Fabrication of oxide nanoparticles using oxidation of magnetic alloys in polyimide

Sung K. Lim, Keum Jee Chung, Young-Ho Kim, C. K. Kim and C. S. Yoon[1,*]

[1] Department of Materials Science and Engineering, Hanyang University, Seoul, 133-781, Korea

*Corresponding author: e-mail: csyoon@hanyang.ac.kr, Phone: +82 2 2290 0384, Fax: +82 2 2290 1838

Oxide nanoparticles embedded in a polyimide (PI) matrix was fabricated by oxidizing a layer of $Ni_{80}Fe_{20}$ ($Co_{80}Fe_{20}$) metal film sandwiched between two PI precursor layers. Oxide nanoparticles nucleated in the PI matrix as a by-product of the imidization process. The 3.5 nm-thick $Ni_{80}Fe_{20}$ film was converted into a mono-layer of NiO oxide particles whose average size was 4.5 nm in diameter. When the metal film thickness was above 3.5 nm, a continuous layer of the metal film was found with selectively oxidized regions along the grain boundary. Similar observation was previously made when the γ-Fe_2O_3 particles were produced using the same reaction [1,2]. In case of the $Co_{80}Fe_{20}$ thin film, the oxide particles were composed of Co_3O_4 with spinel structure. These Co_3O_4 particles were, however, rather irregularly shaped with a wide size distribution whereas the NiO nanoparticles had spherical shapes with much narrower size distribution. X-ray photoelectron spectroscopy of oxide nanoparticles showed that the particles had a varying degree of metallic residue, suggesting that these nanoparticles could have metallic cores, surrounded by an oxide layer. Comparing with the γ-Fe_2O_3 particles produced using the same procedure, relatively larger amount of metallic residue was detected from the NiO and Co_3O_4 particles, which explains the higher magnetic moment measured from the NiO and Co_3O_4 particles.

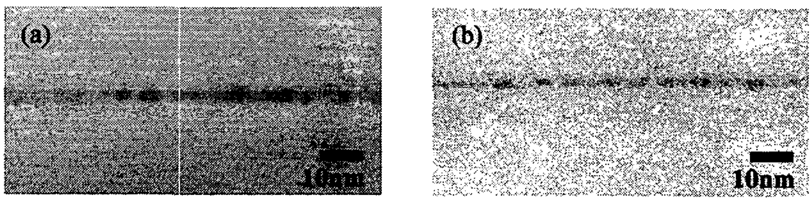

Fig 1. Cross-sectioal TEM images of the nanoparticles: (a) NiO, (b) Co_3O_4

References

[1] Sung K. Lim et al., J. Colloid Interface Sci.(in press)

[2] Y. M. Chiang et al., Physical Ceramics (John Wiley & Sons, Inc., NewYork, 1997), p. 368.