# Synthesis of Controlled Size $GdPO_4 \cdot H_2O$ Nanorods

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## Abstract

Due to the wide nanoparticles application, the synthesis of nanoparticles and the study of their properties are of great interest to scientists. Special attention is paid not only to particle size but also to their morphology, since the physical properties depend on the morphology of the nanoparticles. The Eu doped $GdPO_4$ has luminescent properties. These particles can be applicable in biomedicine, for example, in biological labels, biological images and drug delivery [1,2].

In this study Eu doped $GdPO_4 \cdot H_2O$ samples were prepared by hydrothermal method. Our goal is to investigate the dependence of morphology and size of $GdPO_4 \cdot H_2O$ nanoparticles on the synthesis conditions. One parameter was changed during each synthesis. The synthesis of $Gd_{0.85}Eu_{0.15}PO_4 \cdot H_2O$ was performed by changing the solvent amount ($H_2O$) in reactor of hydrothermal autoclave, the amount of reagents was kept the same. The pH of the solution adjusted with adding nitric acid. Samples were analysed by X-ray diffraction analysis and scanning electron microscopy. The luminescence properties also have been measured.

## Experimental

The starting materials were $Gd(NO_3)_3 \cdot 6H_2O$, (99.9%, Glentham), $Eu(NO_3)_3 \cdot 6H_2O$ (99.9%, Alfa Aesar), $C_4H_6O_6$ (99.5%), $NH_4H_2PO_4$. All materials were dissolving separately in distilled water. $Gd(NO_3)_3 \cdot 6H_2O$, $Eu(NO_3)_3 \cdot 6H_2O$ and $C_4H_6O_6$ solutions were mixed together for 30 min. at 50 $^0$C. $NH_4H_2PO_4$ solution were added slowly to prepared $Gd(NO_3) \cdot 6H_2O$, $Eu(NO_3)_3 \cdot 6H_2O$ and $C_4H_6O_6$ solution and mixed for 30 min. at 50 °C. The pH was adjusted by adding $NH_4OH$ or $HNO_3$.

The hydrothermal syntheses were performed in Berghof High-pressure reactor BR, temperature controller BTC-3000, heating equipment BMH Heating jacket and IKA RH Digital mixer.

The temperature was slowly increased to 180 °C and maintained throughout the syntheses.

Obtained mixture was centrifuged at 7000 rpm, and washed with distilled water. This procedure was repeated 4 times, and 2 times this procedure was repeated using $C_2H_5OH$ for washing. The precipitate was left to dry in air at 70 °C.

X-ray diffraction (XRD) analysis was performed using a Rigaku MiniFlex II.

For particles morphology and size analyses the Hitachi SU-70 scanning electron microscope (SEM) was used.

