Preparation and Properties of Upconversion Nanoparticles and Semiconductor Quantum Dots Hybrid Nanomaterials

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Abstract:

Electromagnetic wave upconversion nanoparticles (UCNPs) can convert near-infrared light (NIR) into shorter wavelength ultraviolet light or visible light, which has the characteristics of minimal light damage to living organisms and high detection sensitivity. Quantum dots (QDs) also have excellent properties such as strong fluorescence brightness and good photostability. After reviewing relevant literature, we learned that UCNPs using $LiYF_4$ instead of $NaYF_4$ as the host material can have stronger photoluminescence intensity. Using InP to replace the toxic cadmium-containing CdSe core-shell QDs can reduce environmental hazards and have a relatively narrow radiation width.

Therefore, in this study, we prepared core-shell type ligand-free $LiYF_4$: $Yb^{3+}_{0.25}/Ho^{3+}_{0.01}$@ $LiYF_4$:$Yb^{3+}_{0.2}$ UCNPs with green light emitting property by thermal decomposition approach, and synthesized water-soluble anionic core-shell type InP/ZnS QDs that can absorb the green light band. Both UCNPs and QDs were characterized by X-ray diffraction (XRD) and transmission electron microscopy (TEM) measurements. Through electrostatic attraction, anionic type QDs could adsorbed on the surface of positively charged UCNPs. The fluorescence resonance energy transfer (FRET) behavior was observed between UCNPs and QDs under NIR irradiation. The FRET facilitated the identification and sterilization of pathogens.

Keywords:

Upconversion nanoparticles, quantum dots, $LiYF_4$, InP, fluorescence resonance energy transfer.