Enhancing Upconversion Nanosystems by Moiety Engineered NIR Dyes for biomedical applications

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Lanthanide-doped upconversion nanoparticles (UCNPs) are capable of converting lower energy near-infrared (NIR) light into visible emissions. Their many distinguished properties, including broadly tuneable emission colours and low cytotoxicity, are highly attractive for a range of applications, such as bioimaging, single-molecule tracking, and super-resolution microscopy. Typically, sensitizer ions (Yb^{3+}) and activator ions (Er^{3+}, Tm^{3+}, or Ho^{3+}) are codoped in an optically inert host, such as $NaYF_4$. The small absorption cross sections of lanthanide ions largely limit the light conversion efficiency of UCNPs. Hybrid upconversion nanosystems have been reported to improve the low absorption efficiency of UCNPs.

In this presentation, I will show the dye strategy to sensitise the upconversion nanoparticles, which enable five to six orders of magnitude of upconversion emission enhancement. I will introduce the advance of organic-inorganic hybrids, the design principle of these hybrid photonic materials, and our recent progress on discovery in this field. I will discuss our recent achievement in enhancing the quantum yield of NIR dyes and improving their stability by deactivating photoinduced oxidization. Taking together the synergistic effect, we have achieved a 242-fold upconversion emission enhancement over the benchmark of the IR806-sensitized system and an ~800,000-fold increase over the bare UCNPs. This work suggests a new avenue by moiety engineering to improve the brightness of the dye-sensitized upconversion nanohybrids. The study allows our application of these materials in enhanced NIR-II Imaging and precise treatment of bacterial infection.

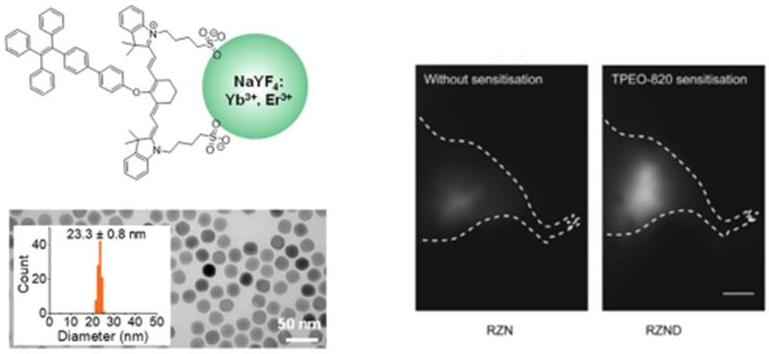

Figure 1: Dye-sensitised upconversion nanohybrids and their applications in bioimaging.

References:

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