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Nanomaterials for Temperature Sensing

The ever-growing demands in nanotechnology and nanomedicine require the noninvasive, accurate, and self-referenced measurement of temperature at the submicrometer scale. In this context, the thermal dependence of the luminescence of certain phosphors provides high detection sensitivity and spatial resolution with short acquisition times [1].
Lanthanide (Ln)-bearing materials are among the most versatile probes used in luminescence nanothermometry and in this talk I shall highlight three classes of examples. Coordination polymer thermometers ascertain the absolute temperature via the measurement of the intensities of two transitions of distinct emitting centres (so-called dual-centre thermometers) [2]: a ligand (linker) and a Ln^{3+} ion (e.g., Eu^{3+} or Tb^{3+}); two Ln^{3+} ions (so far, Eu^{3+} and Tb^{3+}); or a dye hosted in the MOFs nanopores and a Ln^{3+} ion. Such materials are amenable to tuning of their optical properties and, thus, of their thermometry response [3, 4]. Another type of luminescent materials, core-shell $NaYF_4$:Yb/Er nanoparticles, dispersed into suitable solvents, perform as upconversion nanothermometers, allowing the investigation of the century-old problem of measuring the instantaneous Brownian velocity of 'ultramicroscopic' particles [5]. Finally, thermometers and heaters may be integrated offering potential applications in nanotechnology and biomedicine (e.g., hyperthermia) [6]. Such heater–thermometer nanoplatforms are capable of measuring the plasmon-induced local temperature increase of Au nanorods via the ratiometric upconversion of $(Gd,Yb,Er)_2O_3$ nanothermometers [7].

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