

# Engineering upconversion nanoparticles coated with SiO<sub>2</sub> aiming for singlet oxygen generation

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The search for multifunctional luminescent materials with theranostic potential for cancer is currently experiencing exponential growth, as cancer remains the second leading cause of death globally, primarily due to late-stage diagnosis. Notably, such platforms offer the ability to integrate various diagnostic and therapeutic techniques into a single system, rendering them highly promising for clinical applications. Cancer cells can be detected through the measurement of molecular oxygen (<sup>3</sup>O<sub>2</sub>) concentration in tissues, as hypoxic conditions are indicative of pathological processes, including inflammatory diseases, cardiac ischemia, brain disorders, and cancer [1]. Additionally, the generation of singlet oxygen (<sup>1</sup>O<sub>2</sub>) has been strategically utilized as a therapeutic approach in cancer treatment [2]. In this study, upconversion nanoparticles (UCNPs: NaYF<sub>4</sub>:Yb<sup>3+</sup>,Nd<sup>3+</sup>,Tm<sup>3+</sup>@NaYF<sub>4</sub>:Yb<sup>3+</sup>,Nd<sup>3+</sup>) were synthesized via the thermal decomposition method and subsequently coated with SiO<sub>2</sub> (UCNPs@SiO<sub>2</sub>). The core (NaYF<sub>4</sub>:Yb<sup>3+</sup>,Nd<sup>3+</sup>,Tm<sup>3+</sup>) and core-shell (NaYF<sub>4</sub>:Yb<sup>3+</sup>,Nd<sup>3+</sup>,Tm<sup>3+</sup>@NaYF<sub>4</sub>:Yb<sup>3+</sup>,Nd<sup>3+</sup>) nanoparticles exhibited the hexagonal phase (β-phase), as confirmed by comparison with the XRD pattern. The core particles were formed with great size and shape control, exhibiting an average diameter of approximately 21.9±1 nm, as determined by TEM analysis. Following the formation of the shell, the particles adopted an oblate spherical morphology with an average size of 30.3±1.8 nm. The SiO<sub>2</sub> coating was verified through TEM images, and the final UCNPs@SiO<sub>2</sub> nanoparticles were estimated to have a size of 54.6±5.8 nm, demonstrating remarkable stability in aqueous solutions. The UCNPs@SiO<sub>2</sub> nanoparticles exhibited mainly bands in blue emission range under excitation at 808 and 980 nm, originating from the Tm<sup>3+</sup> ion. These blue emissions can be utilized to excite molecules grafted onto the UCNPs@SiO<sub>2</sub> surface, with the aim of enabling oxygen sensing and the generation of singlet oxygen.

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## References

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