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화학기상응축법에 의한 코발트계 나노입자의 제조 및 특성

Preparation and properties of cobalt-based nanoparticles prepared by chemical vapor condensation process

한국기계연구원 Z. H. Wang* · 최철진 · 김병기 · 김진천,
Institute of Metal Research Z.D. Zhang

1. Introduction

Nanomaterials with the particle size below 100nm have been attracting a great deal of attention because of their potential applications in areas such as electronics, optics, catalysis, magnetic data storage [1]. Nanoparticles metal have the disadvantage of being prone to rapid environmental degradation, owing to a very high surface area to volume ratio and high reactivity. Investigations have been done for nanoparticles of magnetic materials such as Fe, Co, Fe(C), Co(C) and their alloys [2,3].

In present work, magnetic nanoparticles of Co(C) and Co-Fe alloy were synthesized by chemical vapor condensation process. Iron carbonyl ($Fe(CO)_5$) and cobalt carbonyl ($Co_2(CO)_8$) were used as the sources under a flowing helium or CO gas atmosphere.

2. Experimental details

The basic equipment in present work is same as that have been described [4]. Characteristics of Co(C) and Fe-Co alloy nanoparticles were investigated systematically by means of X-ray diffraction (XRD), transmission electron microscopy (TEM), vibrating sample magnetometer (VSM).

3. Results and discussions

TEM images (Fig. 1) showed the microstructure of Co(C), the microstructure of Fe-Co alloys nanoparitlces has been shown last time [4]. The shape is nearly spherical with core-shell structure; the shell thickness is nearly 3-7nm. The black core is metallic and shell is different for Co(C) and Fe-Co nanoparticles. The shell is amorphous graphite for Co(C) with CO as carrier gas; however, metal oxides covered the Fe-Co nanoparticles with Ar as carrier gas.

The XRD patterns (Fig. 2) showed the phases of fcc-Co, hcp-Co, and carbides (Co_2C, Co_3C) were obtained. The phases are not changed with changing the decomposition temperatures. The Fe-Co alloys nanoparticles with different content were synthesized by CVC process (Fig. 3). When the Co content below 40wt%, there is bcc Fe-Co, and fcc and bcc Fe-Co coexist when Co content over 40wt%.

(Fig. 4) shows the decomposition temperature dependence of the magnetic properties of Co(C) nanopartilces. The saturation magnetization and coercivity continuously increase with increasing decomposition temperature. The highest value is 146.9emu/g. However, the saturation magnetization and coercivity of Fe-Co alloys nanoparitlces have closed relation with Co content. The saturation magnetization increases with increasing Co content and reaches highest value at 40

wt% Co, meanwhile, coercivity increases with increasing Co content[4].

4. Conclusions

The Co(C) and Fe-Co alloys nanoparticles were synthesized by CVC process. The different shell can be obtained by using different carrier gas; the shell of Co(C) is amorphous graphite in CO gas, the shell of Fe-Co alloys nanoparticles is metal oxides in Ar gas, because of passivation process in air. The magnetic properties of Co(C) increase with increasing decomposition temperature. the saturation magnetization and coercivity of Fe-Co alloys nanoparticles increase with increasing Co content, and the saturation magnetization have largest value at 40 wt% Co.

5. References

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