DOI: 10.1017/S1431927605504689
Microsc Microanal 11(Suppl 2), 2005

Magnetic Hollow Silica Nanostructures

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Magnetic nanoparticles with properties of superparamagnetism, high saturation magnetization, high magnetic susceptibility and low toxicity, have been studied broadly for applications in biology and medicine. Magnetic nanoparticles are usually prepared in diamagnetic carriers to enhance biocompatibility and prevent their natural tendency of aggregation. Magnetic hollow silica nanocomposites, however, are of special interests since they have unique properties, such as large surface area, hollow cores, and magnetism. In this paper, we present a novel synthetic route for magnetic hollow silica nanostructures.

Spherical and needle-like calcium carbonate nanoparticles were synthesized by a high gravity technique. Magnetic hollow silica nanostructures were synthesized via a sol-gel method by using nanosized calcium carbonate as a sacrificial template, and Fe3O4 nanoparticle and tetraethoxysilane (TEOS) as precursors. As-synthesized magnetic hollow silica nanostructures were examined using a LEO 1530 VP field emission scanning electron microscope (FESEM) and JEOL 2010 transmission electron microscope (TEM) equipped with EDAX energy dispersive spectroscopy (EDS).

Fig.1 (a) and (b) show FESEM images of magnetic hollow silica nanospheres and nanotubes, respectively. It can be seen that magnetic hollow silica nanospheres (MHSNS) and magnetic hollow silica nanotubes (MHSNT) have well-defined spherical- and tubular- like shapes. Both single and aggregated MHSNS can be found in the yielded product as shown in TEM images of Fig.2 (a) and (b), respectively. The silica hollow nanospheres have a diameter of 25-60 nm with a shell thickness of about 10 nm. Fe_3O_4 nanoparticles with a diameter of 10 nm are mostly embedded in the silica shells, which gives the hollow silica nanospheres magnetic properties. A high resolution TEM image of magnetite nanoparticles is shown in Fig.2(c), indicating that the nanoparticles still keep the crystal structure even after weak acid and heat treatment. The MHSNT are shown in Fig.2(d). Most of the nanoparticles are embedded in the shells, however, few stick on the surface. By tilting a nanotube to edge-on orientation, the magnetite nanoparticles were easily found embedded inside the shells as shown in Fig. 2(e). It is expected that MHSNS and MHSNT can be exploited as delivery vehicles and supports in bioscience and nanomedicine.

References

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[3] We gratefully acknowledge the support of this work by the Advanced Materials Research Institute through the DARPA Grant No. HR0011-04-C-0068.

