

Microstructure and Interphase Magnetic Coupling in Nd₂Fe₁₄B/ α -Fe Nanocomposites Obtained by Mechanical Milling and Short Time Annealing





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Abstract: This study presents the effect of different milling times and short time annealing on the structural and magnetic properties of Nd₂Fe₁₄B/10wt% Fe nanocomposites prepared by high energy ball milling. The XRD peaks of the hard magnetic phase disappear after milling due to the damaging of the Nd₂Fe₁₄B crystal structure. After annealing, the characteristic peaks of the hard magnetic phase are restored with a limited growth of the soft magnetic phase crystallites. The magnetic behavior was investigated from hysteresis curves and dM/dH vs. H plots. The best exchange coupling was obtained for the 6 h milled sample annealed at 700 °C for 2 minutes with a maximum coercive field value of 0.44 T. Taking into account the milling and annealing conditions, the $Nd_2Fe_{14}B/\alpha$ -Fe exchange coupling is analyzed.

Experimental:

- \succ The Nd₂Fe₁₄B hard phase was prepared by induction melting in an Ar atmosphere, followed by annealing in vacuum at 950 °C for 68 h. The ingot was ground to a fine powder under 500 µm. The soft magnetic phase (12 g of NC 100.24 commercial Fe powder – Höganäs product) was milled with 5 ml benzene for 4 h in an inert Ar atmosphere with a ball to powder weight ratio of 10:1.
- The Nd₂Fe₁₄B powder was mixed with the pre-milled Fe phase in a weight ratio of 90% Nd₂Fe₁₄B/10% Fe. The mixture was dry-milled in Ar for 2, 4 and 6 h respectively with a ball to powder weight ratio of 10:1. The milled samples were annealed in an Ar atmosphere at 700, 750 and 800 °C for 0.5-2.5 min and guenched in water.



- \succ X-Ray diffraction measurements were performed on a Brüker D8 Advance diffractometer using Cu K_a radiation.
- Magnetic measurements were carried out on powder samples fixed in epoxy resin using the extraction method at 300 K in applied fields up to $\pm 10T$. Assuming isolated spherical magnetic particles we used a demagnetization factor of 1/3 for magnetic data.

Results and Discussions:



For *classically annealed samples*, the interphase exchange coupling is better after 6 h MM compared to 8 h MM [1,2]. What will happen after short time annealing?





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