

# Accepted Manuscript

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PII: S0165-9936(15)00008-4

DOI: <http://dx.doi.org/doi: 10.1016/j.trac.2014.11.014>

Reference: TRAC 14371

To appear in: *Trends in Analytical Chemistry*



Please cite this article as: Suying Xu, Sheng Huang, Qian He, Leyu Wang, Upconversion nanophosphores for bioimaging, *Trends in Analytical Chemistry* (2015), <http://dx.doi.org/doi: 10.1016/j.trac.2014.11.014>.

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# Upconversion nanophosphores for bioimaging

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## HIGHLIGHTS

- Upconversion nanophosphores show great advantages in bioimaging applications
- Synthesis methods, surface-modification strategies for upconversion nanophosphores
- Upconversion nanophosphores with ultrasmall size and high luminescence
- We summarize recent applications of upconversion nanophosphores in bioimaging
- Challenges for future developments of upconversion nanophosphores in bioimaging

## ABSTRACT

Upconversion nanophosphore (UCNP)-based optical imaging is a promising technique in the field of bioimaging due to the unique optical properties of UCNPs. UCNPs can be excited by long wavelength light with low power density and have excellent biocompatibility. By carefully controlling the synthesis of UCNPs, near-infrared emission can also be obtained. Such NIR-to-NIR bioimaging probes show great advantages in terms of bioimaging, such as deep penetration and low autofluorescence. Moreover, UCNPs can also offer a platform for fabricating multifunctional nanocomposites for multi-modal imaging by incorporating magnetic resonance imaging, X-ray computed tomography and single-photon emission computerized tomography techniques. In this review, we briefly introduce the fundamental points of UCNPs, highlight the methods of synthesis and surface-modification strategies, and summarize recent progress. We also discuss the current issues faced by researchers.

### Keywords:

Bioimaging

Fluorescence

Nanocomposite

Nanoparticle

Nanophosphore

Near-infrared

Optical imaging

Surface modification

Synthesis

Upconversion luminescence

*Abbreviations:* AEP, 2-aminoethyl dihydrogen phosphate; CB, Conduction band; CTAB, Cetyltrimethylammonium bromide; EDTA, Ethylenediamine tetraacetic acid; LSS, Liquid-solid-solution; MRI, Magnetic resonance imaging; NIR, Near-infrared; NP, Nanoparticle; OA, Oleylamine; OCMC, *O*-carboxymethyl chitosan; PAA, Poly(acrylic acid); PEI, Poly(ethylene imine); PET, Positron-emission tomography; PVP, Polyvinylpyrrolidone; UCNP, Upconversion nanophosphores; VB, Valence band; X-ray CT, X-ray computed tomography

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