Introduction
Cobalt ferrite (CFO) can exhibit large magnetic anisotropy, $K_u$ under certain symmetry reduction conditions. Extraordinarily large $K_u$ of almost 10 Merg/cm$^3$ obtained by introducing a tetragonal distortion (c/a<1) in the structure has been reported in epitaxially strained CFO thin films [1]. Since epitaxial strain is limited to thin films, development of the material in the form of nanoparticles is necessary for bulk production. The introduction of lattice distortion via Jahn-Teller (JT) effect by substituting Cu$^{2+}$ ion in the B-sites of spinel Fe$^3$O$_4$ particles has been proposed [2]. However, due to the oxidation of Fe$^{2+}$ to Fe$^{3+}$ at high temperature, no JT distortion could be confirmed. To explore the JT distortion, the B-site ion of the spinel ferrite has to be highly stable in the divalent state, such as for Co$^{2+}$. In this study, we report the fabrication of cobalt substituted copper ferrite and the effect of tetragonal distortion on its magnetic properties.

Experimental procedures
(Co,Cu)Fe$_2$O$_4$ particles were prepared by coprecipitation and flux methods. The aqueous solutions containing Co$^{2+}$, Cu$^{2+}$, and Fe$^{3+}$ were mixed with NaOH aqueous solution, and heated at 95°C for 3 h to form a precipitate. This was then mixed with KBr flux, and heated at 850°C for 3 hours. The obtained particles were next rinsed with water to remove the KBr flux. Finally, the particles were subjected to heat treatment at 900°C for 2 h, followed by furnace cooling. Characterizations were performed using x-ray diffraction (XRD) and a vibrating sample magnetometer (VSM) at room temperature.

Results
Figure 1 (a) shows the XRD patterns for (Cu,Co)Fe$_2$O$_4$ particles after flux treatment. The structure is that of a cubic spinel structure with faint traces of CuO. After heat treatment at 900°C for 2 h, tetragonal spinel phase could be confirmed (Fig.1 (b)). The single phase showed that both Co and Cu were completely substituted into the spinel structure. Fig. 2 shows the magnetization curves of the particles. It can clearly be seen that the cubic-tetragonal transformation results in a high increase of coercivity. The saturation magnetization values show good agreement with that of an inverse spinel. For the tetragonal (Cu,Co)Fe$_2$O$_4$ particles, the saturation magnetization was 26 emu/g, whereas the coercivity was about 2000 Oe.

References