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Review

Lanthanide upconversion nanoparticles and applications in bioassays and bioimaging: A review

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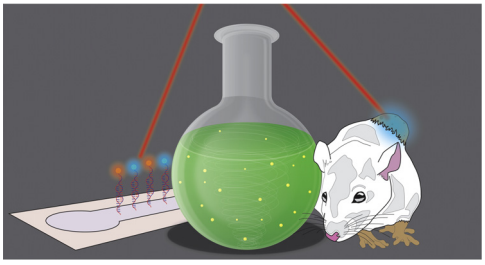
HIGHLIGHTS

- UCNP synthesis and surface modifications, and UC mechanisms and theory are discussed.
- Examples of UCNPs as passive labels and as donors in LRET based assays are described.
- Optical multiplexing capacity of UCNPs for diagnostics and imaging is considered.
- UCNPs are described for use as in vivo biomarkers for multi-modal imaging and theranostics.

GRAPHICAL ABSTRACT



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ABSTRACT

Through the process of photon upconversion, trivalent lanthanide doped nanocrystals convert long-wavelength excitation radiation in the infrared or near infrared region to higher energy emission radiation from ultraviolet to infrared. Such materials offer potential for numerous advantages in analytical applications in comparison to molecular fluorophores and quantum dots. The use of IR radiation as an excitation source reduces autofluorescence and scattering of excitation radiation, which leads to a reduction of background in optical experiments. The upconverting nanocrystals offer excellent photostability and are composed of materials that are not particularly toxic to biological organisms. Excitation at long wavelengths also minimizes damage to biological materials. In this review, the different mechanisms responsible for the upconversion process, and methods that are used to synthesize and decorate upconverting nanoparticles are presented to indicate how absorption and emission can be tuned. Examples of recent applications of upconverting nanoparticles in bioassays for the detection of proteins, nucleic acids, metabolites and metal ions offer indications of analytical advantages in the development of methods of analysis. Examples include multi-color and multi-modal imaging, and the use of upconverting nanoparticles in theranostics.

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Contents

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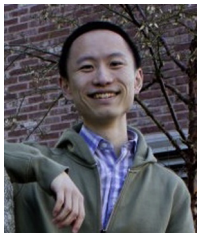

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