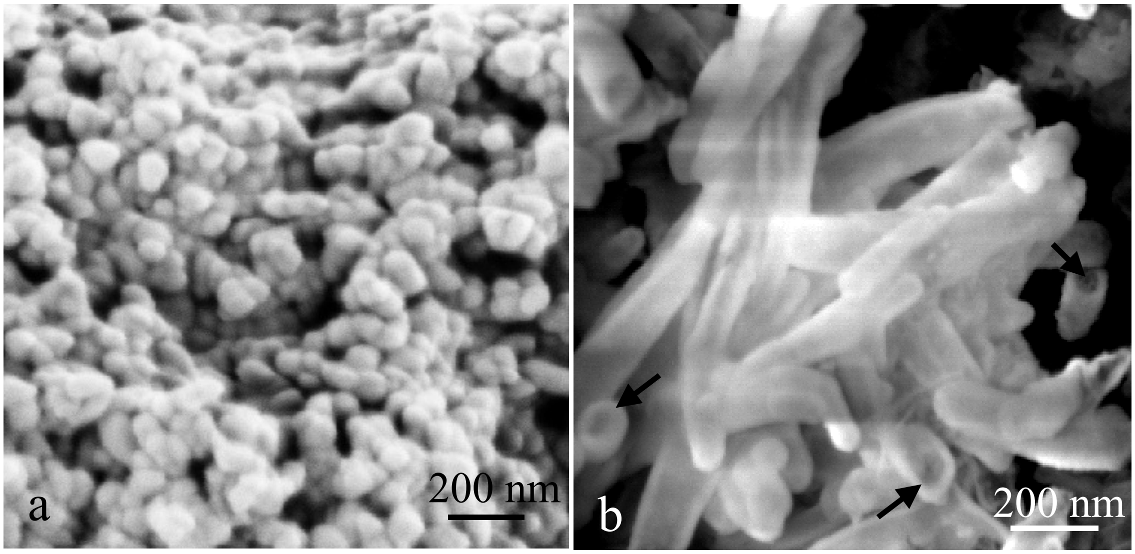

Figure 1 FESEM image of (a) MHSNS and (b) MHSNT. The surfaces are smooth and few magnetic nanoparticles are seen on the surfaces.

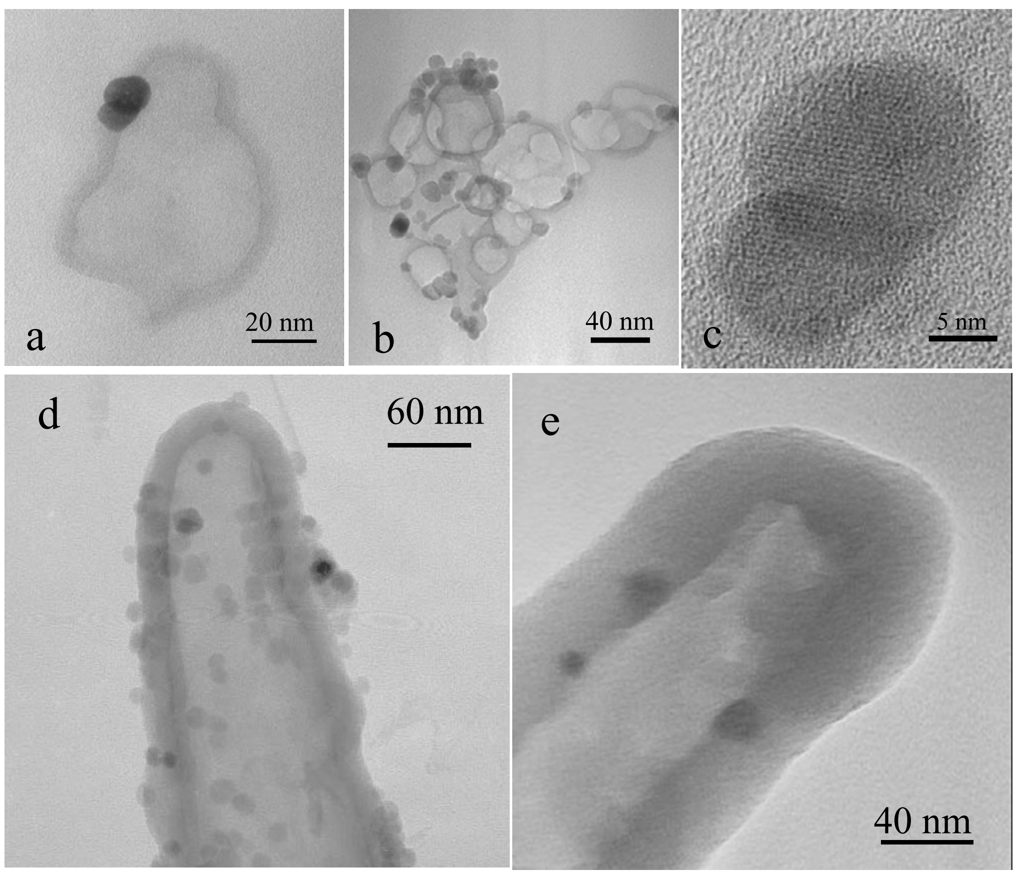

Figure 2 TEM images of (a) single MHSNS, (b) aggregated MHSNS, (c) Fe_3O_4 magnetic nanoparticle lattice, (d) a MHSNT, and (e) a MHSNT at edge-on condition.

https://doi.org/10.1017/S1431927605504689 Published online by Cambridge University Press