Near-Infrared-Sensitive Nanomaterials based on Ru Complex-Functionalized Upconverting Nanoparticles for Biomedical Applications

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Upconverting Nanoparticles (UCNPs) convert near-infrared light to UV or visible light, which can trigger photocreatants. Many applications based on the UCNP-assisted photochemistry including multimodal bioimaging, photodynamic therapy, and drug/gene delivery, photoisomerization, photocleavage, photopolymerization, cell adhesion, and bending of elastomers have been developed. The reported excitation intensity for UCNP-assisted photochemistry is typically between several hundred mW/cm² to several hundred W/cm². The relatively high-intensity NIR light required by UCNP-assisted photochemistry may damage cells, tissue, and other biomaterials. Therefore, the reduction of the excitation intensity for UCNP-assisted photochemistry to a medically harmless level is an important objective. Here, we demonstrate how to reduce the intensity of NIR light for UCNP-assisted photochemistry[1]. Based on the low excitation intensity for UCNP-assisted photochemistry, the applications including the photon upconverting lithography[2](Figure 1) and drug delivery system[3](Figure 2) were developed.

Figure 1 Schematic of photon upconversion lithography (PUCL) for the patterning of proteins. Note: Polyethylene glycol, which is co-grafted with Ru complexes on the upconverting nanoparticles (UCNPs), is not shown for clarity.

Figure 2 Schematic illustration: upconverted blue luminescence triggers cleavage of Ru complexes and release of doxorubicin from DOX-UCNP@mSiO2-Ru nanoparticles.