

## MAGNETIZATION ESTIMATION FROM MFM IMAGES

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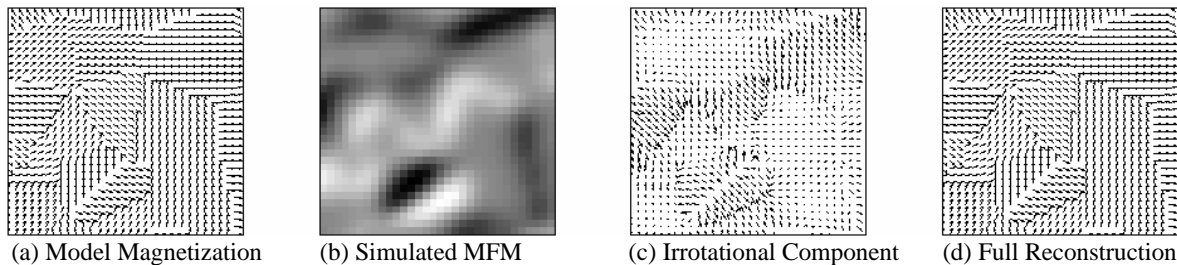
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Magnetic force microscopy (MFM) measurements only provide information about the divergence of the magnetization being studied. To fully understand such details as magnetic stability and storage capacity, the complete magnetization is needed. We outline two methods of obtaining useful estimates of the total vector magnetization in thin film longitudinal media from MFM measurements and display simulation results.

Our thin film medium model assumes fixed medium thickness and fixed magnetization magnitude. Magnetization is invariant in the direction perpendicular to the surface of the film and has no component in this direction. The medium is partitioned into uniformly magnetized regions called "grains" using Voronoi tessellation (fig. a) [1]. The MFM image of the simulated pattern is the second derivative of the perpendicular field component at a fixed height (fig. b). Within this framework, the irrotational component of the magnetization (fig. c) can be reconstructed from an MFM image [2].

The first approach to estimating the magnetization involves observing the effects of a 180 degree magnetization "switch" of a single grain. The MFM image before the switch is subtracted from the MFM image after the switch [3]. The irrotational component associated with the switched grain is reconstructed from the difference image. Outside the grain boundary, the solenoidal component of the magnetization of the grain is the negative of the irrotational part. Inside the grain, the solenoidal part is found by using the known irrotational part, the constant magnetization constraint, and the fixed solenoidal part outside the grain. Applying this procedure to each grain in turn results in the estimate of the complete magnetization (fig. d).

Our second estimation method, currently under development, models the MFM image as a two dimensional random process that depends upon the grain magnetization angles. Given an MFM image, we attempt to find the most likely magnetization pattern that satisfies the constant magnitude constraint. The advantage of this method is that, unlike the first approach, it requires no knowledge of grain boundaries or assumptions on switching behavior.



[1] Porter, D.G., et. al., *Journal of Applied Physics*, vol. 79, no. 8, pp. 4695-4697, April 1996.

[2] Beardsley, I.A., *IEEE Trans. Magn.*, vol. 25, no. 1, Jan. 1989.

[3] Jander, A.; Indeck, R.S.; Muller, M.W., *IEEE Trans. Magn.*, vol.35, no.5 pt.2, p3995-3997, Jan. 1999.