Instrument-Based Noise Analysis of First Order Reversal Curve (FORC) Measurements

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In an ideal magnetic system, all magnetic particles are identical in both their physical and magnetic properties. In reality, no matter what method is chosen for the synthesis, there are distributions in physical (size, composition, crystallinity, etc.) and magnetic (moment, coercivity, anisotropy, etc.) properties. Here, we will discuss our efforts to make the First Order Reversal Curve (FORC) method into a quantitative analysis technique for identifying distributions in coercivity and magnetic anisotropy. In particular, we compare the effect of instrument settings (fixed vs. variable ranging for moment detection, amplitude, averaging time, etc.) and smoothing methods. For example, cubic spline weighting damps out only high order oscillations, enabling us to identify instrument generated noise in the FORC data, such as the transition (which involves a change in resistor) from low-field to high-field operation of superconducting magnets. This noise analysis also highlights the optimal measurement conditions. To illustrate these differences, we have used a well characterized system of nickel nanorods, approximately 200 nm in length. These nanorods are dispersed in a hydrogel and then gelled in the absence of any magnetic field in order to obtain an isotropic distribution.