**Thermometry: a novel functionality for magnetic nanoparticles**

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Temperature is a fundamental thermodynamic variable, the measurement of which is crucial in countless scientific investigations and technological developments, accounting at present for 75%–80% of the sensor market throughout the world. The traditional liquid-filled and bimetallic thermometers, the thermocouples, the pyrometers and the thermistors are generally not suitable for temperature measurements at scales below 10 μm. This intrinsic limitation has encouraged the development of new non-contact accurate thermometers with micrometric and nanometric precision, a challenging research topic increasingly hankered for.

This work describes absolute temperature sensing/mapping − in the 10-350 K range and submicrometer spatial resolution − using magnetic siloxane-based hybrid nanoparticles (NPs) co-doped with Eu3+ and Tb3+ tris(β-diketonate) chelates. This unique luminescent self-referencing nanothermometer has been recently reported by us [1,2]. The developed thermometer has up to 4.9%·$K^{-1}$ temperature sensitivity (1.5 times larger than the highest value reported previously) and it exhibits high photostability for long-term use. The variation of the Eu3+/Tb3+ ratio affords tunability to the temperature working range as shown in Figure 1. Alternatively, tunability is also accomplished by changing the host matrix, thus modifying the interaction between the Ln3+ and the host matrix energy levels.

The nanothermometer is a versatile material which can be processed in different forms adapted to the desired application, e.g. a thick film coating an integrated circuit trough which we obtain a high resolution 2-D temperature mapping depicted in Fig. 2. The presentation will also include an account on current state of the art of thermometry at the nanoscale and in particular of lanthanide-based luminescent molecular thermometry.

**References:**

[1] a) C.D.S. Brites, P.P. Lima, N.J.O. Silva, A. Millán, V.S. Amaral, F. Palacio, L.D. Carlos, Adv. Mater., 2010, 22, 4499; b) F. Palacio, A. Millán, N. J. Silva, L. D. Carlos, V. Amaral, P. P. Lima, C. D. S. Brites, Spain Patent P200930367, 2009.

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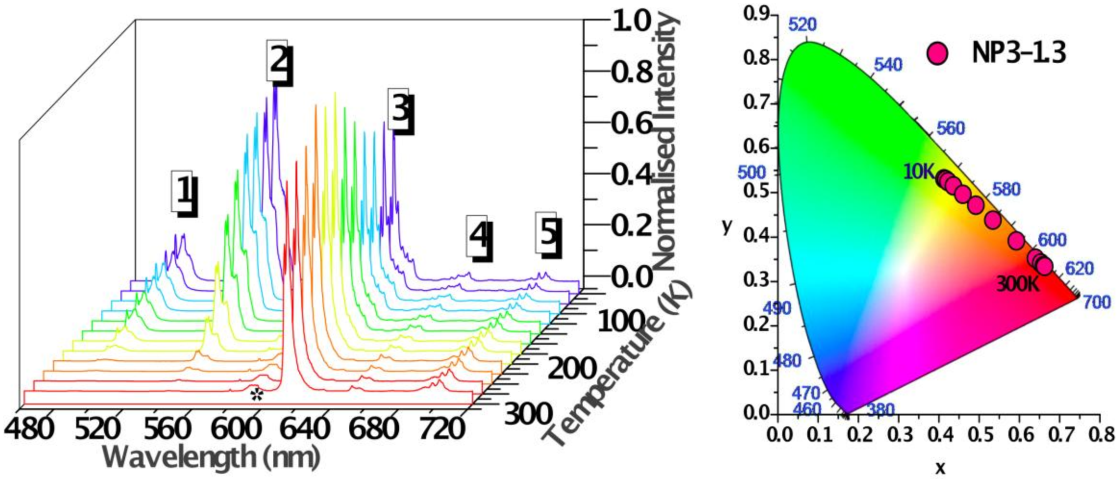


Figure 1. a) Photoluminescence of the molecular thermometer inserted in g $Fe_2O_3$@TEOS/APTES magnetic nanoparticles excited at 357 nm and recorded between 14 and 300K: **1** and **2** are the $^5D_4 \rightarrow {}^7F_{6,5}$ emissions of $Tb^{3+}$ and **3**, **4** and **5** are the $^5D_0 \rightarrow {}^7F_{2\text{-}4}$ ones of $Eu_{3+}$; b) CIE chromaticity diagram showing the temperature dependence of the (x,y) color coordinates of the nanoparticulate thermometer.

