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OPTIMIZATION OF SYNTHESIS PARAMETERS FOR WELL-DEFINED UPCONVERTING NANOPARTICLES

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Lanthanide-doped upconverting nanoparticles (UCNPs) exhibit a unique capability to convert near-infrared (NIR) radiation into higher energy light (visible or UV), making them promising candidates for applications in bio-related fields. NIR irradiations can penetrate through the skin into deeper tissues without causing extensive heating, making NIR-excited UCNPs extensively researched for potential utilization in theranostics, bioanalytics, and bioimaging. Additionally, these UCNPs show promise for applications such as super-resolution imaging, NIR-II imaging, encoded barcodes, fingerprinting, NIR vision, optogenetics, UCNP-assisted photochemical manipulations, optical tweezers, 3D printing, lasing, UCNP-molecule nanohybrids, etc [1]. However, the effective application of UCNPs in various fields necessitates well-defined morphological and optical properties, and the variation of synthesis conditions are the main parameter which can be adapted to engineer these qualities.

This work focuses on optimizing synthesis parameters of UCNPs with general formula $NaGdF_4$:18%Yb^{3+},2%Er^{3+}. The impact of synthesis temperature, as well as the molar ratio of lanthanide salt to NH_4F, on the changes in morphology and optical properties of UCNPs were assessed. Particle size, shape and uniformity were analyzed by SEM imaging, crystal phase, and purity by X-Ray diffraction. Additionally, emission intensity and lifetime were determined using photoluminescence (PL) spectroscopy.

The empirical data obtained in this study provides further insights into the influence of synthesis conditions on the properties of $NaGdF_4$:18%Yb^{3+},2%Er^{3+} UCNPs. This knowledge is essential in tailoring the particles for specific applications and further modification.

[1] K. Malhotra, D. Hrovat, B. Kumar, G. Qu, J. Van Houten, R. Ahmed, P.I A. E. Piunno, P. T. Gunning, and U. J. Krull. Lanthanide-Doped Upconversion Nanoparticles: Exploring A Treasure Trove of NIR-Mediated Emerging Applications. ACS Applied Materials Interfaces 2023 15 (2), 2499-2528.