808 nm Laser irradiated upconversion nanoparticle coated with antimony shell for bioimaging and photothermal therapy *in vitro*

Abstract

Combining treatment and diagnosis, called theranostics, which is achieved within single nanoparticle is an ultimate goal of many studies. Herein, we developed a new nanotheranostic agent − Nd^{3+}-sensitized upconversion nanoparticles core for dual modal imaging (i.e., upconversion luminescence imaging and magnetic resonance imaging) and antimony nanoshell for photothermal therapy (PTT). The core-shell-shell upconversion nanoparticles ($NaYF_4$:Yb,Er@$NaYF_4$:Yb,Nd@$NaGdF_4$:Nd, named as UCNP) were firstly synthesized using thermal decomposition method and then were coated by antimony shell over the surface of UCNP using simple cost and time effective new method. Furthermore, the surface of UCNP@Sb nanostructures was modified with DSPE-PEG in order to enhance the water solubility and biocompatibility. The final nanotheranostic agent, named as UCNP@Sb-PEG, exhibits very low toxicity, good biocompatibility, very good photothermal therapeutic effect, and efficient upconversion luminescence (UCL) imaging of HeLa cells under only one laser (808 nm) irradiation. The antimony shell is quenching the upconversion emission in pristine nanotheranostic agent, but interestingly, the UCL intensity of the agent recovers progressively under 808 nm laser irradiation due to light induced degradability of antimony shell. Besides, high longitudinal relaxivity (r_1) obtained from the experiment approves excellent potential of the nanotheranostic agent for T_1-weighted magnetic resonance imaging application.