

Chemistry of Contrast Media

Particles and Polymers

Designed Synthesis of Uniform-sized Iron Oxide Nanoparticles for Multifunctional Medical Applications

Taeghwan Hyeon

Seoul National University, Seoul, South Korea

Learning Objectives:

- Colloidal Synthesis of uniform-sized iron oxide nanoparticles
- MRI contrast agent applications of uniform-sized iron oxide nanoparticles
- Assembled uniform-sized iron oxide nanoparticles for theragnostic applications

Recently our group developed several kinds of MRI contrast agents using uniform-sized iron oxide nanoparticles. For example, using 3 nm-sized iron oxide nanoparticles, new non-toxic MRI contrast agent was realized for high resolution MRI of blood vessels down to 0.2 mm, which can be potentially applied to early diagnosis of cancers, stroke, and cardiovascular diseases. 50-nm ferrimagnetic iron oxide nanocrystals (FION) were employed as MRI contrast agents for single cells and transplanted pancreas islets. We prepared Fe₃O₄/TaO_x core/shell nanoparticles for simultaneous MRI and CT imaging. We fabricated tumor pH-sensitive magnetic nanogrenades composed of self-assembled iron oxide nanoparticles and pH-responsive ligands. We successfully visualized small tumors implanted in mice via unique pH-responsive T1 MRI and fluorescence, demonstrating early-stage diagnosis of tumors. Furthermore, pH-triggered generation of singlet oxygen enabled pH-dependent photodynamic therapy to selectively kill cancer cells.

Relevant Publications:

1. Multifunctional Tumor pH-Sensitive Self-Assembled Nanoparticles for Bimodal Imaging and Treatment of Resistant Heterogeneous Tumors, *J. Am. Chem. Soc.* 2014, 136, 5647-5655.
2. High-Resolution Three-Photon Biomedical Imaging using Doped ZnS Nanocrystals, *Nature Mater.* 2013, 12, 359-366.
3. Designed synthesis of uniformly sized iron oxide nanoparticles for efficient magnetic resonance imaging contrast agents, *Chem. Soc. Rev. (Tutorial Review)* 2012, 41, 2575-2589.
4. Large-scale Synthesis of Uniform and Extremely Small-sized Iron Oxide Nanoparticles for High-resolution T1 Magnetic Resonance Imaging Contrast Agents, *J. Am. Chem. Soc.* 2011, 133, 12624-12631.
5. Magnetosome-like ferrimagnetic iron oxide nanocubes for highly sensitive MRI of single cells and transplanted pancreatic islets, *Proc. Natl. Acad. Sci. USA* 2011, 108, 2662.