Thermally induced switching field distribution of individual single nanomagnets in a large assembly

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The Anomalous Hall Effect (AHE) can be used to measure the magnetization reversal of individual nanomagnets, under varying field angle and wide temperature range [1]. By passing a current through the magnetic elements, and measuring the voltage generated perpendicular to the current direction, one can determine the component of magnetisation perpendicular to the film plane. This extremely sensitive method can be used to observe reversal of magnetic elements with diameters below 10 nm or individual elements inside large assemblies.

In this work, we investigate the magnetization reversal of 180 nm $Co_{80}Pt_{20}$ dots, with a focus on the thermally induced switching field distribution (SFD_T) of individual dots in an array. Several steps and plateaus, due to the independent reversal of individual dots, are clearly visible on the hysteresis curves of an array of $Co_{80}Pt_{20}$ dots measured by AHE. Different switching field values are obtained for the same dot from 1000 repetitive measurements. The variation in switching field, observed for all dots, is due to thermal fluctuation, which causes a broadening of the SFD_T at temperatures above 0 K. A straightforward Arrhenius based model is used in order to calculate the SWD_T of a dot due to thermal fluctuation. Figure 1 shows that the experimental SFD_T coincide well with the modeled distributions, from which we can extract the energy barrier E_0, activation volume V and switching field at 0 K H_{0s}

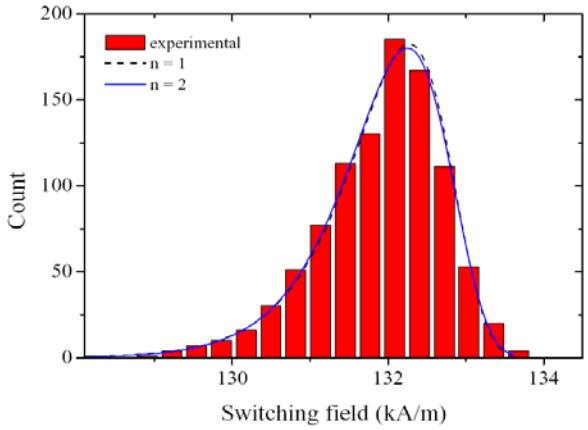

Fig. 1: SFD_T of the first switching $Co_{80}Pt_{20}$ dots, obtained from 1000 measurements. The lines show the fit to the measured data.

We zoomed in on the first and last switching dots in order to determine the origin of the high difference in their switching field. Our analysis shows that the anisotropy in the strong dot is higher than the weak dot, which is a very important observation and limits the possible origins of the switching field distribution. Temperature and angular dependence will be carried out in order to unravel the causes for the variation in switching fields between dots.

The Anomalous Hall Effect provides a unique measurement tool to analyze the thermally induced reversal of nanometer sized magnetic elements inside large arrays, and can be fruitfully applied to other systems such as self assembled arrays of FePt particles.

[1] N. Kikuchi *et al.*, *APL.* 82, 4313 (2003), JMMM 287, 320 (2005)