Development of Advanced Upconversion Nanomaterials for Bioimaging and Biosensing

*Xiaoxue Xu**

[1]*Institute for Biomedical Materials and Devices, Faculty of Science, University of Technology Sydney, NSW, Australia, 2007

E-mail: xiaoxuehelen.xu@uts.edu.au

Lanthanide ions doped upconversion nanoparticle (UCNPs) exhibit upconverting luminescence to emit higher energy emissions at UV and visible range after absorption of two or more photons from lower energy wavelength. Their unique optical and magnetic properties such as zero auto-fluorescence, better penetration depth, and low excitation light power, have demonstated broad applications in biosensing and bioimaging.

To full exploit the UCNPs in clinic diagnosis settings, advanced upconversion nanostructures are developed. We designed and fabricated core-porous shell UCNPs consisting $NaYF_4$: Yb, Er as core for fluorescent imaging and $NaGdF_4$ porous shell as Magnetic Resonance Imaging (MRI) contrast agent. As shown in Figure 1, the luminescence from the core is well protected by the shell, while the porous shell exposes more Gd3+ for produced high MRI signals. The high luminescent emission and improved MRI performances of core-porous shell UCNPs demonstrate their high feasibility as multimodal biomedical imaging contrast agent.

With further surface functionalization, sensing the single stranded DNA fragments have been conducted. We constructed a 'turn-off' luminescent resonance energy transfer sensor based on UCNPs with specific surface modification. As shown in Figure 2, the silica coated UCNPs can be functionalized and conjugated with single stranded DNA fragments and the complementary DNA with quencher (Iowa black). The binding of the capture DNA and the complimentary DNA brought the UCNPs and the quencher together for LRET to occur, thus the quenched UCNPs sensed the presence of complimentary DNA. The 'turn-off' sensor suggested the quantifying detection of ssDNA fragments, which can be highly potential for detection of the circulating tumor DNA fragments in blood.

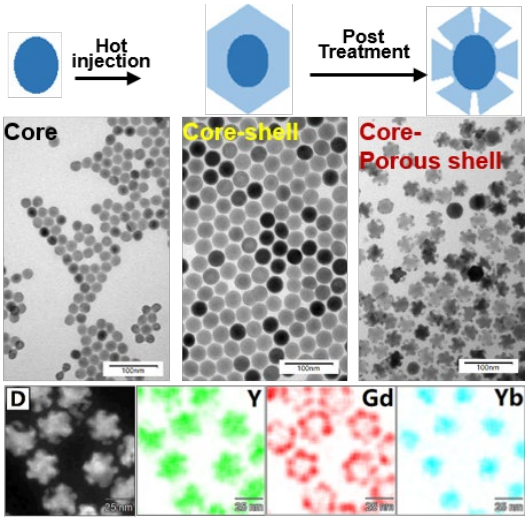

Figure 1 The scheme of the fabrication of core-porous shell UCNPs and the morphology and composition of the core, core-shell and core-porous shell UCNPs.

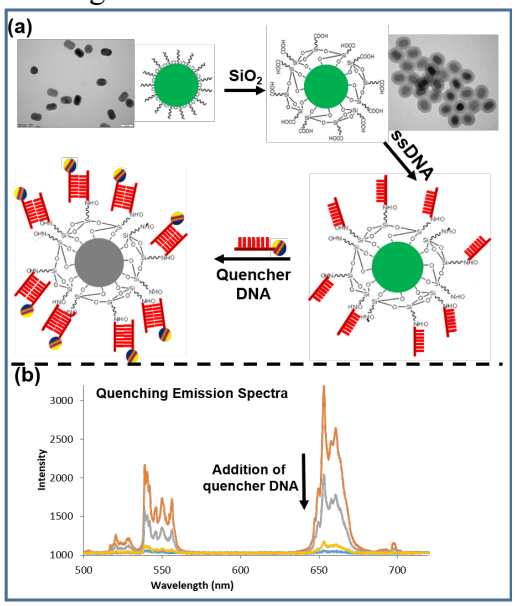

Figure 2 A 'turn-off' biosensor consruction and the sensing of DNA fragments.