# Biodegradable inorganic upconversion nanocrystals developed for in vivo applications

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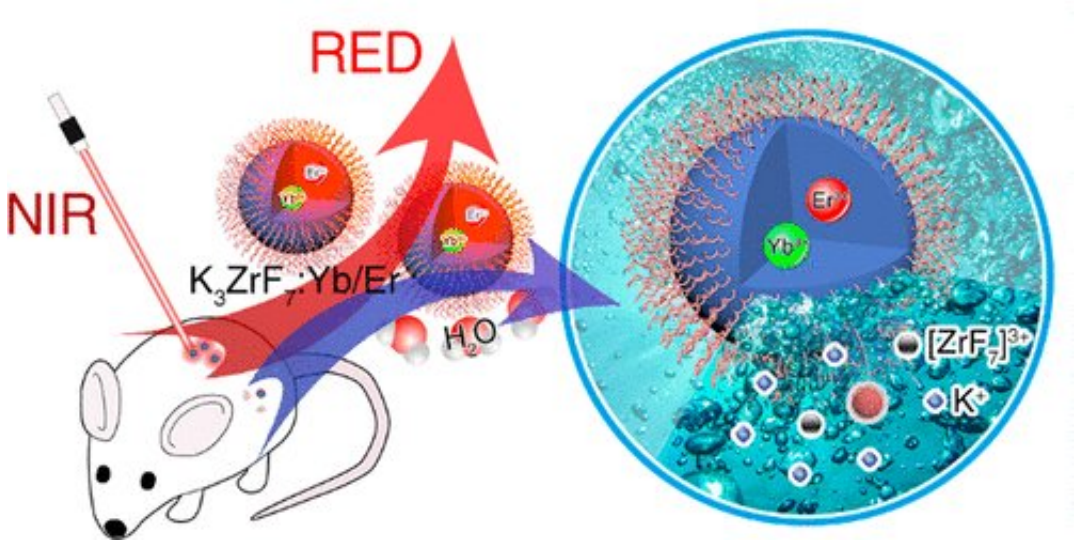


Graphical Abstract. Credit: https://pubs.acs.org/doi/10.1021/acsnano.0c02601

Lanthanide-doped inorganic upconversion nanocrystals (UCNCs) are attracting more attention, as they are potential fluorescent diagnostic and therapeutic agents for in vivo applications including biological imaging and disease theragnostics.

However, all currently available lanthanide-doped inorganic UCNCs, as exemplified by the most presentative *b*-$NaYF_4$:Yb/Er, are not biodegradable and thus cannot be harmlessly eliminated from the body

of living organisms in a reasonable period of time, making their clinical translations nearly impossible.

In a study published in *ACS Nano*, the research group led by Prof. Hong Maochun from Fujian Institute of Research on the Structure of Matter (FJIRSM) of the Chinese Academy of Sciences reported a new class of red-emitting biodegradable UCNCs based on $Yb^{3+}/Er^{3+}$-doped inorganic potassium heptafluozirconate ($K_3ZrF_7$:Yb/Er) that features dynamically "soft" crystal lattice containing water-soluble $[ZrF7]^{3-}$ cluster and $K^+$ cation.

The researchers found that this arrangement of $K_3ZrF_7$ crystal lattice enables the preparation of a family of red-emitting biodegradable inorganic UCNCs after substituted $Yb^{3+}/Er^{3+}$ doping into the high-symmetry host matrix.

In particular, the red-emitting $K_3ZrF_7$:Yb/Er UCNCs exhibit a pH-dependent biodegradation capability upon exposure to water both in vitro and in vivo, and of which the rapid biodegradation rate, monitored by using the intrinsic red upconversion luminescence (UCL), can be tuned by changing the pH value during degradation process.

Through histopathological and elemental analyses, the researchers also found that the final biodegradation products of $K_3ZrF_7$:Yb/Er UCNCs can rapidly excrete from the bodies of mice in a short period of time without evident toxicity to their muscles and main organs, in stark contrast to the non-degradable b-$NaYF_4$:Yb/Er UCNCs that primarily accumulate in the main organs of mice.

This study unambiguously offers an opportunity to produce a family of UCL diagnostic and therapeutic agents that are biodegradable in vivo during a reasonable period of time after carrying out their biological applications, which also stimulate an upsurge of research interest on

biodegradable $Ln^{3+}$-doped inorganic UCNCs for various biomedical applications and benefit their future clinical translations.

**More information:** Pengfei Peng et al. Biodegradable Inorganic Upconversion Nanocrystals for In Vivo Applications, *ACS Nano* (2020). DOI: 10.1021/acsnano.0c02601