



Features of the magnetization reversal processes in sintered permanent magnets Nd-Fe-B and Sm-Co type

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BACKGROUND

The mechanism behind the high-coercivity state in sintered **Nd-Fe-B** and **Sm(Co,Fe,Cu,Zr)_z** permanent magnets remains unresolved. While traditionally attributed to **nucleation** (Nd₂Fe₁₄B) and **domain wall pinning** (Sm-based compounds), recent studies [1,2] indicate a more complex magnetisation reversal process.

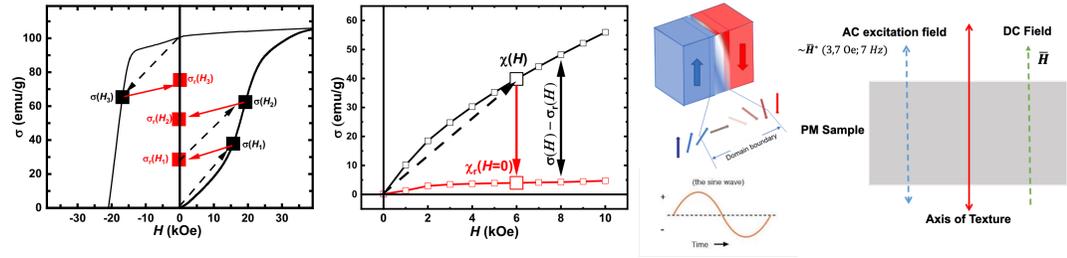
AIM

To develop **methods** for determining **the mechanisms of high-coercivity formation** and to apply them to hard magnetic materials based on Nd-Fe-B and Sm(Co,Fe,Cu,Zr)_z compounds.

APPROACH

We propose a method based on the analysis of magnetometric measurements, including:

- magnetization curves
- differential susceptibility: $d\sigma/dH$
- reversible susceptibility: $\chi_r(H)$
- reversible contribution to magnetization: $\Delta\sigma(H) = \sigma(H) - \sigma_r(H)$



