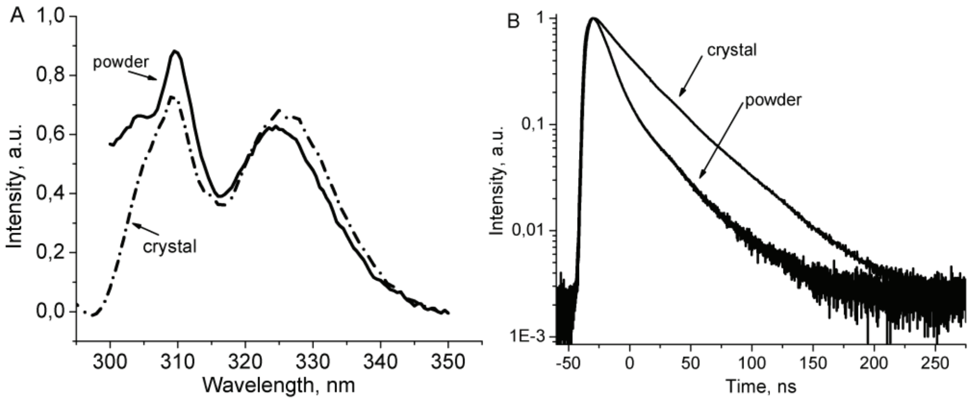

Fig. 1. A) Ce:$LiYF_4$ PL spectra of nanoparticles (powder) and monocrystal (crystal), B) luminescence decay for nanoparticles(powder) and monocrystal (crystal) detected at 311 nm.

The decay curve of obtained powder (Fig 1B) compared to bulk material reveals fast component usually attributed to surface quenching factors and slower component which is also quenched (21 ns vs 37 ns for bulk). The obtained luminescence decay picture is characteristic for nanosized crystalline material [5]. We believe that the hydrodynamic radius obtained is evidence of agglomeration of nanoparticles as it has been noticed in work [2]. Thus we propose the ablation of bulk Ce:$LiYF_4$ crystal in water produces crystalline nanoparticles of Ce:$LiYF_4$.

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References

[1] S. Ye, R. Hu, N. Jiang, H. Wang, D. Wang, Dalton Trans. **44**, 15583 (2015)

[2] D. Zhang, G. De, L. Zi, Y. Xu, S. Liu, Mater. Res. Express **3**, 075005 (2016)

[3] J.A. Capobianco et al., Chem. Eur. J. **15**, 9660 (2009)

[4] F. Mafuné, J.-Y. Kohno, Y. Takeda, T. Kondow, H. Sawabe, Journal of Physical Chemistry B **39** , 9111 (2000)

[5] D.R. Cooper, K. Kudinov, P. Tyagi, C.K. Hill, S.E. Bradforth, J.L. Nadeau, Phys. Chem. Chem. Phys. **16**, 12441 (2014)