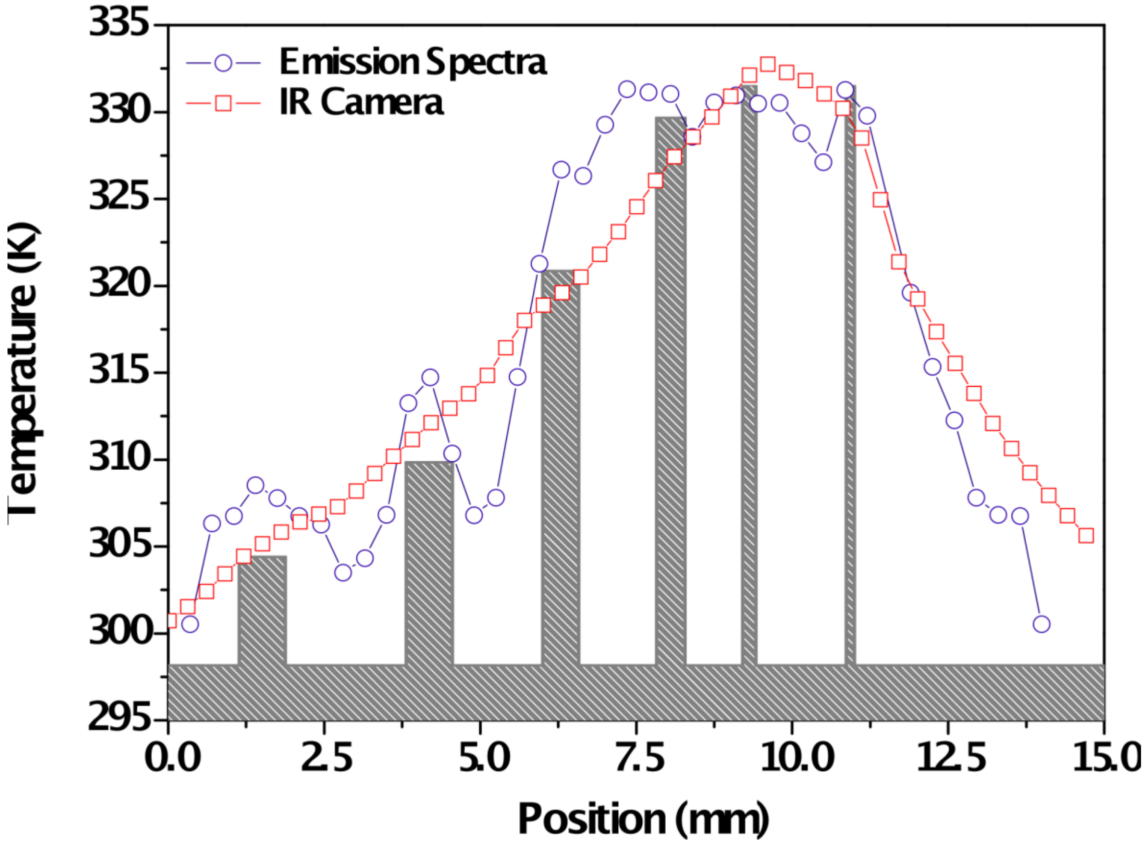


Figure 2. Temperature profiles obtained with the molecular thermometer processed as a coating paint onto a variable resistance (blue circles, the size corresponds to the temperature uncertainly of 0.5 degree) as compared with the measurements performed using an IR camera (red squares).