Researchers develop dual-excitation decoding strategy for high-accuracy thermal sensing

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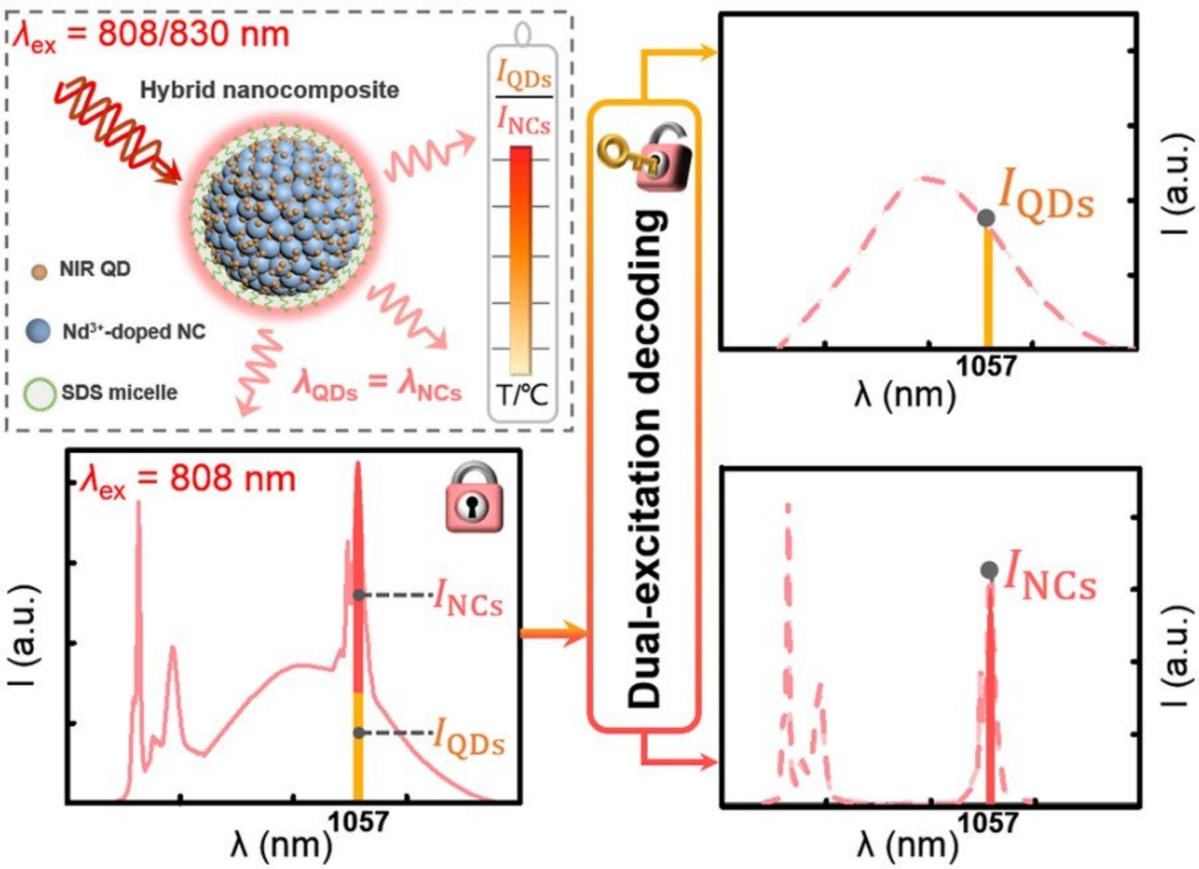

Schematic illustration of the dual-excitation decoding strategy based on hybrid nanocomposites for thermal sensing by using the intensity ratio of two emissions at identical wavelength as the thermometric parameter. Credit: Prof. CHEN Xueyuan's group

Luminescent nanothermometry is a non-invasive method of detecting temperature in vivo, which is important in biology and nanomedicine researches.

Traditional ratiometric thermometry methods generally use the intensity ratio of two non-overlapping emissions with distinct thermal responses as the thermometric parameter. However, such methods suffer from a very low accuracy in deep-tissue temperature reading.

In a study published in *Advanced Science,* a research group led by Prof. Chen Xueyuan from the Fujian Institute of Research on the Structure of Matter (FJIRSM) of the Chinese Academy of Sciences proposed a novel dual-excitation decoding strategy for high-accuracy thermal sensing.

This strategy is based on hybrid nanocomposites comprising self-assembled NIR quantum dots (QDs) and Nd^{3+} doped fluoride nanocrystals (NCs), wherein the intensity ratio of two emissions at identical wavelength is defined as the thermometric parameter to avoid deleterious interference from wavelength- and temperature-dependent photon attenuation in tissue.

The researchers elaborately designed the hybrid nanocomposites composed of NIR QDs and NCs to acquire the intensity ratio of two overlapping emissions at 1057 nm ascribed to QDs and NCs, respectively, as the thermometric parameter under 808 nm excitation.

Benefiting from the disparate absorption properties between QDs and NCs, the overlapping emission signals could be handily decoded to acquire their intensity ratio through the dual-excitation decoding strategy that employed another 830 nm laser beam following the same optical path as 808 nm laser to exclusively excite QDs.

Furthermore, the researchers verified in the proof-of-concept ex vivo experiments that, at a detection depth of ~ 1.1 mm in tissue, such dual-excitation decoding strategy was capable of achieving high-accuracy temperature reading with a small error of ~ 2.3 °C, close to the thermal resolution of thermometers (~ 1.8 °C).

By contrast, under the same experimental conditions, a large error of ~ 43.0 °C occurred for the traditional ratiometric thermometry mode based on the non-overlapping emissions at 1025 and 863 nm from QDs and NCs, respectively.

The proposed thermal sensing strategy can minimize the deleterious interference from wavelength-dependent photon attenuation in tissue.

More information: Shaohua Yu et al. A Dual-Excitation Decoding Strategy Based on NIR Hybrid Nanocomposites for High-Accuracy Thermal Sensing, *Advanced Science* (2020). DOI: 10.1002/advs.202001589

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