

# Effect of annealing on the microstructure and magnetic properties of Fe-based nanocomposite materials

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**Abstract:** The influence of annealing on microstructure, magnetic properties including the giant magnetoimpedance (GMI) effect of a Fe-based nanocomposite has been investigated. The nanocomposite structure composed of ultra-fine Fe(Si) grains embedded in an amorphous matrix was attained by annealing the Fe-based amorphous alloy prepared by rapid quenching method. The GMI profiles were measured for samples annealed at different temperatures ranging from 350 to 650 °C in vacuum and for 30 min. It is found that the mean grain size of the  $\alpha$ -Fe(Si) crystallites in the order of 12 nm remains almost unchanged until the annealing temperature reached 540 °C. A decrease of anisotropy field and an increase of GMI with increasing annealing temperature up to 540 °C were observed and ascribed to the increase of the magnetic permeability and the decrease of the coercivity, whereas the opposite tendency was found for the sample annealed above 600 °C which is likely due to the microstructural change caused by high-temperature annealing. This indicates that variation in the magnetic characteristic of the amorphous phase upon annealing changed the intergrain exchange coupling. This altered both the magnetic softness and the effective anisotropy and consequently modified the GMI features. The study of the temperature dependence of the GMI effect provides further understanding of the magnetic exchange between these crystallized grains through the amorphous boundaries in Fe-based nanocrystalline materials. © 2005 Elsevier Ltd. All rights reserved.

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