XXI Brazilian Meeting on Inorganic Chemistry
X Brazilian Meeting on Rare Earths
III Workshop on Theoretical Bioinorganic Chemistry
Belo Horizonte, September 12 - 15th 2024

Architectural Control of Lanthanide-based Nanoparticles: from Potential Multimodal Imaging Probes to Miniature Thermometers

Eva Hemmer [1]

[1]*Department of Chemistry and Biomolecular Sciences, University of Ottawa, Ottawa, Canada*
E-mail:ehemmer@uottawa.ca

Thematic Area: Rare-Earths

Keywords: lanthanide-based nanoparticles, microwave-assisted synthesis, optical properties

The remarkable optical properties of the lanthanides (Ln) make Ln-based materials ideal for applications ranging from biomedicine to optoelectronics and energy conversion technology. Upconverting nanoparticles (UCNPs) based on sodium lanthanide fluorides ($NaLnF_4$) are commonly synthesized by the thermal decomposition of metal precursors in high-boiling-point solvents, based on convectional heating. Microwave reactors can improve reproducibility as offering better control over a reaction environment. More homogeneous heat distribution yields narrow size distributions, and rapid heating to the desired temperature shortens reaction times from hours to minutes. We developed a fast and reliable microwave-assisted synthetic approach allowing crystalline phase, architectural, and size control of $NaLnF_4$ from sub-3 to ca. 25 nm. Careful architecture design and choice of Ln^{3+} dopant ions allow to tune the optical properties of the resultant nanoparticles, i.e., upconversion and near-infrared emission. Particular attention is paid to structural and optomagnetic control, seeking biomedical application. For instance, multimodal bioimaging probes merging optical imaging, magnetic resonance imaging (MRI), and X-ray computed tomography (CT) capabilities have attracted considerable attention due to their potential biomedical applications. This includes nanoparticles that combine upconverting Er^{3+}/Yb^{3+} and magnetic $NaDyF_4$ for optical/T_2-weighted MRI/CT multimodal capabilities. In addition to multimodal imaging, Ln-NPs are promising candidates for application in nanothermometry due to the distinct, temperature-induced changes in their spectral features. We seek the development of novel Ln-based nanothermometers for new opportunities in the near-infrared biological transparency windows (1000 to 2000 nm), by doping Ln^{3+} ions, such as Er^{3+} and Tm^{3+} as well as unconventional Pr^{3+}, into core-multi-shell lanthanide-based nanoparticles. This presentation will shed light on recent results with respect to microwave-assisted synthesis of Ln-based nanomaterials as well as structural and optomagnetic properties.