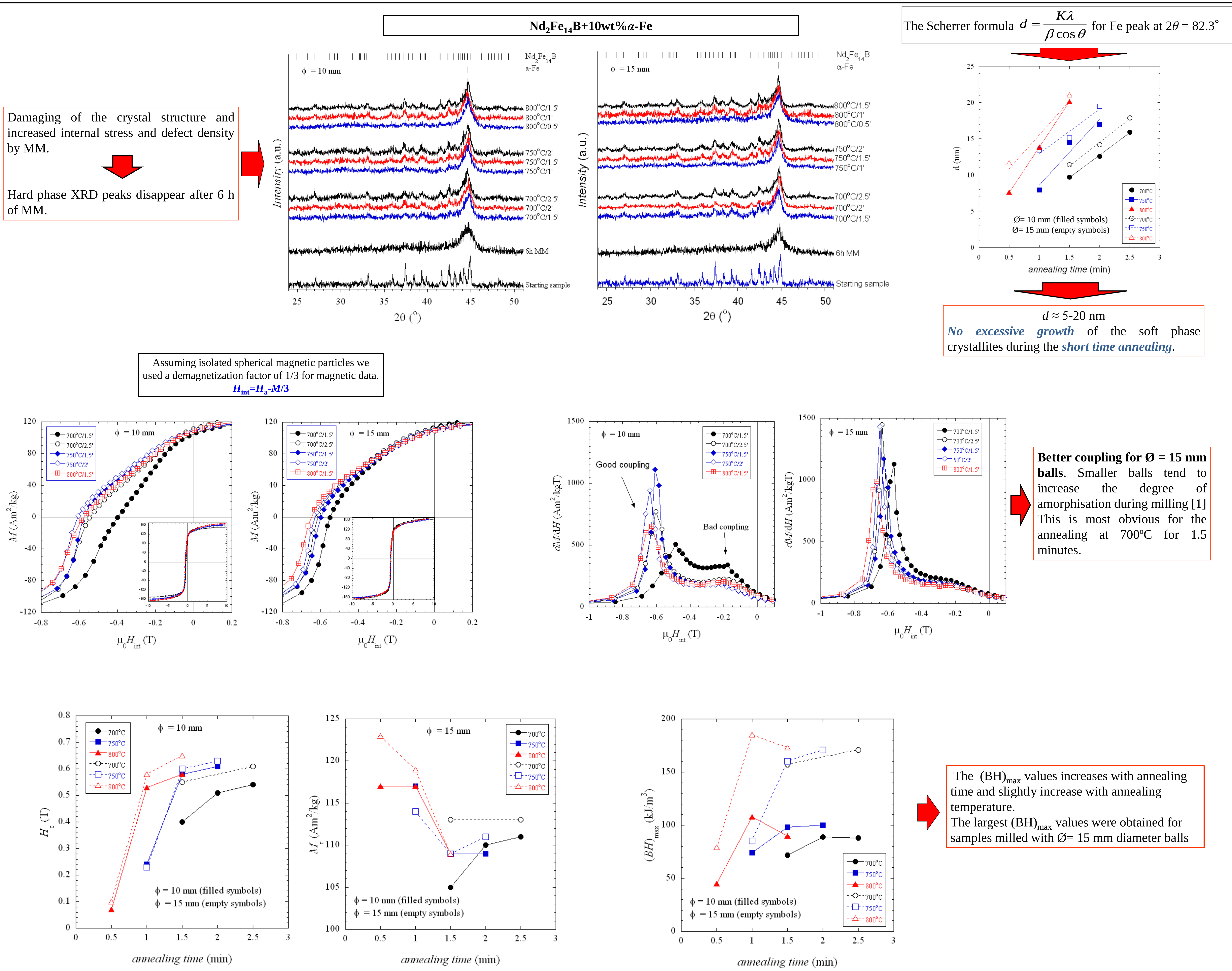


Abstract: The effects of milling conditions on the microstructure and interphase exchange coupling of Nd₂Fe₁₄B+10wt% α -Fe nanocomposites were investigated. The α -Fe crystallite size is critical for obtaining an efficient interphase exchange coupling. The problem of damaging the Nd₂Fe₁₄B crystal structure during milling was addressed by using different milling conditions. Nd₂Fe₁₄B+10wt% α -Fe powder samples were prepared through mechanical milling for 6 h with $\phi = 10$ mm and $\phi = 15$ mm balls respectively. The restoration of the Nd₂Fe₁₄B crystal structure after annealing was confirmed by XRD, with a limited growth of α -Fe crystallites. The magnetic behavior was investigated from hysteresis curves and dM/dH vs. H plots. The samples milled with $\phi = 10$ mm diameter balls show good interphase exchange coupling, however, milling with larger diameter balls determined higher coercivities and better interphase exchange coupling due to the reduced damaging of the Nd₂Fe₁₄B crystal structure during milling. The best exchange coupling was obtained for the samples annealed at 800°C for 1.5 minutes, with a maximum coercive field of about 0.65 T. The Nd₂Fe₁₄B/ α -Fe exchange coupling was analyzed as a function of milling and annealing conditions.

Experimental:

- The Nd₂Fe₁₄B hard phase was prepared by induction melting in an Ar atmosphere, followed by annealing in vacuum at 950 ° C for 72 h. The ingot was ground to a fine powder under 500 μ m. The soft magnetic phase is NC 100.24 commercial Fe powder – Höganäs product
- The Nd₂Fe₁₄B powder was mixed with the Fe in a weight ratio of 90% Nd₂Fe₁₄B/10% Fe. The mixture was dry-milled (with $\phi = 10$ mm and $\phi = 15$ mm diameter balls respectively, 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 quenched in water.
- X-Ray diffraction measurements were performed on a Brüker D8 Advance diffractometer using Cu K α 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 ± 10 T. Assuming isolated spherical magnetic particles we used a demagnetization factor of 1/3 for magnetic data.

Results and Discussions:



Conclusions:

- **Short time annealing restores the structure of the hard phase** destroyed by milling with a **limited growth of the soft magnetic crystallites**.
- The exchange **coupling strength** is greater when milling with $\phi = 15$ mm diameter balls, due to less damage to the crystalline structure of the hard phase.
- The **best exchange coupling** was obtained for the **6 h MM with $\phi = 15$ mm** sample annealed at **800°C for 1.5 minutes** with a maximum coercive field value of **0.65 T**.
- The highest **energy product** 185 KJ/m³ is **comparable** with the best reported values on rare-earth nanocomposites [2].

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