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Synthesis of Novel monodisperse Cobalt nanoparticles using cobalt acetate

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Introduction

Magnetic nanoparticles (MNPs), such as Fe, Co, Ni etc, have been the focus of an increasing among researchers of various fields due to their promising applications in high-density magnetic recording and biomedical (MRI), and drug delivery, etc., in recently years. Especially, cobalt nanoparticles exhibit a variety of structural, magnetic, electronic, and catalytic properties depending on their size and crystalline structure. Their high coercivity finds the application in magnetic recording media. With decreasing nanoparticle size, saturation magnetization was sharply dropped due to the increase in the surface-to-volume ratio and the presence of cobalt oxide layer on the particle surface [1,3].

Cobalt nanoparticles have been synthesized by varieties of methods including gas vapor condensation, grinding, chemical vapor condensation, reverse micelle technique, reduction of cobalt salts, and thermal decomposition [4-10]. To apply nanoparticles in various potential devices, it is very important to control the size and shape and to keep the thermal and chemical stability of the nanoparticles. In this study, trioctylphosphine (TOP) was as the parameter surfactant to control the novel cobalt nanoparticles. And the 1,2-dodecanthiol was also as activity used to accelerate the cobalt particles forming.

Experimental

Cobalt acetate (0.5g) as a precursor was dissolved in 40 mL trioctylamine mixed together with 1,2-dodecanthiol and various surfactants: Oleylamine, oleic acid, and trioctylphosphine. In addition, polyvinylpyrrolidone was added as a supplemental reagent. The mixed solution placed in a four-neck distillation flask was heated up to 280 °C for 60 minutes while high purity N_2 was flushing through the flask to eliminate O_2. The particles synthesized were washed with n-hexane and acetone (99.99%) in vacuum before characterization by atransmission electron microscope (TEM), X-ray diffractometer (XRD) and vibrate sample magnetometer (VSM).

Results and discussions

Fig. 1(a) and Fig. 1(b) show TEM images of Co nanoparticles synthesized in the absence of TOP and with 2 ml TOP, respectively. In the absence of TOP, triangular-prism-shaped nanoparticles of about 50 nm in average size were produced (Fig. 1a). This implies that the mixture of surfactants and reductant suppressed the particle growth along certain directions. As TOP was injected into the reactor, the particle size dropped to about 10 nm in average size; while spherical, prism-like, and some irregular shapes coexisted (Fig. 1b). This significant effect of TOP on the particle size may be attributed to its greater steric dimension (e.g., bulkier than tributylphosphine), slowing down the particle growth to reduce the size. Puntes et al. used a surfactant mixture of TOP and oleic acid to modulate the relative growth rates of different faces, yielding cobalt nanodisks [3].

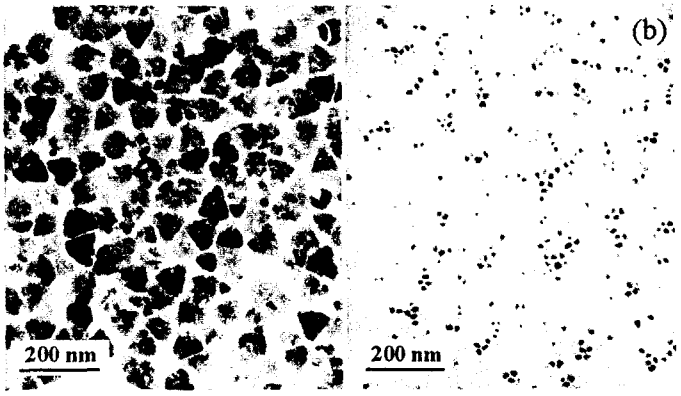

Fig. 1 TEM images of Co nanoparticles with different concentration of TOP. (a) 0 ml; (b) 2 ml.

The XRD pattern of the prism-like particles as shown in Fig. 2 revealed that these particles had hexagonal crystalline structure, possessing higher magnetocrystalline anisotropy than the other phase. Figure 3 shows magnetic characterization of cobalt nanoparticles. It is very obviously that the prism-like particles passes more large coercive force than another.

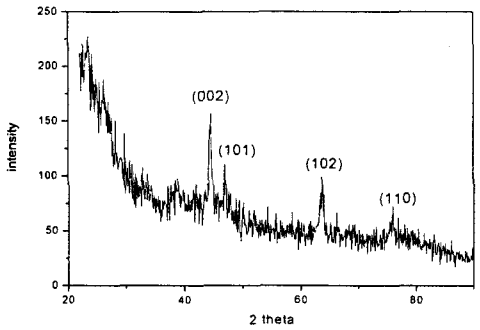

Fig. 2 XRD pattern of Co nanoparticles without TOP.

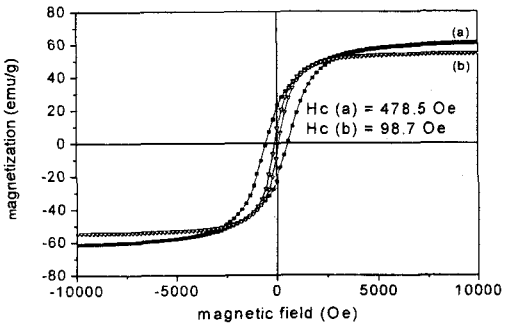

Fig. 3 Magnetic hysteresis of Co nanoparticles.

Conclusion

Triangle-prism-shape cobalt nanoparticles were synthesized from cobalt acetate by thermal decomposition method. The particle size displays equally about 50 nm without TOP and 10 nm with 2 ml TOP. The Co nanoparticles show hexagonal crystalline structure agreement with particles' XRD pattern. The two saturated magnetization and coercivity is 61.1, 54.5 emu/g and 478.5, 98.7 Oe, respectively.

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