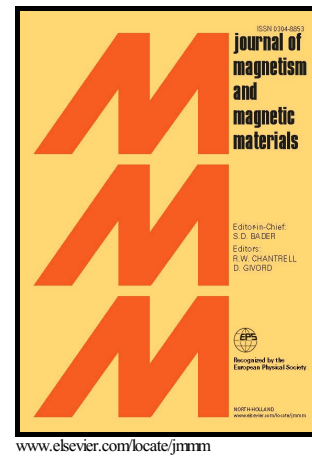


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Micromagnetic Finite Element Study for Magnetic Properties of Nanocomposite Exchange Coupled Nd₂Fe₁₄B/ α -Fe Multilayer Systems

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Abstract

In this study, magnetic properties of exchange coupled nanocomposite multilayer thin films constructed alternately with magnetic hard Nd₂Fe₁₄B layers and soft α -Fe layers have been studied by micromagnetic finite element method (FEM). According to the results, effects of the thicknesses of layers and the magneto-crystalline anisotropy on the magnetic properties of the Nd₂Fe₁₄B/ α -Fe multilayer systems have been estimated. On the other hand, the results have been analyzed by means of efficiency of interphase exchange coupling, which can be estimated by volume ratios of exchange coupled areas between magnetically hard Nd₂Fe₁₄B and soft α -Fe phase layers. The results show that the magnetic properties of exchange coupled Nd₂Fe₁₄B/ α -Fe multilayer systems can be enhanced by efficient interphase exchange coupling between magnetically hard Nd₂Fe₁₄B layers and soft α -Fe layers.

Keywords: Nanocomposite permanent magnet, Exchange coupling, Micromagnetic finite element simulation, Microstructure, Multilayer magnetic system

1. Introduction

Since nanocomposite exchange coupled permanent magnets, including Nd₂Fe₁₄B/ α -Fe magnets, had been discovered [1, 2], they have been considered as practically valuable magnetic materials, because of their good magnetic properties (e.g. high remanence, maximum energy product) and their thermal and chemical stability with low cost by replacing iron to comparatively expensive Nd₂Fe₁₄B composition. In nanocomposite Nd₂Fe₁₄B/ α -Fe magnetic system, magnetically hard Nd₂Fe₁₄B phase and soft α -Fe phase can be exchange coupled. Through the exchange coupling between Nd₂Fe₁₄B phase and α -Fe phase, Nd₂Fe₁₄B phase grains can magnetically “harden” α -Fe phase and α -Fe phase can increase saturated magnetization of the nanocomposite system [3]. So the Many researchers have theoretically [3] and experimentally [4-8] studied the magnetic properties and behaviors of exchange coupled nanocomposite magnets including Nd₂Fe₁₄B/ α -Fe magnets.

Micromagnetic finite element method (FEM) has been recognized as one of the most powerful tools to understand relations between microstructures and magnetic properties of exchange coupled

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