Electronic Supplementary Material

How to calibrate luminescent crossover thermometers: A note on "quasi"-Boltzmann thermometers

Benedikt Bendel,[a] and Markus Suta[a] *

[a] Inorganic Photoactive Materials, Institute of Inorganic and Structural Chemistry, Heinrich Heine University Düsseldorf, Universitätsstraße 1, 40225 Düsseldorf, Germany.

* Corresponding author: markus.suta@hhu.de

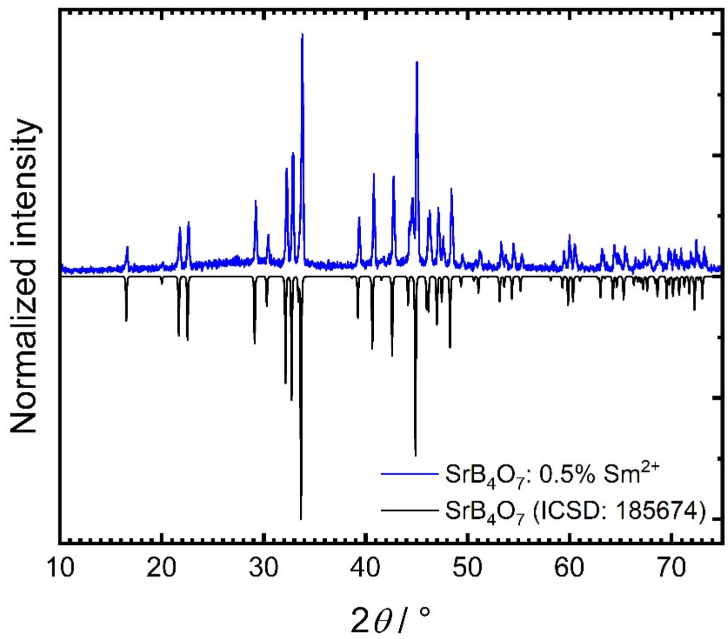

Figure S1. Powder X-ray diffraction pattern (Cu $K_{\alpha 1}$ radiation, λ = 1.5406 Å) of synthesized microcrystalline SrB_4O_7: 0.5% Sm^{2+} in comparison to a database pattern simulated from single-crystal structural data on SrB_4O_7 (ICSD depository no.: 185674)[1].

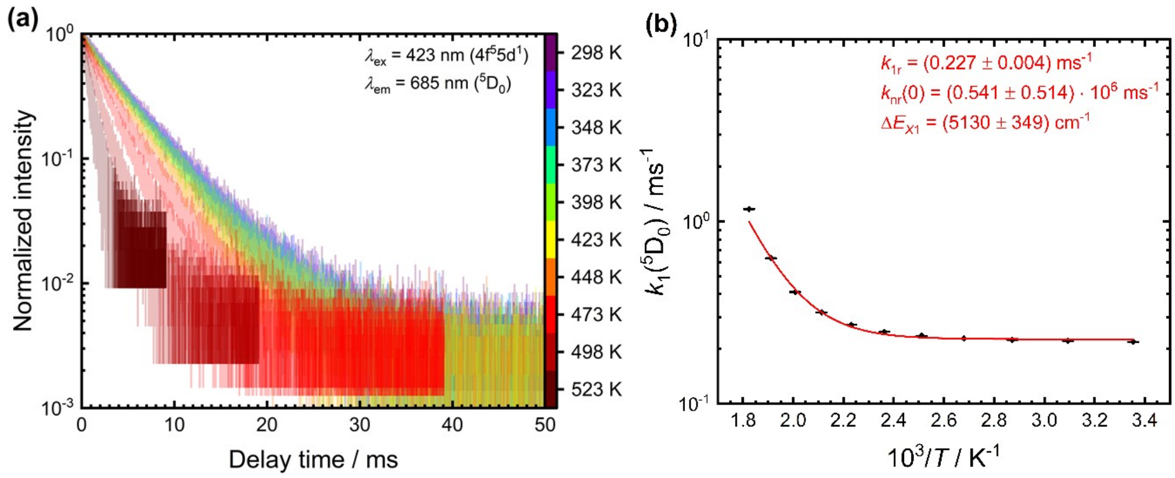

Figure S2. **(a)** Temperature-dependent luminescence decay curves (λ_{ex} = 423 nm) of the $^5D_0 \rightarrow {}^7F_0$-related emission at 685 nm. All curves showed a single exponential decay. **(b)** Temperature evolution of the extracted decay rates k_1. The red line indicates a fit to the sum of k_{1r} and the non-radiative contribution modelled by eq. (1) in the manuscript. Due to the lack of more high-temperature points, $k_{nr}(0)$ and ΔE_{X1} cannot be reliably determined from the fit.

Derivation of eq. (4) from eq. (3) in the manuscript

We start with eq. (3) of the manuscript

$$R_{21}(T) = \frac{I_2}{I_1} = C\frac{n_2}{n_1} = C\frac{\alpha_{a2}k_{1r} + (\alpha_{a1}+\alpha_{a2})k_{nr}(0)\exp\left(-\frac{\Delta E_{X1}}{k_BT}\right)}{\alpha_{a1}k_{2r} + (\alpha_{a1}+\alpha_{a2})k_{nr}(0)}. \quad \text{(S1)}$$

The electronic pre-constant C can be defined as

$$C = \frac{k_{2r}}{k_{1r}}, \quad \text{(S2)}$$

if the two radiative transitions denote the cumulated transitions from the excited states $|2\rangle$ and $|1\rangle$ to the different ground levels, respectively (such that no branching ratios need to be considered). In that case, eq. (S1) evolves to

$$R_{21}(T) = \frac{\alpha_{a2}k_{2r}}{\alpha_{a1}k_{2r} + (\alpha_{a1}+\alpha_{a2})k_{nr}(0)} + \frac{k_{2r}}{k_{1r}}\frac{(\alpha_{a1}+\alpha_{a2})k_{nr}(0)}{\alpha_{a1}k_{2r} + (\alpha_{a1}+\alpha_{a2})k_{nr}(0)}\exp\left(-\frac{\Delta E_{X1}}{k_BT}\right), \quad \text{(S3)}$$

and with the abbreviation

$$k_{eff} = \alpha_{a1}k_{2r} + (\alpha_{a1}+\alpha_{a2})k_{nr}(0), \quad \text{(S4)}$$

we finally arrive at eq. (4) of the manuscript

$$R_{21}(T) = \frac{\alpha_{a2}k_{2r}}{k_{eff}} + \frac{k_{2r}}{k_{1r}}\frac{(\alpha_{a1}+\alpha_{a2})k_{nr}(0)}{k_{eff}}\exp\left(-\frac{\Delta E_{X1}}{k_BT}\right) \equiv A + B\exp\left(-\frac{\Delta E_{X1}}{k_BT}\right). \quad \text{(S4)}$$

References

[1] W. D. Stein, J. Liebertz, P. Becker, L. Bohaty, M. Braden, *Eur. J. Phys. B*, 2012, **85**, 236.