

Upconverting Nanoparticles: Energy Transfer with Dye Molecules in Suspensions and Thin Film Systems

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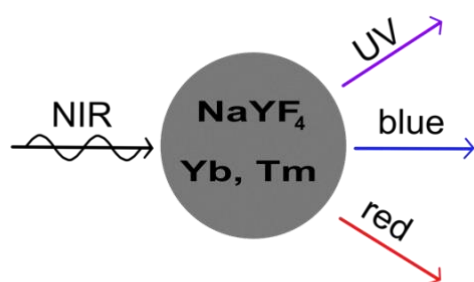
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Recently, nano-scale functional materials have made advancements in many scientific fields: a new revolutionary approach is the application of upconverting nanoparticles (UCNPs) in photodynamic cancer therapy and solar cells.

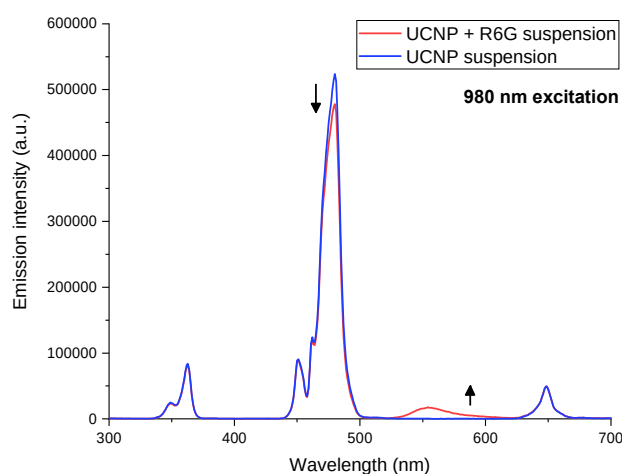
UCNPs show anti-Stokes emissions: under near-infrared excitation photons of higher energy (in the visible and UV range) are emitted (Fig. 1). Furthermore, these emitted photons can later be absorbed by fluorescent dye molecules, which then transfer this energy to a semiconductor nanomaterial, e.g. TiO₂.

NaYF₄ : 20% Yb³⁺, 0.5% Tm³⁺ UCNPs were prepared via solvothermal synthesis. Both ethanolic and water-based suspensions showed intensive anti-Stokes emissions under NIR excitation. UCNP-containing thin-film model systems were prepared on glass substrates by spin-coating using water-based chitosan-matrix. The thin coatings showed significant upconversion emission intensities and energy transfer between the UCNPs and Rhodamine 6G (R6G) molecules was detected.

Experiments on the upconversion induced photodegradation of R6G via titania nanoparticles were conducted: the UCNPs showed energy transfer with both R6G molecules (Fig. 2) and TiO₂ nanoparticles under 980 nm excitation, the photodegradation of the dye molecules was measured with UV-Vis spectroscopy.



1. Figure: The upconversion phenomenon



2. Figure: Energy transfer between UCNPs and R6G molecules