Highly efficient dye-sensitized, lanthanide-doped, upconversion luminescent nanoprobes

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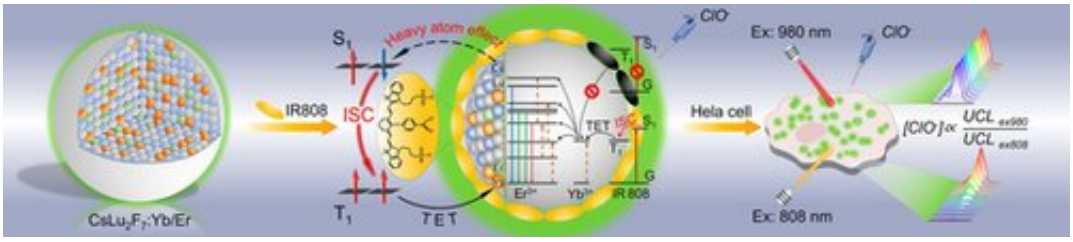

Graphical abstract. Credit: DOI: 10.1002/anie.202112125

Lanthanide (Ln^{3+})-doped upconversion (UC) nanocrystals (NCs) have attracted considerable interest due to their superior optical features. Unfortunately, the relatively low luminescence intensity is a major drawback that seriously hinders their practical applications.

Organic dyes with large absorption cross-sections are often used as sensitization antennas. Currently, the sensitization efficiency from conventional singlet excited states of the organic dyes is greatly restricted by the long-distance cascaded energy transfer from dyes to the Ln^{3+} activators.

In a study published in *Angewandte Chemie International Edition*, a research group led by Prof. Chen Xueyuan from Fujian Institute of Research on the Structure of Matter (FJIRSM) of the Chinese Academy of Sciences proposed a novel class of Ln^{3+}-doped UCNCs based on

Yb/Er-doped $CsLu_2F_7$.

Benefiting from the significant heavy atomic effect of cesium and lutetium, IR808 dye modified on the surface of NCs exhibited near-unity (99.3 percent) intersystem crossing efficiency from singlet to triplet excited states, resulting in 1309-fold and more than 180-fold increase in UC intensity and absolute UC quantum yield of Er^{3+} over the bare counterparts, respectively.

The researchers constructed an 808-nm/980-nm dual excited ratiometric luminescence nanoprobe based on the IR808-modified $CsLu_2F_7$:Yb/Er NCs. They then used the UC luminescence (UCL) excited by 808 nm and 980 nm as the detection signal and the self-calibration signal, respectively. Taking advantage of the 808-nm/980-nm dual excited ratiometric UCL, they explored the IR808-modified $CsLu_2F_7$:Yb/Er NCs as excellent bioprobes for in vitro assay of NaClO with the limit of detection down to 65.3 nM.

Furthermore, the researchers achieved the sensitive assay of hypochlorite in live cancer cells on the basis of the ratiometric signals of 980-nm and 808-nm excited UCL images of $CsLu_2F_7$:Yb/Er nanoprobes, where the 980-nm excited UC emission was employed as a self-calibrated signal to alleviate the interference of intracellular fluctuation.

This study provides a versatile and convenient approach for the design of highly efficient Ln^{3+}-doped UC nano-bioprobes through triplet sensitization of organic dyes, thereby may accelerate their bioapplications for accurate intracellular sensing and diseases diagnostics.

More information: Peng Zhang et al, Enhancing Dye-Triplet-Sensitized Upconversion Emission Through the Heavy-Atom Effect in CsLu 2 F 7 :Yb/Er Nanoprobes, *Angewandte*

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