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Co nanoparticle synthesis by thermal decomposition of non-toxic cobalt acetate

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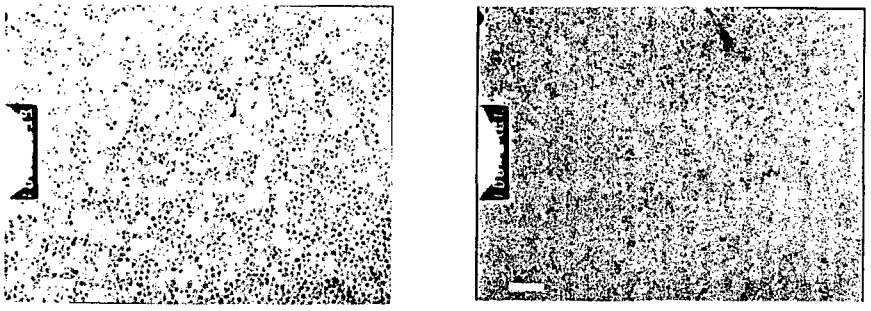
Introduction Transition metal (Fe, Co, and Ni) nanoparticles have found wide applications in catalysts, solar energy absorption, and magnetic recording. Of the three transition metals that are normally ferromagnetic, the nanoparticles of pure cobalt probably have special significance in both theory and technology, because they have uniaxial hexagonal close-packed structure besides face-centered cubic structure [1]. A variety of methods have been developed to prepare the cobalt nanoparticles: reverse micelles [2], chemical vapor condensation [3], reduction [4,5], ion-exchange [6] and thermal decomposition [7], etc. For the thermal decomposition method, $Co_2(CO)_8$ was commonly selected as a precursor. However, this has critical disadvantages such as higher price and acute toxicity. The objective of the present study is to synthesize Co nanoparticles from cheap, non-toxic cobalt acetate by the thermal decomposition.

Experimental A reactant of 0.294g $Co(CH_3COO)_2$ was first dissolved into 35 ml trioctylamine in a 250 ml three-neck distillation flask. Then a certain amount surfactants, trioctylphosphine (TOP) and oleic acid, were added into the solution. After flushed with high-purity N_2 gas for 10 min to eliminate O_2, the flask was heated to 260 °C for 120 min, and then cooled to the room temperature. The high purity N_2 gas was introduced to the flask during heating and cooling processes. The prepared particles were washed with n-hexane or acetone and then dried in vacuum. The particles were characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD), and vibrating sample magnetometer (VSM).

Results and Discussion Cubic Co nanoparticles of 10-12 nm in their size were produced by the thermal decomposition as shown in Fig. 1(a). The particle size distribution was very uniform. When these nanoparticles were irradiated by ultrasonic (210W, 20 kHz) for 10 min, the particle size decreased to 6-8 nm as shown in Fig. 1(b). Figure 2 shows XRD pattern of these cobalt nanoparticles coated with TOP and oleic acid demonstrating that all the peaks corresponded to the cobalt structure. The peaks of the particles irradiated by ultrasonic was lower and wider than those of as-prepared particles.



(a) as-prepared by thermal decomposition (b) ultrasonic irradiated

Fig. 1. TEM images of the cobalt nanoparticles synthesized from cobalt acetate.

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Figure 3 shows the magnetic hysteresis loop of the as-prepared particles measured by the VSM. The coercive force and the saturation magnetization were 67.2 Oe and 53.8 emu/g, respectively. Although the particle size was rather small, still these particles have non-zero coercive force; while much lower than that (190.3 Oe) of the cobalt particles prepared from $Co_2(CO)_8$ [8]. The particle size of the latter ranged from 30 to 40 nm.

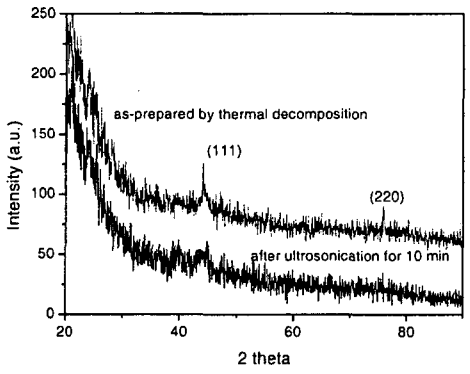

Fig. 2. XRD pattern of the cobalt nanoparticles.

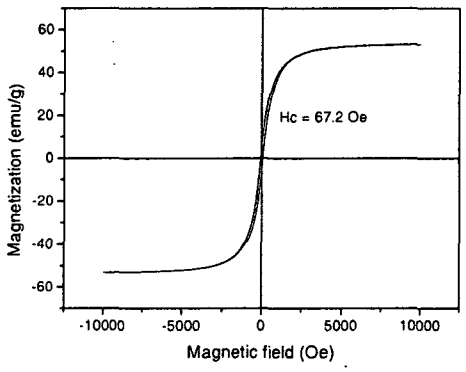

Fig. 3. Magnetization curve of the cobalt nanoparticles.

Conclusion Cobalt nanoparticles were successfully synthesized by thermal decomposition of cobalt acetate as a precursor, which is very cheap and non-toxic. We could also control the particle size by irradiating ultrasonic to the as-prepared particles. The non-zero coercive force might enable these cobalt nanoparticles to be used as magnetic storage media.

References

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