

MW assisted one pot synthesis of NaYF₄ - a multivariable analysis

Elaine Andrade de Mattos¹, Samuel Anderson Alves de Sousa², Lucas Carvalho Veloso Rodrigues³

¹University of Sao Paulo (IQ) , ²Universidade Federal do Piauí (Departamento de Química, Centro de Ciências da Natureza) , ³University of Sao Paulo (Instituto de Química, Departamento de Química Fundamental)

e-mail: elaine.mattos@usp.br

The NaYF₄:Er,Yb material has garnered significant attention in recent research due to its exceptional upconversion luminescence properties. This material efficiently converts near-infrared (NIR) light into visible or ultraviolet light through a process mediated by rare-earth dopants, particularly ytterbium (Yb³⁺) and erbium (Er³⁺). The unique optical characteristics of NaYF₄:Er,Yb make it highly valuable for applications in bioimaging, photodynamic therapy, solar cells, anti-counterfeiting, and optoelectronic devices.

Among the various host lattices explored for upconversion materials, β -phase NaYF₄ stands out as the most efficient due to both its low phonon energy, which minimizes non-radiative losses and its non-centrosymmetric sites which enhances luminescence efficiency. The combination of Yb³⁺ as a sensitizer and Er³⁺ as an activator enables efficient energy transfer, allowing for precise control over emission wavelengths and intensities.

Recent advancements in nanostructuring, surface functionalization, and hybrid composites have further expanded the potential of NaYF₄:Er,Yb in next-generation optical and biomedical technologies. As researchers continue to optimize its synthesis and functionalization, the formation of size and shape-controlled nanoparticles is famously a multi-step heavily controlled solvothermal synthesis.

With the use of a Raman coupled-microwave reactor β -NaYF₄ nanoparticles of 12 nm have been successfully synthesised and characterized via transmission microscopy and x-ray diffraction.

In order to understand the effect of the synthesis parameters in the NPs size and size distribution; and make this reaction as reproducible as possible under different MW-reactors, a statistical study has been conducted, varying the amounts of solvents, temperature and time, in the making of a multivariate curve resolution, that strives to simplify and make available the synthesis of this well-known luminescent material.

Acknowledgements

CAPES 88887.710854/2022-00, FAPESP 2021/08111-2 e 2021/05603-1

References

Rongwangge Xu, Hanyu Wang, Yuyang Li, Junyi Gu, Xiang Ren, Hongmin Ma, Dan Wu, Qin Wei, A sandwich-type photoelectrochemical immunosensor for the detection of SARS-CoV-2 N protein based on CdS:Mn sensitized Bi₂MoO₆/In₂S₃ and NaYF₄:Yb, Er for signal

amplification, Sensors and Actuators B: Chemical, Volume 427, 2025

Alexander N. Solodov, Konstantin Zimin, Ramilya M. Gataullina, Almaz A. Zagidullin, Andrey V. Leontyev, Artemii G. Shmelev, Larisa A. Nurtdinova, Victor G. Nikiforov, Oleg Kh Khasanov, Liliya M. Amirova, Dmitrii A. Tayurskii, Anna Ivanova, Airat Kiiamov, Dmitrii K. Zharkov, Fluorescent polymer composites based on core-shell NaYF₄:Yb/Er@NaGdF₄:Ce/Tb structures for temperature monitoring and anti-counterfeiting protection, Optical Materials, Volume 159, 2025

Suta, M. (2025) 'What makes β -NaYF₄:Er³⁺, Yb³⁺ such a successful luminescent thermometer?', Nanoscale [Preprint]. <https://doi.org/10.1039/d4nr04392h>.