Evolving microstructure, magnetic properties and phase transition in a mechanically alloyed Ni0.5Zn0.5Fe2O4 single sample

ABSTRACT

We report on an investigation to unravel the dependence of magnetic properties on microstructure while they evolve in parallel under the influence of sintering temperature of a single sample of Ni0.5Zn0.5Fe2O4 synthesized via mechanical alloying. A single sample, instead of the normally practiced approach of using multiple samples, was sintered at various sintering temperatures from 500 °C to 1400 °C. The morphology of the samples was studied by means of scanning electron microscopy (SEM) equipped with EDX; density measurement was conducted using the Archimedes principle; and hysteresis measurement was carried out using a Bï H hysteresisgraph system. XRD data showed that the first appearance of a single phase was at 800 °C and an amorphous phase was traced at lower sintering temperatures. We correlated the microstructure and the magnetic properties and showed that the important grain-size threshold for the appearance of significant ordered magnetism (mainly ferromagnetism) was about Ó0.3 µm. We found that there were three stages of magnetic phase evolution produced via the sintering process with increasing temperatures. The first stage was dominated by paramagnetic states with some superparamagnetic behavior; the second stage was influenced by moderately ferromagnetic states and some paramagnetic states; and the third stage consisted of strongly ferromagnetic states with negligible paramagnetic states. We found that three factors sensitively influenced the sample's content of ordered magnetismð the ferrite-phase crystallinity degree, the number of grains above the critical grain size and the number of large enough grains for domain wall accommodation.

Keyword: Ferrite; Mechanical alloying; Sintering temperature; Microstructure evolution; Ferromagnetic state