

25th Nano Congress for Future Advancements

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12th Edition of International Conference on

Nanopharmaceutics and Advanced Drug Delivery

August 16-18, 2018 | Dublin, Ireland

Fluorescent and T1 MRI active multilayer nanoparticle for imaging and targeting cellular delivery

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Multifunctional plasmonic nanostructures have enormous potential in the treatment of solid tumors, however, tracking particles with drug cargo and triggering the release of the cargo in mapped tumors is still impossible. To overcome this challenge we have developed an MRI and fluorescent active nanostructure nanomatryoshka. This new nanostructure with IR plasmonic signatures is composed of a 50 nm Au core surrounded by dye molecules and Gd(III)-DOTA chelate doped SiO₂ inner-shell and an outer Au shell. The experimental results demonstrates an enhanced T₁ relaxation ($r_1 \sim 24 \text{ mM}^{-1} \text{ s}^{-1}$ at 4.7 T) compared to the clinical Gd(III)-DOTA chelating agents ($r_1 \sim 4 \text{ mM}^{-1} \text{ s}^{-1}$). Further, this design preserves the fluorescence signal (65%) after 24 hours of exposure, leading to enhanced fluorescence photostability (23x). This dual-imaging functionality nanosystem increases MRI sensitivity by concentrating Gd(III) ions into the Gd-NMs, reduces the potential toxicity of Gd(III) ions and dye molecules by preventing their release *in vivo* through the outer Au shell protection, and the terminal gold layer surface can then be functionalized to increase cellular uptake, circulation time, or thermal drug-release properties.

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