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## Co existence of fcc and hcp crystalline structures in cobalt nanoparticles

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**Introduction** The synthesis of magnetic nanoparticles with controlled size and composition is of fundamental and technological interest. The effort to understand the physics of these structures has been paralleled by attempts to exploit their beneficial properties. Progress in ultrahigh-density magnetic recording is due in part to the development of metal thin film media with smaller particles, narrower size distributions, and optimized compositions [1]. Cobalt nanoparticles display a wealth of size-dependent structural, magnetic, electronic, and catalytic properties. In particular, the exponential dependence of the magnetization relaxation time on the particle volume has spurred intensive studies of Co nanoparticle synthesis for magnetic storage purposes [2]. Anisotropic cobalt nanoparticles have attracted great interest owing to their high saturation magnetization [3]. Although a variety of methods have been developed to prepare the cobalt nanoparticles such as reverse micelles [4], chemical vapor condensation [5], reduction method [3,6], and thermal decomposition method [2], it is still required to further improve their magnetic properties for practical applications. In this study, we aimed to synthesize Co nanoparticles having higher magnetization and coercive force by thermal decomposition of a precursor, cobalt carbonyl.

**Experimental** A precursor of 0.368 g Co2(CO)8 and a surfactant of 0.5 ml oleylamine (0.04 M) were dissolved into 35 ml trioctylamine in a 250 ml three-neck distillation flask. The flask was flushed with high-purity N2 gas for 10 min to purge oxygen. Then, the reactor was heated to 182 ℃ for 90 min. The high purity N2 gas was introduced to the reactor during the whole process of reaction. The prepared particles were washed with n-hexane and 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** Figure 1(a) shows the TEM image of cobalt particles synthesized by decomposition in the absence of any surfactant, while Fig. 1(b) showing that prepared in the presence of the surfactant. In the absence of a surfactant, particles agglomerated together to result in their agglomerate size of about 300-400 nm. Around these agglomerated particles, some small individual particles were also observed in Fig. 1(a). As the surfactant oleylamine was added into the reactor, the individual particles were not agglomerated due to the coating layer of the surfactant on the particle surface as shown in Fig. 1(b). These isolated particles seemed to have bimodal size distribution: larger particles ranged from 30 to 40 nm while smaller a few nm in their size. The larger particles might form by the growth of the smaller particles via coagulation. The smaller particles can be regarded as nuclei formed in the beginning of the reaction, and some of them did not coagulate probably due to interference of the surfactant at a rather high concentration.

The XRD peaks of the particles coated with the surfactant show the coexistence of face centered cubic and hexagonal close packed crystalline structures of the cobalt (Fig. 2). This structure may be in favorable for higher coercive force of magnetic materials. Figure 3 shows the magnetic hysteresis loop of the Co nanoparticles prepared in the presence of the surfactant measured by the VSM. The coercive force and saturation magnetization were estimated at 190.3 Oe

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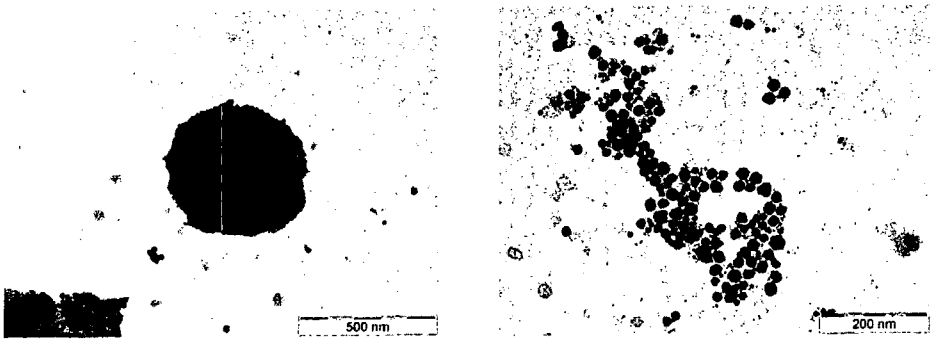
and 113.1 emu/g, respectively. This rather large coercive force makes these particles suitable for the magnetic storage media.




(a) no surfactant added (b) with the surfactant

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

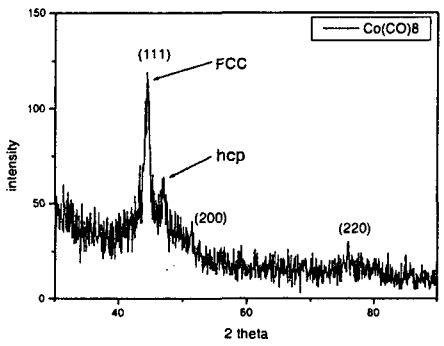



Fig. 2. XRD pattern of Co nanoparticles.

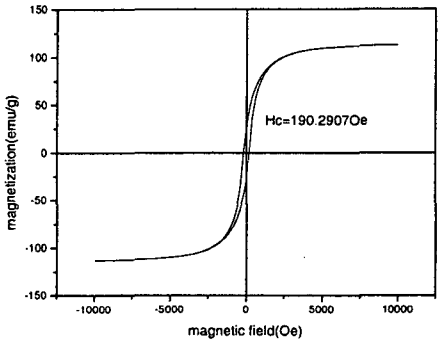



Fig. 3. Magnetization curve of Co nanoparticles.

**Conclusion** Magnetic cobalt nanoparticles were successfully synthesized by thermal decomposition of $Co_2(CO)_8$ in the presence of a surfactant. The coexistence of fcc and hcp structure and somewhat larger particle size might lead to a high coercive force, which is favorable for the application in magnetic storage media.

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