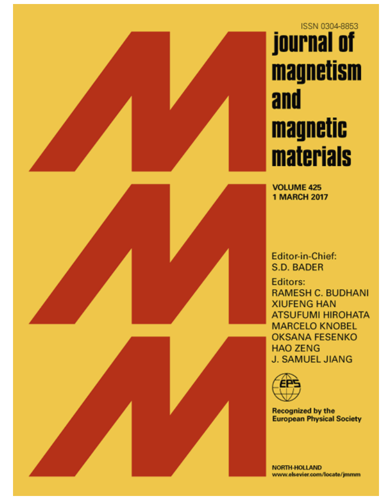

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PII: S0304-8853(18)31607-X
DOI: https://doi.org/10.1016/j.jmmm.2018.10.032
Reference: MAGMA 64443

To appear in: *Journal of Magnetism and Magnetic Materials*

Received Date: 28 May 2018
Revised Date: 25 September 2018
Accepted Date: 8 October 2018

Please cite this article as: A. Hosokawa, K. Takagi, T. Kuriiwa, Y. Inoue, K. Ozaki, Severe plastic deformation of Nd-Fe-B nanocomposite magnets at room temperature, *Journal of Magnetism and Magnetic Materials* (2018), doi: https://doi.org/10.1016/j.jmmm.2018.10.032

Severe plastic deformation of Nd-Fe-B nanocomposite magnets at room temperature

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Abstract:
A newly developed isotropic $Nd_2Fe_{14}B$/α-Fe nanocomposite magnet was subjected to a series of investigations of its microstructure and magnetic properties. The performance of the optimally annealed sample was found to be H_c = 9.7 kOe and $\sigma_{sat.}$ = 171 emu/g. Moreover, an attempt was made to produce anisotropic nanocomposite magnets by a high-pressure torsion (HPT) experiment performed at room temperature. The microstructural analyses by TEM in 2D and by FIB-SEM serial sectioning in 3D elucidated that the two-phases microstructure is not distorted homogeneously but shear bands (SBs) are formed. It was found that both the hard magnetic $Nd_2Fe_{14}B$ and soft magnetic α-Fe phases are distorted significantly near those SBs even though the crystallographic orientations of the $Nd_2Fe_{14}B$ grains are randomized therein. The relationships between this microstructure developed by HPT and the corresponding magnetic properties are discussed.

Keywords: permanent magnet, texture, melt spinning, high-pressure torsion, SPD, FIB-SEM, TEM

1. Introduction

Nanocomposite magnets are predicted to be a new class of permanent magnet materials that consist of a highly refined two-phase microstructure composed of magnetically hard and soft magnetic materials (e.g. $Nd_2Fe_{14}B$ and α-Fe phases). This class of materials is expected to replace Nd-Fe-B magnets by combining the advantages of both hard and soft magnetic phases by virtue of exchange coupling at the interface [1-3]. However, no successful result that surpasses the performance of the Nd-Fe-B magnet has been reported, in spite of the efforts of many researchers to develop this class of permanent magnets over nearly three decades [3-13]. One of the difficulties lies in producing anisotropic nanocomposite magnets. By contrast, isotropic nanocomposite magnets can be produced