TRENT UNIVERSITY

CHEMISTRY/PHYSICS SEMINAR SERIES

# Dr. Eva Hemmer

**Associate Professor, Materials Science, University of Ottawa**

**Wednesday, February 14, 2024**
**11:00 a.m. to 11:50 a.m. in ENW 115**

## Exploring the Optical Features of Lanthanides: From Synthesis to Potential Applications

**ABSTRACT**

The remarkable optomagnetic properties of the lanthanides (Ln) make Ln-based materials ideal for biomedical applications, including diagnostic (e.g., imaging, nanothermometry) and therapeutic (e.g., drug delivery, photodynamic therapy) approaches. This is due the unique electronic properties of the f-elements allowing for upconversion and near-infrared emission under near-infrared excitation as well as high magnetic moments. Moreover, the temperature dependence of their optical features allows to use lanthanide-based materials as nanothermometers for optical temperature read-out.

Yet, challenges remain. Low emission intensity and efficiency of small nanoparticles (NPs), and reliable, fast synthesis routes. As material chemists, we tackle these challenges with new designs of Ln-NPs by chemically controlled synthesis, application-oriented surface chemistry, and understanding of structure-property-relationships. Sodium lanthanide fluorides (NaLnF4) are our favorite materials, and we developed a fast and reliable microwave-assisted synthesis approach allowing crystalline phase and size control in the sub 20nm realm. Such control is crucial for the understanding of fundamental structure-property relationships and to optimize their optical and magnetic properties, when aiming for the design of next-generation optical probes or contrast agents for magnetic resonance imaging. For instance, NaGdF4 NPs are gaining interest as alternative MRI contrast agent, while co-doping with Ln3+ ions renders them excellent candidates for photoluminescent optical probes. Having a fast and reliable synthesis route towards NaLnF4 NPs on hand, we now explore various nanoparticle architectures and compositions with the goal to optimize their optical properties, ultimately resulting in the design of biocompatible multimodal bioprobes.

This presentation will shed light on recent results and remaining challenges in the field of Ln-based nanostructures with respect to their microwave-assisted synthesis as well as structural and optical properties, seeking biomedical (and beyond) application, while also touching on hyperspectral imaging as an emerging analytical tool offering spatio-spectral information about Ln-based materials.

**BIOGRAPHY – Eva Hemmer**

**Dr. Eva Hemmer is an Associate Professor of Materials Chemistry at the University of Ottawa. She received her PhD (2008) in materials science from Saarland University (Germany), focusing on single-source-precursors and their application in the bottom-up synthesis of inorganic nanomaterials. This experience was further deepened during her postdoctoral studies when she worked on rare-earth-based nanoparticles for near-infrared bioimaging with Prof. Soga (Tokyo University of Science, Japan, 2009-2012). In 2013 she was awarded a Feodor Lynen Research Postdoctoral Fellowship from the Alexander von Humboldt Foundation to work in the groups of Profs. Vetrone and Légaré at Institut National de la Recherche Scientifique (Montreal, 2012-2015) to develop rare-earth-based optical nanothermometers. In 2016 Dr. Hemmer came to Ottawa; since then, her research focuses on new designs of rare-earth-based nanoparticles for optical, bioimaging, and optomagnetic applications. She received the 2021 Jubilee Global Diversity Award of the ACerS (American Ceramic Society; Engineering Ceramics Division), as well as the 2021 Early-career Achievement Award in Nanoscience and Nanotechnology by NanoOntario. Her commitment to higher-level education and to the broader materials community – for instance as active member of the ACerS or as Chair of the Student Engagement Sub-Committee of the Materials Research Society – was recognized with the AcerS' Du-Co Ceramics Young Professional Award.**