

**Zeitschrift:** Helvetica Physica Acta  
**Band:** 62 (1989)  
**Heft:** 6-7

**Artikel:** The measurement of the magnetic anisotropy and some related properties in hard magnetic materials  
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**DOI:** <https://doi.org/10.5169/seals-116109>

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THE MEASUREMENT OF THE MAGNETIC ANISOTROPY AND SOME RELATED  
PROPERTIES IN HARD MAGNETIC MATERIALS

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Abstract: Some methods developed at the MASPEC Institute for the measurement of the anisotropy field, texture and single or polydomain particle status in uniaxial ferromagnets are presented.

1. Introduction

The measurement of the magnetic anisotropy ( $H_A$ ) is an important issue for the characterization of hard magnetic materials, either from a fundamental or applicative point of view.  $H_A$  is a relevant property which qualify these materials for different applications. In particular anisotropy is a necessary condition for the existence of the coercivity and it determines the occurrence of first-order magnetization processes (FOMP) and spin reorientations transitions (SRT). An important requirement is the possibility of measuring the anisotropy field directly in polycrystalline samples. Also the knowledge of some characteristics connected to  $H_A$  such as the single or polydomain status of the particles and the polydomain sample texture is particularly important for magnetic recording and permanent magnet applications respectively.

2. Experimental Methods

Transverse susceptibility. The reversible transverse susceptibility  $\chi_t$  of a ferromagnet, having a positive uniaxial anisotropy, can be measured as a function of the applied magnetic field. The presence of peaks in the  $\chi_t(H)$  curve of a polycrystal was predicted (1) on the basis of the Stoner and Wohlfarth model. An experimental method and apparatus (2) based on the measurement of the field dependence of the a.c. transverse susceptibility,

has been developed and it allows for a precise determination of both the coercive and anisotropy fields in an uniaxial ferromagnet, provided it is made of single domain particles. This peculiarity allows for distinguishing between single or polydomain status of the particles in the sample. The absence of the peak at  $H = H_A$  in the  $\chi_t(H)$  curve of a polydomain particles sample is due to the shielding signal originated by: the domain walls motion (Fig.1).

Singular Point Detection technique (SPD). In the magnetization curve of a polycrystal there are no indications for the determination of the anisotropy field ( $H_A$ ) that is the field needed to saturate the sample along a hard direction. It has been demonstrated

(3) that a peak, located at  $H=H_A$  is observed in the  $n$ th derivative  $d^n M/dH^n$  of the magnetization with respect to the applied field. The order  $n$  of the derivative depends on the crystal symmetry and on the easy axis direction ( $n=2$  in an easy axis ferromagnet). Such a peak is due exclusively to the grains having their easy axis at right angles with respect to the field. This implies:

- 1) the peak position is independent on any sample texture
- 2) the peak amplitude is proportional to the number of grains at right angles. Thus informations on the sample texture of oriented polycrystals are obtained by measuring the peak amplitude as a function of the sample orientation with respect to the field.

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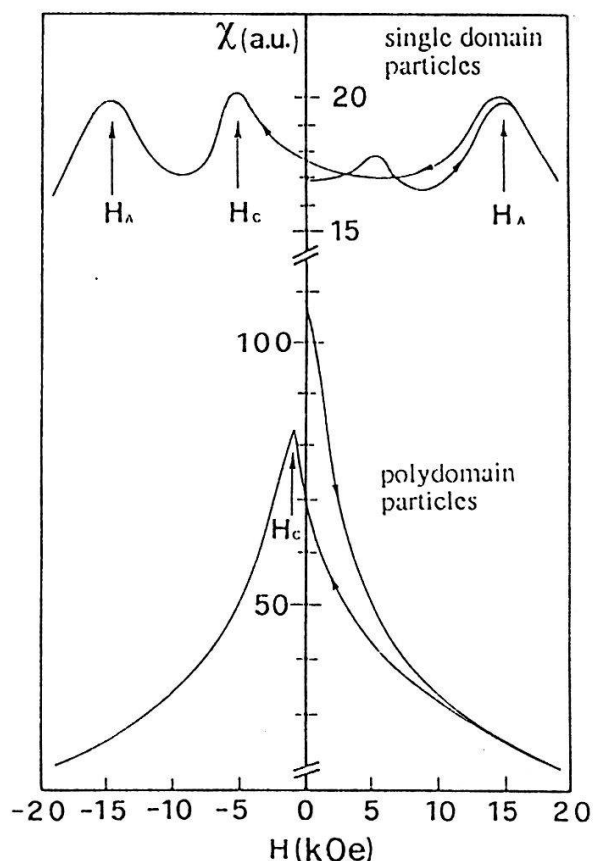


Fig.1 Transverse susceptibility  $\chi_t$  as a function of the external bias field  $H$