Magnetic phase transition of mechanically alloyed single sample Co0.5Ni0.5Fe2O4

ABSTRACT

The parallel evolutional relationship between microstructural properties and magnetic and electrical properties was elucidated through this study. A Co0.5Ni0.5Fe2O4 rod sample was prepared via high energy ball milling and subsequent moulding into a nano-sized compacted powder. This single sample was sintered through 10 cycles at different sintering temperatures in the range of 500 °C–1400 °C. After each sintering, the sample was characterized for its phase, microstructural, density, magnetic and electrical properties using XRD, SEM, B-H tracer, Curie temperature measurement and two probes method. An integrated study of microstructural properties with elevating sintering temperature would point to the existence of three stages of sintering, which involved atomic, interfaces (lattice and boundaries), and volume diffusions respectively. Three distinct shape-differentiated groups of B–H hysteresis loops were observed. The existence of these groups was associated with microstructural properties such as phase purity, volume fraction of disordered phase or grain boundaries, and grain size. In terms of average grain size, from 48.25 nm to 71.93 nm, a weak paramagnetic behaviour was observed; while from 83.65 nm to 374.79 nm, a relatively square-shaped hysteresis loops with moderate ferromagnetic behaviours were observed. The occurrences of erect and well-defined sigmoid-shape were observable when there were sufficiently high single-phase purity and crystallinity, where the average grain size was in the range of 964.73 nm–11215.91 nm. The critical grain size of 186.75 nm was found by plotting average grain size against coercivity, suggesting the number of single-domain particles was reduced, and the number of multi-domain particles was increased by increasing sintering temperature. The electrical resistivity variations were strongly related to the microstructural properties.

Keyword: Co0.5Ni0.5Fe2O4; Microstructural evolution; Activation energy; Magnetic transition