Redox-activated magnetic nanocrystal for accurate T1 and T2 multimodal MR imaging of cancer

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T1/T2 dual-mode magnetic resonance (MR) imaging contrast agents have gained considerable attention because they have the ability to improve accuracy by visualization of two complementary data within one instrument. However, most of those nano-platforms are "always ON" regardless of their interaction with biological targets resulting in poor target-to-background signal ratio.
Herein, we introduced an intelligent strategy of paramagnetic relaxation switch (PRS) for dual MR imaging system with enhanced accuracy. Superparamagnetic Fe_3O_4 nanoparticle was synthesized and coated with Mn_3O_4 shell through thermal decomposition method, and consecutively surface-modified with polysorbate 80. The Mn_3O_4 shell acted as not only a protector of core Fe_3O_4 from aqueous environment for attenuation of T2 relaxation but redoxable PRS activated in intracellular environment. The Mn_3O_4 of the nanocrystal was reduced to generate large amounts of Mn^{2+} ions by glutathione (GSH) and allowed interaction of Fe_3O_4 with protons of water simultaneously. We investigated the OFF/ON operation mechanism of PRS according to GSH levels in solution and human cancer cell line, and confirmed efficiently enhanced T1/T2 relaxivity of the particle.