

Tuning Mn⁴⁺ Luminescence Kinetics via the Nephelauxetic Effect for Lifetime Thermometry

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Luminescence thermometry is a versatile remote technique for temperature sensing, based on temperature-dependent luminescence. Among different approaches, luminescence Kinetics is a reliable parameter due to its immunity to spectral distortions.

In transition metal ion-doped phosphors, luminescence originates from *d-d* transitions, where unshielded *d* electrons are sensitive to crystal field and temperature [1]. The host lattice governs emission behavior and thermometric performance [2]. Although Mn⁴⁺ based luminescence thermometry using emission kinetics is well studied, predictive models remain limited. Designing such thermometers requires understanding the relationship between the host composition and thermometric behavior. Here, we propose a model describing the ²E state lifetime of Mn⁴⁺ ions and the corresponding absolute and relative sensitivities in terms of the nephelauxetic effect.

In this study, Mn⁴⁺ doped double perovskites Sr₂InNbO₆, Sr₂InTaO₆, Ba₂InNbO₆, and Ba₂InTaO₆ are investigated by varying A and B' site cations to relate structure property relationships to thermometric behavior. Results show that, beyond the *Dq/B* parameter, additional host dependent effects significantly influence temperature response, enabling selection of optimized materials for Mn⁴⁺ based luminescence thermometry.

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