Self-temperature sensing in functional lanthanide coordination materials using hybridization of luminescence and absorption properties

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Temperature sensing, i.e, thermometry, is undoubtedly an essential technique for characterizing the thermodynamic state of an object. Among various thermometry techniques, luminescence ratiometric thermometry has caught tremendous scientific attention since 1990s, because it showed overwhelming advantages of non-invasive (remote probing) feature, high sensitivity/stability, self-reference capability, and nanometer spatial resolution. Various successful applications have been demonstrated in biological study, information communication technology, energy and catalysis, nanofluids, etc.

Nevertheless, the thermometer and the target are always two separate materials, so, an issue of thermal lagging due to their divided chemical compositions is always inevitable, and it causes less timely probing of the target temperature, leading to sensing error. In this regard, my research focuses on merging the temperature probes and functional targets as a single-phase material so that the targets can sense the self-temperature without thermal lagging. My study materials are lanthanide complexes, which could show intriguing functionality of single-molecule magnet (SMM) behavior and various optical properties such as visible-to-near infrared emission and absorption. The former SMM property is promising for futuristic high-density information storage thanks to the magnetic memory effect of a molecular origin; however, the performance of SMM is strongly temperature dependent, so knowing the temperature information is crucial. The latter optical features could provide thermally dependent emission or absorption spectra, thus providing valuable information for thermometry. Conjunction of SMM and thermometric features will lead to functional materials capable of self-temperature sensing. In this seminar, I will demonstrate our recent progress in constructing lanthanide-based SMMs that are able to measure self-temperature.

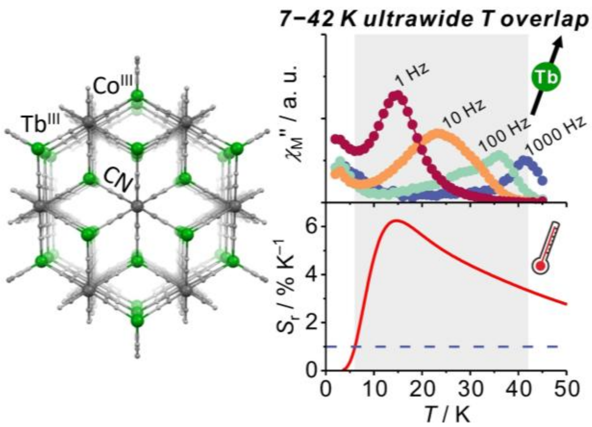

Fig. 1 Structure of a 3-D cyanido-bridged Tb^{III}–Co^{III} coordination framework (left), showing SMM functional character (right top) and thermometry (right bottom).

[1] J. Wang, J. J. Zakrzewski, M. Zychowicz, Y. Xin, H. Tokoro, S. Chorazy, S. Ohkoshi ***Angew. Chem. Int. Ed.*** 2023, *62*, e2023063.

[2] J. Wang, J. J. Zakrzewski, M. Zychowicz, V. Vieru, L.F. Chibotaru, K. Nakabayashi, S. Chorazy, S. Ohkoshi ***Chem. Sci.***, 2021, *12*, 730–741.

[3] J. Wang, J. J. Zakrzewski, M. Heczko, M. Zychowicz, K. Nakagawa, K. Nakabayashi, B. Sieklucka, S. Chorazy, S. Ohkoshi ***J. Am. Chem. Soc.***, 2020, *142*, 3970–3979.