Eddy current microscopy

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Oscillating ferromagnetic probes, as typically used in magnetic force microscopy (MFM), induce eddy currents within conducting materials. These currents lead to an electrodynamic interaction between the probe and sample. As a consequence, the oscillation of the probe is affected, leading to a contrast in the phase, amplitude, or frequency-shift image. Eddy current imaging is highly sensitive to local variations in the material composition, even involving the analysis of subsurface features. Furthermore, it is possible to image stray fields of ferromagnetic domains and walls with nonmagnetic but conducting probes being oscillated at close proximity to magnetic samples. The latter configuration induces eddy currents within the probe, leading to images with a resolution comparable with that of MFM. In order to understand the contrast, the induced eddy current density and the resulting force between probe and sample are calculated by solving the Helmholtz equation for a dipole oscillating above a conducting surface. Theory and experimental data confirm that eddy current microscopy (ECM) is a new powerful tool providing force microscopy with a certain material-sensitive contrast and additionally permitting an absolutely nondestructive imaging of the softest magnetic materials.