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Preparation of iron nanoparticles with $Fe(CO)_5$ at low temperature

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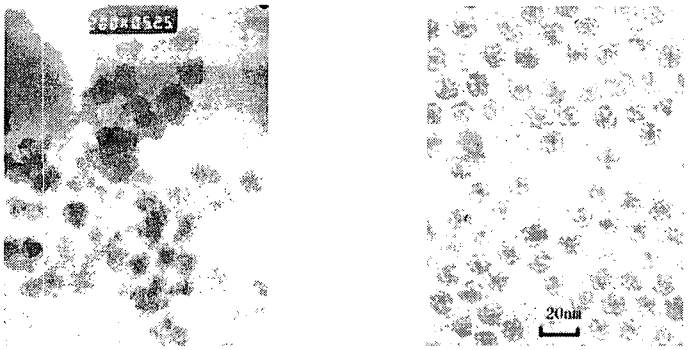
Introduction Magnetic metal nanoparticles have been intensively studied in recent years because of their novel physical and chemical properties [1-2], especially to the magnetic properties and application potential in data records and storage. Among these magnetic metal materials, iron nanoparticles have a role of outstanding magnetic properties and important industry application until present, iron nanoparticles have been prepared by several methods such as, chemical vapor deposition (CVD) [3]; sonochemistry [4,5]; chemical vapor condensation [6] and boron hydride reduction and freeze drying; reverse micelles [7-8]. In this study, the iron magnetic nanoparticles were synthesized by thermal decomposition method at low temperature. These particles were characterized by XRD, TEM and VSM. The results show that the size is about 10 nm. The hysteresis curves show that the coercive field Hc is 121.05 Oe and the saturation magnetization is 91.92 emu/g.

Experimental method In this study, 90 ml kerosene and a certain amount surfactant were heated in a 250 ml three-neck distillation flask until 160 °C, and then 5g-iron carbonyl was added into the heated solution. The reaction was continued for 60 min. at 160 °C, and then it was cooled to room temperature. Prior to heating, the system was flushed with high-purity N_2 gas for 8 ~ 10 min to eliminate O_2. The high purity N_2 gas was introduced to the system during heating and cooling process. The prepared particles were washed with n-hexane or acetone and then dried in vacuum. The particles were characterized by X-ray diffraction (XRD), Vibrate Sample Magnetometer (VSM) and Transmission electron microscopy (TEM).

Results and Discussion Figure 1 (a) shows that the TEM image of iron particles after decomposing 15 min under without surfactant, and Figure 1(b) is after decomposing 60 min with coating surfactant. It is very obviously that in the case of without surfactant, the particles agglomerated together and the agglomerated size is about 20 nm. While the coated particles with surfactant are uniform spherical shape and the size is about 10 nm. Also the shape and size of the iron particles are varied with depending to the $Fe(CO)_5$ and surfactant concentrations, temperature and reaction time.



(a) (b)

Fig. 1. TEM images of the synthesized iron nanoparticles.

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Figure 2 shows that the X-ray diffraction pattern of the iron particles synthesized without surfactant. The result shows that all the peaks were iron structure and not extra peaks of iron oxides. Figure 3 shows that the magnetic hysteresis loops of iron particles by vibrating sample magnetometer. The coercive force is 121.05 Oe and the saturation magnetization is 91.92 emu/g.

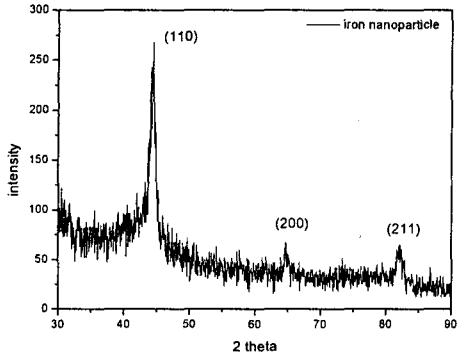

Fig.2. XRD pattern of the iron nanoparticles.

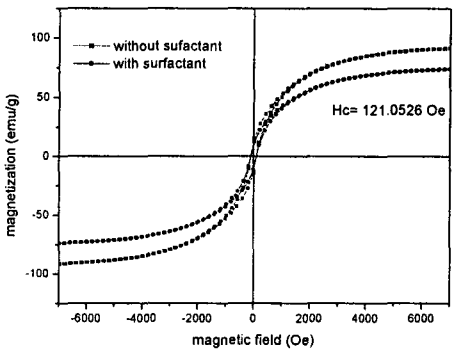

Fig.3. Hysteresis curves of the iron nanoparticles.

Conclusion Iron nanoparticles were successfully synthesized by thermal-decomposition method using iron carbonyl as a precursor under N_2 atmosphere at 160 °C. The particles are homogeneous spherical shape and the average size is about 10 nm. The magnetic coercive force, Hc is 121.05 Oe, the saturated magnetization is 91.92 emu/g.

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