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Structural and magnetic properties of NiFe₂O₄/NiFe bi-magnet and NiFe nano-alloy synthesized from thermal reduction of NiFe₂O₄

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Abstract content
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Bi-magnetic NiFe₂O₄/NiFe nanocomposites and NiFe nano-alloy were synthesized by reduction of NiFe₂O₄ nano-ferrite with activated charcoal (<i>n</i><i>c</i>) in flowing high purity Ar gas atmosphere at 900 ℃ for 3 hours. The parent NiFe₂O₄ nano-ferrite was synthesized by a glycol-thermal method at 200 ℃. Partial and complete reduction yielded NiFe₂O₄/NiFe nanocomposites and NiFe nano-alloy respectively. NiFe was formed at an optimum amount of <i>n</i><i>c</i> = 5. Phase identification, morphology and magnetic properties of the samples were performed by XRD, HRSEM, HRTEM, ⁵⁷Fe Mössbauer spectroscope and a mini cryogenic-free system. The parent sample has an average crystallite size of about 10 nm, an XRD density of about 5.3 g/cm³ and an average lattice parameter of (<i>a</i>) = 8·362±0·007Å. The NiFe nano-alloy exhibited the martensite bcc (α-Fe) and austenite fcc (γ-Fe) phases in coexistence. Fitted Mössbauer analysis for <i>n</i><i>c</i> = 5 and 6 show high hyperfine magnetic fields associated with the bcc phase while the lower field component is associated with the fcc phase of NiFe nano-alloy. The saturation magnetization increased significantly from 57 emu/g to 141 emu/g at room temperature. The saturation magnetization is enhanced at low temperatures with a maximum of 161 emu/g at ≥ 30 K. However, the coercivity showed no significant increase at low temperatures.

Keywords: Nano-ferrite; Nano-alloy; Nanocomposites; Activated charcoal; martensite; austenite; Reduction reaction

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