Synthesis of magnetic Fe_3N and Fe_3C nano-powders by chemical vapor condensation

Dong-won Lee*, Jung-Hyun Bae, Tae-Suk Jang[1], Byoung-Kee Kim
Nanopowder Materials Froup, Korea Institute of Machinery and Materials (KIMM)
1 Division of Materials and Chemical Engineering, Sunmoon University

1. Introduction

Iron based magnetic nanopowders have been actively developed because of the potentially attractive application such as high density recording media or magnetic fluids, exploiting their magnetic properties superior compared to commercialized nanostructured magnetite (Fe_3O_4) powders. In this study, it was tried to synthesize the nanostructured Fe_3C and Fe_3N powders by chemical vapor condensation technique with various process parameters and perform the powder characterization such as microstructures, chemical compositions and magnetic properties.

2. Experiment procedure

Iron pentacarbonyl, $Fe(CO)_5$, was vaporized in the isolated bubbler container(50mm□x100mmH) at 160°C and transferred with the carrier gas of NH_3 for Fe_3N and CO for Fe_3C, respectively, into the hot-wall reactor tube (50mm□x400mmL) held at 500~850°C. The synthesized iron nano-powders were then generated into the chamber vacuumed mechanically and protected with argon gas. The produced powders were collected carefully after they were air-passivated passivation for 2 hours.

3. Results and discussion

It was discovered by X-ray diffraction patterns and chemical analysis results that the phases of produced powders were varied with different reaction temperatures and chamber pressures. That is, the pure Fe_3C and Fe_3N powders were synthesized in the limited conditions as shown in Figure. It was found here that Fe_3N powders were more effectively synthesized than Fe_3C because of the different kinetic behaviors of carbon and nitrogen gas in a vacuum condition. The mean sizes of powders produced at vacuum conditions were about 10~20 nm much lower than those at 1 atm. The coercivity and maximum magnetization of produced powders were measured and the relationship between the magnetic property and particle morphology is being studied with Moessbauer and XPS analysis.