MICROCRYSTALLINE

Nd-Fe-B permanent magnets
(a) N35 (b) N48 (c) N48SH

NANOCRYSTALLINE

Nd-Fe-B powder
MQA

Sm-Co permanent magnets
(a) 6% Cu (b) 9% Cu

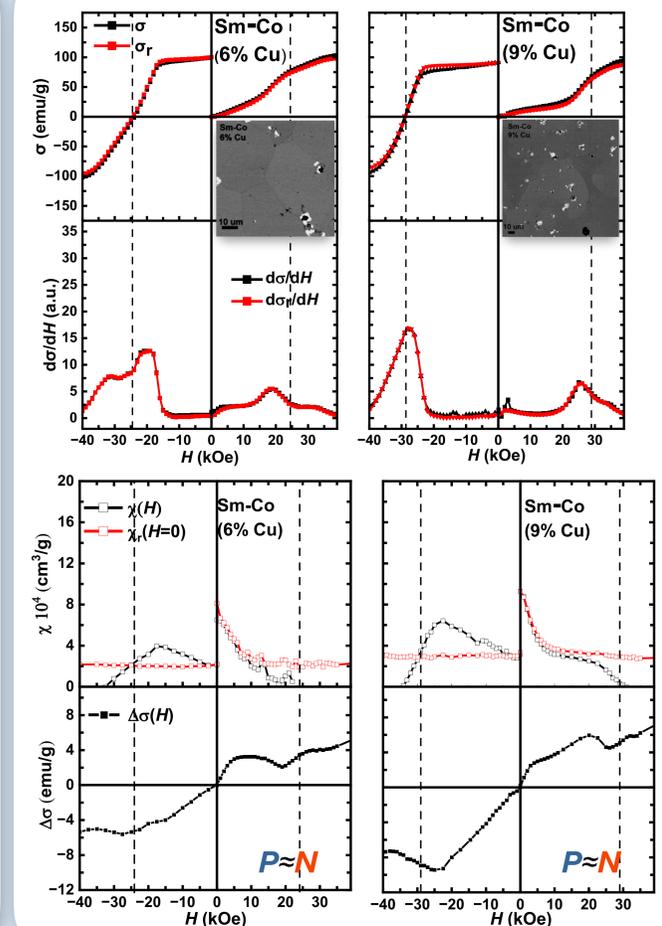
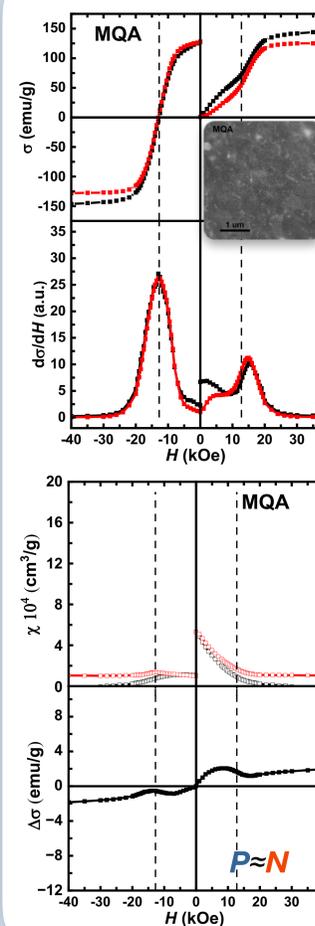
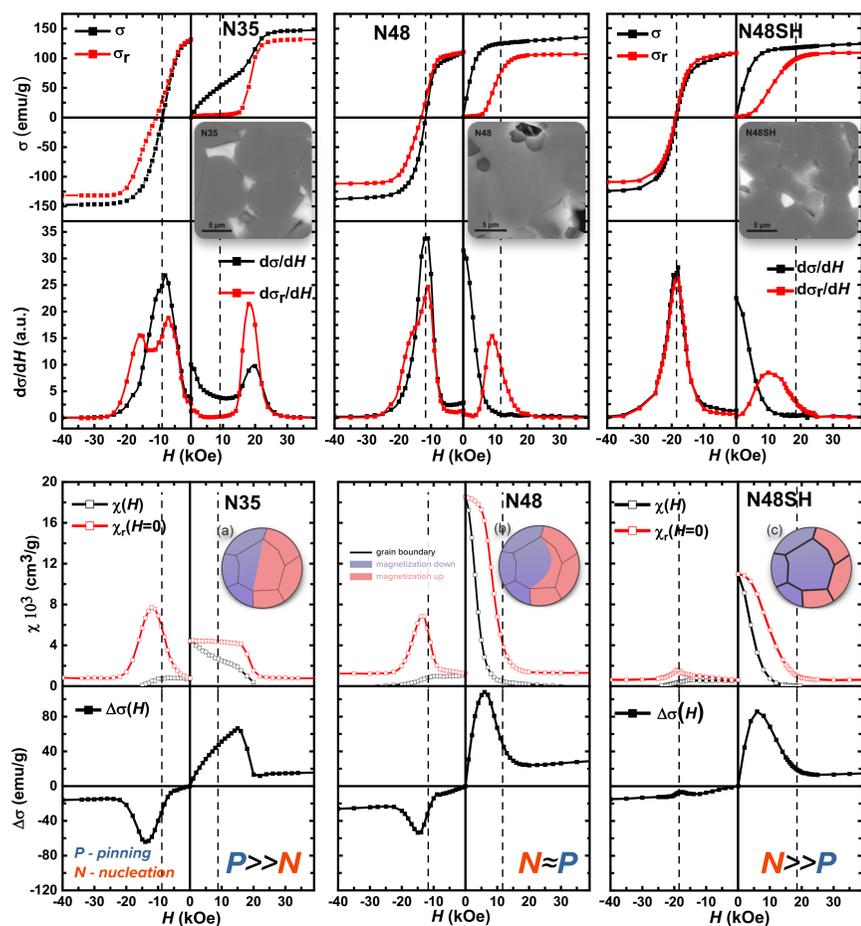
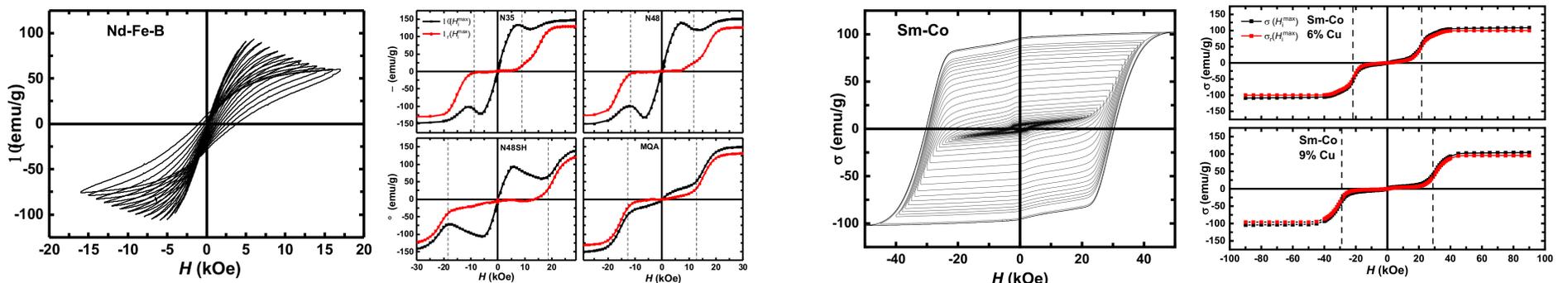


Fig.1. Magnetization and magnetization reversal curves

Fig.2. Magnetic ac reversible susceptibility $\chi_r(H)$ and $\chi_r(H=0)$ and reversible contribution to magnetization $\Delta\sigma(H)=\sigma(H)-\sigma_r(H)$

Fig.3. Minor hysteresis loops from initial state



- ▶ A method was developed to evaluate the roles of **pinning** and **nucleation** in permanent magnets by analyzing the **peak values of reversible magnetization $\Delta\sigma(H)$** and **reversible magnetic susceptibility $\chi_r(H)$** .
- ▶ This method is especially effective for **microcrystalline Nd-Fe-B magnets**.

- ▶ An **anomalous decrease in magnetization** with increasing field was observed in **partial hysteresis loops** for Nd-Fe-B magnets.
- ▶ This behavior indicates a predominance of **single-domain grains** with domain walls **pinned at grain boundaries**.

- ▶ In Sm(Co,Fe,Zr,Cu)_z magnets, an **increase in magnetic susceptibility $\chi(H)$** under a demagnetizing field was observed.
- ▶ This may reflect the response of the **Zr(Co,Cu)₃-type lamellar phase**, previously strongly exchange-coupled with the **2:17 main phase**.

