Fabrication and characterization of magnetic particles via hydrothermal synthesis

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1. Introduction

Ironoxide(Fe_3O_4) have attracted considerable attention due to their potential applications in the field of drug delivery carrier[1], lithium-ion batteries[2] and catalysis[3]. Magnetite Fe_3O_4 has become a particularly interesting research target due to it slow cost, good biocompatibility, as well as outstanding stability in physiological conditions.

Up to now, a variety of methods have been developed to prepare Fe_3O_4, including sol–gel method, co-precipitation. Compared with the abovemethods, hydrothermal method hasinterest owing to low cost, good biocompatibility and outstanding stability in physiological conditions.

This paper reports the growth of magnetic Fe_3O_4 particles from iron powder (spherical, <10 micron) through a alkaline hydrothermal process. We observed an interesting role of KOH on the formation of magnetite octahedron[4].

2. Method

Both Fe powder (99% purity, <10 micron) and potassium hydroxide KOH (85% purity) used in this experiment were of analytical grade without further purification. Typically, Fe powder(1.4g), 1-10 μm in diameter, were dispersed in separate 100mL KOH aqueous solutions of three concentrations: (1) 0.125 (2) 0.625 (3) 1 mol/100mL. The solutionwas then sealed into a Teflon-lined stainless-steel autoclave and kept at 180℃ for 24 h(with different times). Then, the autoclave was allowed to cool at room temperature naturally. The productwas washed with deionized water several times until the filtrate pH 7. The obtained particles were then driedunder vacuum at 50℃for 12 h.

3. Results and discussion

Fig. 1 shows the XRD patterns of both raw iron powder and as-grown products prepared under different KOH concentrations at 180℃ for 24 h, illustrating the diffraction peak intensities of the Fe_3O_4 and iron. The peak intensities of Fe_3O_4 remarkably increased while that of iron decreased with increasing KOH concentration.

Fig. 2 shows SEM images of raw iron powder and as grown products prepared under different KOH concentrations. Fig. 2(a), the morphology of raw iron powders does not appear so uniform. The as-obtained products were spherical in morphology. Fig. 2(c), shows the representative morphology of Fe_3O_4 octahedrons prepared under KOH concentration of 0.625mol/100mL, revealing their smooth surfaces.

Fig. 3 shows the magnetic curves of the Fe powder and magnetite Fe_3O_4. Fig. 1(a) show the values of saturations magnetization is 204.87 emu/g. As shown in Fig. 3 (b), (c), (d), the values of saturations magnetization decrease to 109.23, 97.12 and 90.97 emu/g, respectively.

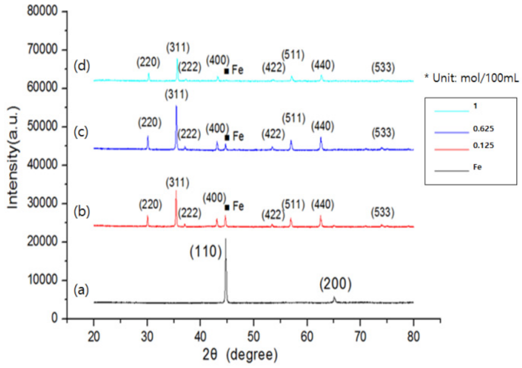

Fig. 1. XRD patterns of (a) Iron powder and Fe_3O_4 powder grown in KOH of concentrations: (b) 0.125 (c) 0.625 (d) 1 mol/100mL.

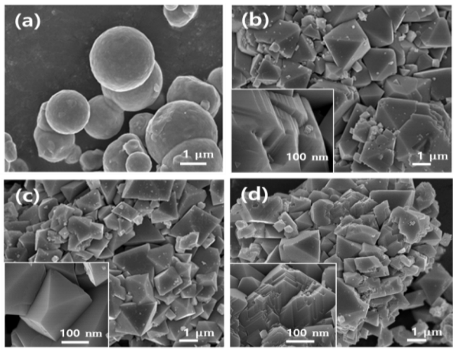

Fig. 2. SEM images of (a) Iron powder and Fe_3O_4 grown in KOH solutions of different concentrations: (b) 0.125 (c) 0.625 (d) 1 mol/100mL.

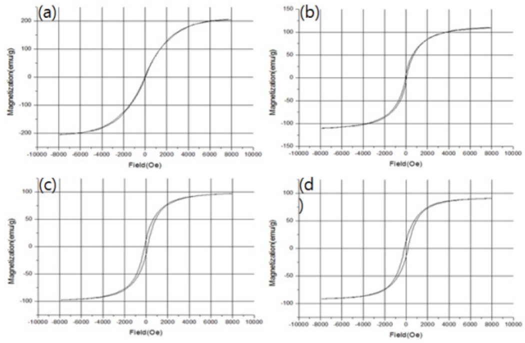

Fig. 3. Magnetic hysteresis loops of (a) Iron powder and Fe_3O_4 grown in KOH solutions of different concentrations:(b) 0.125 (c) 0.625 (d) 1 mol/100mL

4. Conclusions

Micrometer-scale octahedral Fe_3O_4 crystals were grown directly from iron powder via a hydrothermal process.(1) we were experimented with different KOH Molar concentration at the same hydrothermal time and (2) different KOH Molar concentration at the different hydrothermal time. It was found that KOH concentration plays an important role in the formation of magnetite octahedrons. The as-prepared particles(good crystalline, 0.625mol/100mL) exhibited a relatively high saturation magnetization of bulk magnetite(Ms:96.7emu/g).

5. References

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