SWIR luminescence nanothermometry for biomedical applications

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High resolution thermal sensing and bioimaging at the cellular level and in animal models (*in vivo* applications) is interesting for both early diagnosis and controlled treatment via photothermal conversion of several diseases, including cancer. Despite excellent *in vitro* results have been obtained with visible emitting luminescent nanothermometers [1], their application for *in vivo* studies is very limited due to the reduced penetration depth of visible light in biological tissues. This can be overcome if materials with emission and absorption bands lying in the so-called biological windows (BWs) (650-1350 nm) [2] are used, where tissue scattering and absorption are minimized. However, still the quest for a material that maximizes the luminescence quantum efficiency in this region, allowing for high penetration depths in the body is a matter of special interest. Despite all this work, the number of studies exploring the possibilities of longer emission wavelengths in luminescence thermometry are scarce. This includes those lying in the so called short-wavelength infrared (SWIR) that extends from 1.35 to 2.3 µm. SWIR light transmits more effectively (up to three times) through specific biological tissues (oxygenated blood and melanin-containing tumours), achieving higher penetration depths due to the reduced tissue absorbance and scattering in this region [3]. Here, we analyse the possibilities for temperature sensing purposes and the development of primary thermometers with the emissions in the SWIR region generated by Er^{3+}, Tm^{3+} and Ho^{3+} ions in different host matrices, including fluorides ($NaYF_4$), oxyfluorides (NaY_2F_5O), simple oxides (Lu_2O_3) and complex oxides ($KLu(WO_4)_2$). The thermometric responses of these particles are compared with those shown by other Ln^{3+}-doped nanoparticles operating in the visible, and in the BWs, and demonstrated the potentiality of SWIR emitting nanoparticles for temperature measurements in biological tissues by using chicken breast meat. The results indicate that SWIR emitting nanoparticles are good candidates for luminescent nanothermometry in biomedical applications.

References

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Figures

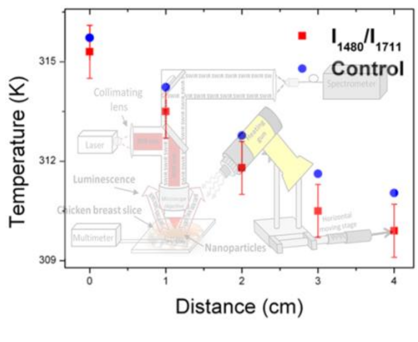

Figure 1: Scheme of the setup used in the temperature sensing experiments and results obtained with luminescent nanoparticles and thermocouple (control).