

News & Analysis

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Nanoparticle–hydrogel hybrid system could allow for safe and effective drug delivery

Upconversion nanoparticles and cross-linked hydrogels show the potential for photosensitive release deep into tissue

Researchers from Université de Sherbrooke (Québec, Canada) and Simon Fraser University (British Columbia, Canada) have demonstrated the release of large proteins from photosensitive hydrogels loaded with core-shell lanthanide upconversion nanoparticles (UCNPs) using near-IR (NIR) light. The development could have significant biomedical implications, allowing for disease-specific drug delivery deep into patients' tissues while avoiding damage to healthy cells.

“Our approach of using upconversion nanoparticles would enable the use of NIR that has much deeper penetration and are less detrimental to healthy cells than UV or visible light. The wavelength issue has long been known as crucial for biomedical applications.”

The scientists describe the hydrogel as a ‘cage’, able to hide biomacromolecules and shutdown their bioactivity, thus, preventing their interaction with other species until triggered release, where bioactivity is restored. The hybrid UCNP–hydrogel system functions as the nanoparticles convert NIR light into UV light, enabling UV light-induced photoreactions to alter the structure of the hydrogels. Such a demonstration is the first of its kind.

The cross-linked hybrid polyacrylamide–poly(ethylene glycol) structure is held together by photoresponsive *o*-nitrobenzyl groups. When exposed to NIR light, the UCNPs within this

system, which convert as many as five NIR photons into a UV photon, generate the UV light required to cleave the *o*-nitrobenzyl groups, allowing the release of the hydrogels contents.

Yue Zhao, Professor at Université de Sherbrooke and part of the research group, explained to *Therapeutic Delivery*, “The results are very significant because they show that by using UCNPs continuous-wave NIR light from a diode laser can effectively activate photochemical reactions requiring UV and visible light in photosensitive biomaterials. Usually, NIR light from a femtosecond pulse laser is used through two-photon absorption, which is less efficient.”

“Many photosensitive vectors are developed for light-triggered disease-specific drug delivery. They generally require the use of UV or visible light for excitation,” added Zhao. “Our approach of using UCNPs would enable the use of NIR that has much deeper penetration and are less detrimental to healthy cells than UV or visible light. The wavelength issue has long been known as crucial for biomedical applications.”

Zhao states that the group now intends to extend the use of UCNPs for NIR-triggered drug release from other vectors such as microcapsules, microgels and nanoparticles.

– Written by James Potticary

Source: Yan B, Boyer JC, Habault D, Branda NR, Zhao Y. Near-infrared light triggered release of biomacromolecules from hydrogels loaded with upconversion nanoparticles. *J. Am. Chem. Soc.* 134(40), 16558–16561 (2012).

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