MAGNETIC DOMAIN DYNAMICS IN NANOCOMPOSITE MATERIALS REVEALED BY REAL-TIME IMAGES

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As the size of a ferromagnet decreases to the nanometer-scale, the mechanism whereby it reverses its magnetization upon application of a reversed external magnetic field may change dramatically. This is especially true when in the form of a composite. In this morphology, the boundary magnetism between the dissimilar magnetic materials becomes most important in determining the bulk magnetic behavior. As the reversal behavior dictates the application of that material, the applications of nanoscale ferromagnets may be quite different from those originally intended for it as a conventional material. Conversely, quite new applications may be found possible for ferromagnets due to their nanoscale morphology. In a conventional material, the easiest way to reverse its magnetization when subjected to a reversed field is to nucleate domains with reversed magnetization that subsequently grow throughout the material at the expense of those domains oriented in opposing directions. In this presentation, pictures of these domain dynamics are shown (using the magneto-optic indicator film, MOIF, technique developed in our laboratory) resulting from collaborations with several groups around the world. Specifically, magnetic domain structure and its dynamics will be shown for several different nanocomposite systems, including a thin film bilayer of an antiferromagnet (AF) – ferromagnet (FM) possessing unidirectional magnetic anisotropy, a bilayer of a “hard” ferromagnet (h-FM) – “soft” ferromagnet (s-FM), an ultrathin Co film, and a Co/Pt multilayer as the material undergoes a reversal process. Lastly, the reversal behavior for the first time will be shown for an “exchange spring” nanocomposite magnet in real time at **High Magnetic Fields** observed very recently in a microscope specially constructed to fit between the pole pieces of a 2 T electromagnet. These findings indicate the physics of magnetization reversal change when material dimensions reduce to the nanoscale. This has important ramifications for magnetic sensors, recording devices, and transformer materials.