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Structure and Magnetic Properties of Carbon-encapsulated Ni Nanoparticles

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The synthesis of the carbon encapsulated Ni nanoparticles has attracted much attention, because of the technological potential applications such as magnetic storage media, ferrofluids to biomedical application [1]. Recently, the carbon-encapsulated magnetic nanoparticles have mainly focused on the preparation method and characterization of nanocomposites. Various physical methods have been utilized successfully for their production. Compared with other methods, the levitational gas condensation (LGC) method is simple, cheap, and easy to implement. In this study, the novel synthesis and magnetic properties of the relatively stable carbon-encapsulated Ni nanoparticles have been demonstrated. The carbon encapsulated Ni nanoparticles were synthesized by a LGC method [2].The starting material was the micron powders of Ni with a size range from 100 to 500 μm. The amount of micron powder fed into the liquid drop-let of seed was controlled at 80 mg/min. The mixed Ar and CH_4 gas pressure in chamber was 84 torr. The morphologies of the carbon-coated Ni nanocrystallites were characterized by transmission electron microscopy (TEM) as shown in Fig. 1. The results indicated that all of the as-made materials were composed of only nanocapsules with the uniform particle size at and below 10 nm. The nanocapsules consisted of outer multi-shells of carbon.

The magnetization curve was measured at room temperature. The hysteresis loop demonstrated that the carbon-coated Ni nanocrystallites exhibited a superparamagnetic behavior at room temperature. The coercive force (Hc) and the magnetization (M) were 76.6 Oe and 19.6 (emu/g), respectively.

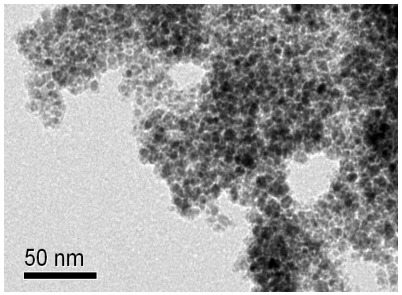

Fig. 1. TEM image of carbon encapsulated Ni.

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Formation of Ni-Co-P Nanogranular Layer on Plate-like Fe-Al-Si Particles via Electroless Deposition Route and Its Effect on the Magnetic Properties

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The electroless deposited soft magnetic films with high saturation magnetization have been recently studied because of their superior overwrite performance [1-3]. In order to apply the ferromagnetic materials to high frequency devices, it is neccessary to understand the dependence of magnetic properties on the microstructure, phase, and thickness of their magnetic materials. For this study, formation of a Ni-Co-P nanograular layer on plate-like Fe-Al-Si alloy particles through the electroless plating route and its related magnetic properties were discussed. The Ni-Co-P nanogranular layers with the thickness from several tens to hundreds nanometer size and 5-50% cobalt content were formed by controlling pH and reaction time in a phosphinate electo-less plating bath. The morphology, crystal structure and electromagnetic properties of the electroless deposited particles with the feromagnetic nanolayer were analyzed with field emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), vibration sample magnetometer (VSM) and vector network analyzer (VNA). The result shows that the deposition depth and crystallinity of the deposited nanolayer depend on plating time and annealing temperature. The annealed nanolayers at 100-700ºC was well-crystallized cubic phase, while as-deposited nanolayer by electro-less plating was amorphous phase. It was confirmed that the plating parameter and crystallinity significantly influenced on their magnetic properties such as saturation magnetization and frequency dependency of permeability. The high power loss was observed in frequency ranges of 20 M~1 GHz due to controlling deposition depth, crystallinity, and Ni/Co ratio of the deposited nanolayer.

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