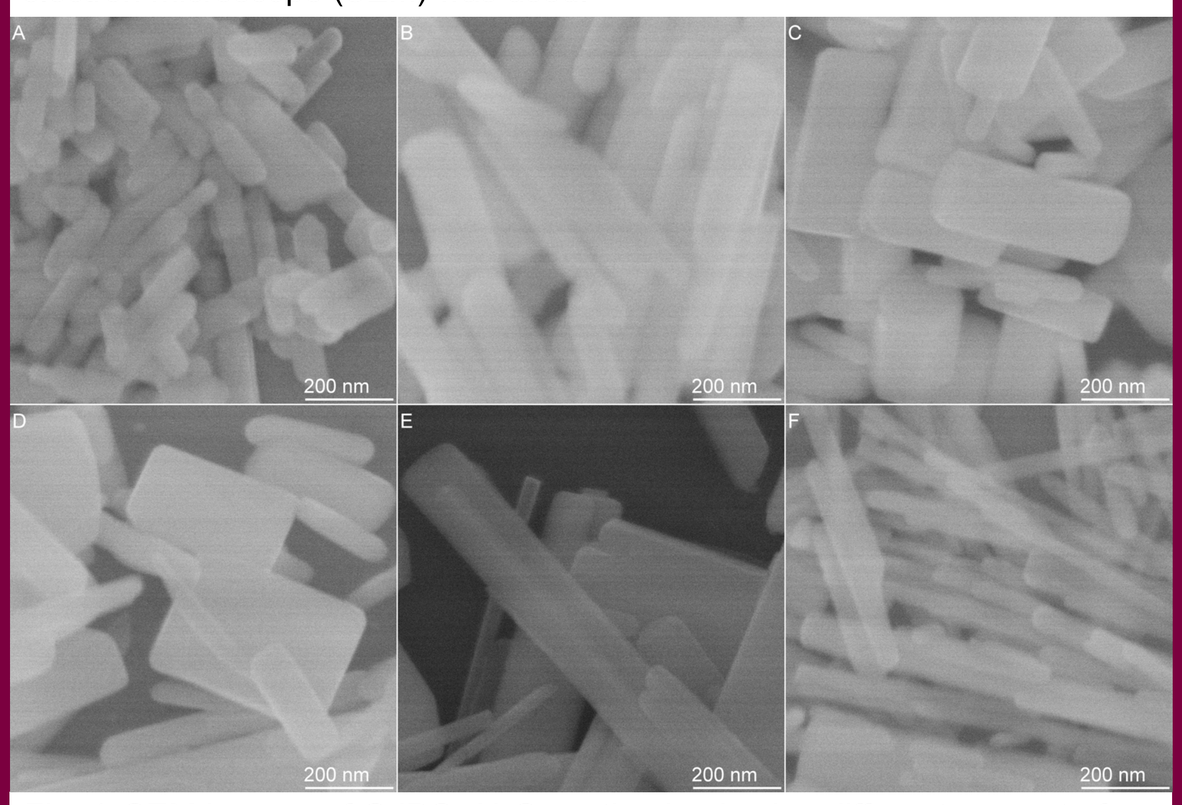


*Fig. 1.* SEM images of $GdPO_4 \cdot H_2O$ synthesized using different amount of solvent ($H_2O$) in reactor of hydrothermal autoclave: (A) V=10ml, (B) V=20ml, (C) V=30ml, (D) V=40ml, (E) V=50ml, (F) V=60ml.

