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Development of monodisperse magnetic porous/hollow nanostructures for biomedical applications

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Recently, studies on therapeutic applications of the magnetic nanoparticles have gained more momentum. The porous/hollow structure also exhibited a great potential to encapsulate small drug molecules. Once inside the porous structures, small drug molecules would be shielded by the shell from fast reaction/deterioration in biological solutions. In our research, monodisperse magnetite Fe_3O_4 porous/hollow nanoparticles were successfully synthesized through one-pot solvothermal process without any surfactant and template as shown in Figure The Fe_3O_4 porous/hollow nanoparticles consisted of numerous tiny grains. Those particles were ferromagnetic with high saturation magnetization. The Fe_3O_4 porous/hollow nanoparticles were synthesized controllably with tunable particle size and porosity by adjusting the initial concentrations of Fe precursor and ammonium acetate. The formation mechanism of the magnetite hollow spheres comprised simultaneous chemical and physical processes including the formation of numerous tiny grains, the spherical assembly of those grains and the chemical conversion coupled with the relocation of the grains. The chemical conversion including a partially reductive reaction of the Fe (III) compounds and subsequent hydrolysis and dehydrolysis reactions of the Fe (III) and Fe (II) compounds to generate Fe_3O_4 caused the non-uniformities of tiny grains and the empty spaces within the spherical assemblies and thus enhanced the outward migration and relocation of the core grains toward the outer layer, resulting in the formation and expansion of the hollow core structure. The porous/hollow nanoparticles could be further coupled with a specific targeting agent and be concentrated around the area of interest, where drug molecules would be released either chemically via a pH control or physically through a magnetic stimulation and activation. Such a controlled drug release warranted the multifunctional porous/hollow nanoparticles a new class of carriers for simultaneous diagnostic and therapeutic applications.

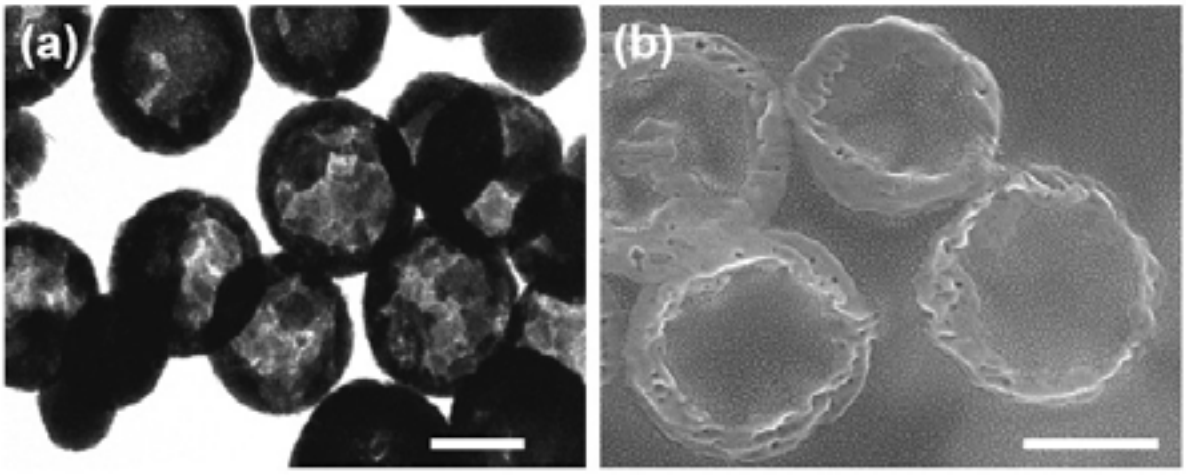

Figure: Representative (a) TEM image and (b) SEM image for the cross-section of the Fe_3O_4 porous/hollow nanospheres.

Recent Publications

1. Nguyen D T and Kim K S (2013) Template-free synthesis and characterization of monodisperse magnetite hollow nanoparticles through solvothermal process. J Nanosci Nanotechnol. 13(8):5773-5776.
2. Nguyen D T, Park D W, Kim T and Kim K S (2013) Controlled synthesis of magnetite porous/hollow nanoparticles through a template-free solvothermal process. J Nanosci Nanotechnol. 15(1):591-594.
3. Nguyen D T and Kim K S (2013) Analysis on development of magnetite hollow spheres through one-pot solvothermal process. AIChEJ. 59(10):3594-3600.

4. Nguyen D T, Charinpanitkul T, Park D W and Kim K S (2013) Preparation of magnetite hollow structure for drug delivery application. J Nanosci Nanotechnol. 14(10):7995-7999.
5. D T Nguyen and K S Kim K.-S (2015) Structural evolution of highly porous/hollow ZnO nanoparticles in sonochemical process. Chemical Engineering J. 276:11-19.

Biography

Kyo-Seon Kim is a Professor of Chemical Engineering at Kangwon National University, Chuncheon, South Korea, where he has been working since 1989. He has completed his BS, MS and PhD degrees in Chemical Engineering at Seoul National University, KAIST and University of Cincinnati, OH, USA in 1979, 1981 and 1989, respectively. His research interests are mainly focused on preparation and modification of nanoparticles for high-functional performances. The main applications of nanoparticles in his researches are in the fields of air pollution control, energy harvesting and development of medical devices.

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