

Undetected thermal overexposures are a frequent yet often overlooked cause of material degradation, structural damage, and critical system failures. Thermal history phosphors offer a powerful solution by permanently recording the maximum temperature exposure through irreversible changes in their luminescent properties. These materials enable straightforward, post-event optical readout without requiring continuous monitoring or external power, making them especially attractive for long-term deployment in inaccessible or energy-constrained environments.

Among the various types of thermal history phosphors, those operating via redox mechanisms are particularly promising, as they rely on thermally induced changes in the oxidation state of dopant ions, which result in distinct and often visually perceptible shifts in emission color. This feature not only allows for intuitive, visual readout, but also provides high sensitivity and precision in identifying the maximal experienced temperature. Despite their significant potential, redox-based thermal history phosphors remain largely unexplored, and the relationships between synthesis parameters, material properties, and sensing performance are poorly understood.

This project addresses these knowledge gaps by developing a systematic framework for the rational design of redox-based THPs. It will establish clear correlations between host composition, dopant ions properties and thermal response behavior. As a result, the project will deliver a promising class of versatile, highly sensitive, and tunable thermal history phosphors that offer dual-readout capability - enabling both accurate maximal experienced temperature determination and immediate visual indication of thermal exposure.