Extraordinary Hall Effect in (Ni$_{80}$Fe$_{20}$)$_x$(SiO$_2$)$_{1-x}$ Thin Films

HUI LIU$^2$, FUK KAY LEE, RONG KUN ZHENG, X.X. ZHANG, OPHELIA K.C. TSUI, Department of Physics and Institute of Nano Science and Technology, Hong Kong University of Science and Technology — The extraordinary Hall effect (EHE) in ferromagnetic samples is generally attributed to scatterings of itinerant electrons in the presence of spin-orbit interactions. In this work, study on the thickness dependence of the EHE in the (Ni$_{80}$Fe$_{20}$)$_x$(SiO$_2$)$_{1-x}$ system showed the spontaneous Hall resistivity, $\rho_{sy}^S$, to be a constant while the Hall coefficient, $R_S(=\rho_{sy}^S/M_S$ where $M_S$ is the saturated magnetization) increased monotonically owing to a depression in $M_S$. We propose the constancy of $\rho_{sy}^S$ with reducing thickness to arise from the sample morphological structure becoming two-dimensional with decreasing film thickness, expected from classical percolation theory. We also find in this system with varying $x$ that $\rho_{sy}^S \propto \rho_{xx}^2$, with $\gamma = 0.53$ to 1 in disagreement with the value 2 frequently attributed to the side jump effect, but explainable in terms of the more general form $\rho_{sy}^S = \rho_{xx} \Delta y_e / \Lambda_{SO}$, where $\Delta y_e$ is the side jump displacement and $\Lambda_{SO}$ the spin-orbit mean-free-path.

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