Orientation Distributions in Magnetic Tape

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Project Objectives
To determine the distribution of particle orientations for MP tape

The particle orientation distribution can be used as a new indication of tape quality

The particle orientation distribution will be used in constitutive equations that describe the mechanical properties of MP tape

Approach

Measure the angular dependence of the magnetic remanence

Extract a particle orientation distribution function from the data

The Experiment

1. Six millimeter diameter samples punched from commercial MP tape, begin with the samples oriented along the easy axis, \( \phi = 0^\circ \)
2. Saturate with an applied field of 10,000 Oe and measure the saturation magnetization, \( M_s \)
3. Set the applied field to zero and measure \( M_s \)
4. Rotate the sample by \( 90^\circ \) and measure \( M_p \)
5. Rotate the sample by \( 85^\circ \) and measure \( M_t \)
6. Set the field to zero and measure \( M_p \)
7. Repeat at \( 5^\circ \) increments to obtain curves of \( M_s(\phi) \), \( M_p(\phi) \) and \( M_t(\phi) \) from 0 to 180°

Distribution of Particle Orientations

Summary of Results for DLT IV Tapes

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<th>Date</th>
<th>( H_c ) (Oe)</th>
<th>SQ</th>
<th>( M_{rt} ) (memu/cm²)</th>
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Conclusions

We can use measurements of the angular dependence of remanence to obtain particle orientation distribution functions

The distribution functions allow us to calculate the order parameter

The order parameter for DLT IV MP tape was in the range of 0.56 to 0.67

Indicates there is plenty of room to improve the degree of orientation of the particles in MP tape

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Luo & Bertram suggest:

\[ f(\Theta, \phi) \propto e^{-f(M_0 \phi) \cos \phi \sin \Theta} \]

This suggests using a single out-of-plane remanence measurement to determine \( f(\Theta, \phi) \)

\[ \frac{M_s}{M_p} = \frac{u_1}{u_3} \]

\[ \frac{M_t}{M_p} = \frac{u_1}{u_3} \]