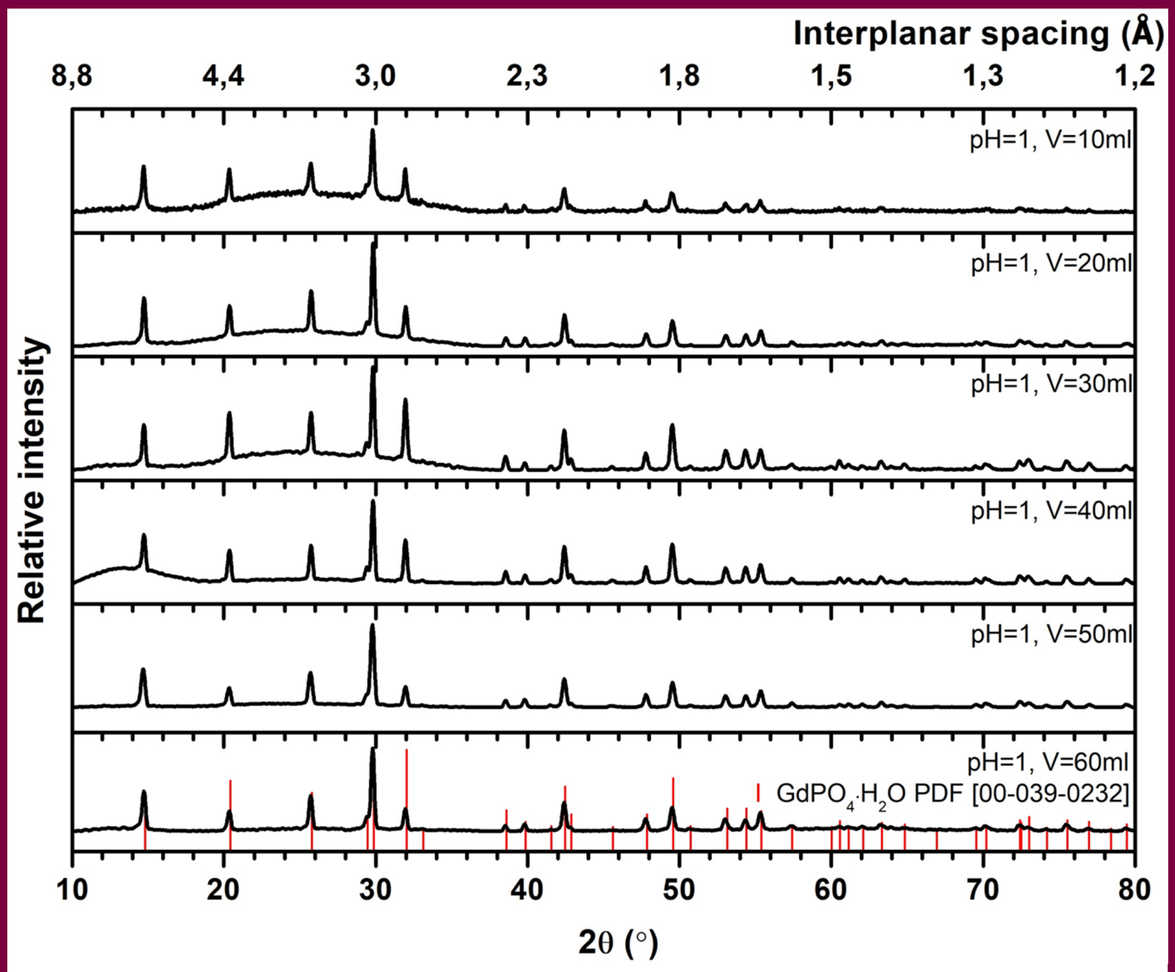


*Fig. 2.* XRD patterns of $GdPO_4 \cdot H_2O$ samples synthesized using different amount of solvent ($H_2O$) in reactor of hydrothermal autoclave.

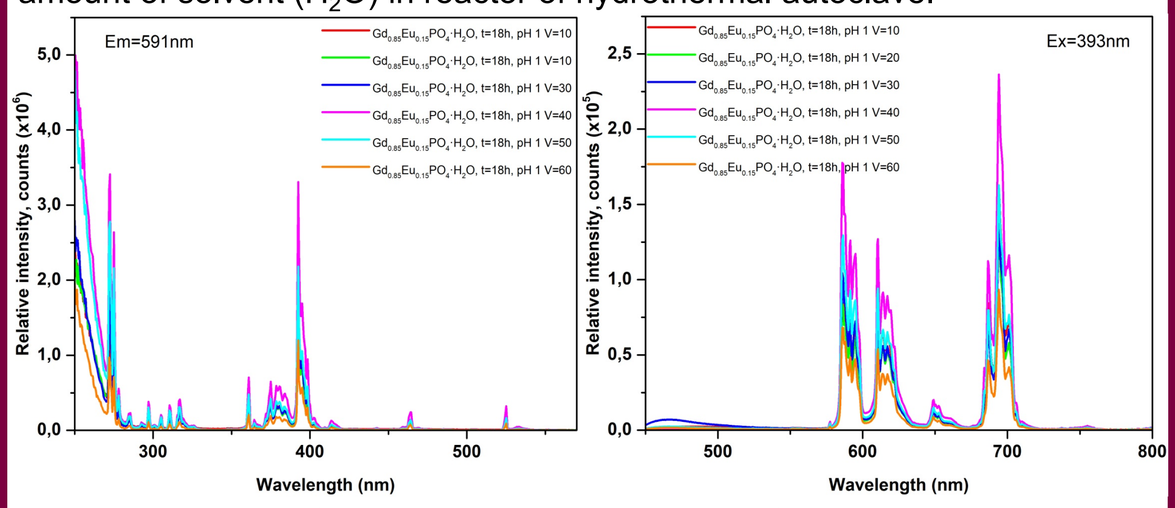


*Fig. 3.* Excitation ($\lambda_{en}$=591 nm) and emission ($\lambda_{ex}$=393 nm) spectra of $GdPO_4 \cdot H_2O$ samples synthesized using different amount of solvent ($H_2O$).

## Conclusions

Eu doped $GdPO_4 \cdot H_2O$ nanoparticles synthesized using different amount of solvent ($H_2O$) were nanorods shape and not uniform in size. With increasing amount of solvent, the longer nanorods were obtained. The diameter of the nanorods increased by increasing the volume of the solvent, but with the volume of the solvent 50ml and 60ml the diameter does not increase.

## References

1. M. Janulevicius, V. Klimkevicius, A. Vanetsev, V. Plausinaitiene, S. Sakirzanovas, A. Katelnikovas. Controlled hydrothermal synthesis, morphological design and colloidal stability of $GdPO_4 \cdot nH_2O$ particles. Materials Today Communications Vol. 23, 2020, 100934.
2. H. Song, L. Zhou, L. Li, F. Hong, X. Luo. Hydrothermal synthesis, characterization and luminescent properties of $GdPO_4 \cdot H_2O:Tb^{3+}$ nanorods and nanobundles. Materials Research Bulletin Vol. 48, 2013, pp 5013–5018.