Researchers Develop Highly Efficient Dye-sensitized Lanthanide-doped Upconversion Luminescent Nanoprobes

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Chinese researchers proposed a novel class of Ln3+-doped UCNCs based on Yb/Er-doped CsLu2F7 that may accelerate their bioapplications for accurate intracellular sensing and diseases diagnostics.

Lanthanide (Ln3+)-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 Ln3+ 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 (CAS) proposed a novel class of Ln3+-doped UCNCs based on Yb/Er-doped CsLu2F7.

Benefiting from the significant heavy atomic effect of cesium and lutetium, IR808 dye modified on the surface of NCs exhibited near-unity (99.3%) 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 Er3+ over the bare counterparts, respectively.

The researchers constructed an 808-nm/980-nm dual excited ratiometric luminescence nanoprobe based on the IR808-modified CsLu2F7: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 CsLu2F7: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 CsLu2F7: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 Ln3+-doped UC nano-bioprobes through triplet sensitization of organic dyes, thereby may accelerate their bioapplications for accurate intracellular sensing and diseases diagnostics.