Synthesis of monodisperse cobalt ferrite ($CoFe_2O_4$) nanoparticles using thermal decomposition method

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Introduction

Because of their interesting properties like electric, catalytic, and optical properties, magnetic, many researchers have paid attention for synthesis of magnetic nanoparticles. For the device application, the technology of controllable nanoparticles is an important issue, especially its size control and self-assembles. Many research groups have studied these topic and we also focused on how to easily select nanoparticles in uniform size and disperse with organic solvent. In case of organic solvent, ethanol and hexane being widely used in cleaning and dispersion.

Experimental

Iron(Ⅲ) acetylacetonate (0.5 mmol), cobalt(Ⅱ) acetylacetonate (0.25 mmol), benzyl ether (20 ml), oleic acid (1 ml), and oleylamine (1 ml) were mixed and mechanically stirred. The mixture was heated to 290 ℃ for 90 min. The mixture was cooled down to room temperature and cleaned with organic solvent. After centrifuging with organic solvent, the brown solution was removed and $CoFe_2O_4$ nanoparticles were obtained.

Results and discussion

$CoFe_2O_4$ nanoparticles were characterized by EDS, XRD, TEM and VSM. EDS element analysis of $CoFe_2O_4$ nanoparticle reveal a presence of Co, Fe and O. XRD peaks shows the strongest and clearest intensity. XRD pattern resulted from Size selection of nanoparticles. It is mean that we could obtain uniformly sized and highly crystallized nanoparticles selectively from hexane-hexane treatment.

TEM images showed size of nanoparticles and dispersion. images showed various size distribution of nanoparticles with some aggregation. So average of nanoparticles diameter is each 20.3 nm, 19.58 nm, 19.84 nm. On the other hand, image of size selected sample shows uniformed size distribution of nanoparticles around 13.5 nm and monodispersion.

VSM showed magnetic properties of $CoFe_2O_4$ nanoparticles. The saturated magnetization of size selected $CoFe_2O_4$ nanoparticle is commonly 37.12 emu/g. but saturated magnetizations of another samples as they have 40.21 emu/g, 39.87 emu/g, 40.01 emu/g are significantly larger than size selected $CoFe_2O_4$ nanoparticle. Because the saturated magnetizations of nanoparticles decrease when specific effective size of nanoparticles decrease. Therefore size selected $CoFe_2O_4$ nanoparticle has the smallest saturation magnetization.

Conclusions

Size selection and monodispersion of $CoFe_2O_4$ nanoparticles have been synthesized using facile thermal decomposition method. Different analysis techniques of TEM, XRD, and MPMS were used to fully characterize the synthesized ferrite nanoparticles. The simple thermal decomposition approach adopted in our work seems to be a promising route for synthesis of various magnetic nanoparticles with monodispersion and uniform size distribution.