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Ferromagnetic nickel filled in borate shell by controlled oxidation-crystallization of boride in air

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Abstract

A model design of protected nanoparticles (NPs) of a ferromagnetic metal such as nickel by using a surface layer of borate make them safer in view of human health and environments. Here we report a simple method of producing one-dimensional ferromagnetic nanostructure (1D-FMN) of Ni-NPs impregnated in stable borate shell by controlled oxidation of a nickel boride in air. Ni-filled nanostructure, ~100 nm diameter and ~1.5 μm length, have transformed out of a surface limited oxidation of a nickel boride (NPs) at ~ 800 °C in air. An antioxidant borate prevents the residual nickel from oxidizing further unless the temperature rises above 800 °C. Result is useful for understanding growth mechanism of 1D-FMN in support with inherited oxide of low-melting-point. A borate assisted 1D-FMN so obtained yields superior magnetic properties, i.e., $M_s = 29.0$ emu/g, $H_c = 236$ Oe and remenance ~ 0.3 at room temperature, in comparison to mostly 1D-FMN reported using a carbon layer.

Key words: Nanocomposites; Magnetic materials; Functional coating; Nanostructures; Borates

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