

Co-occurrence of Anomalous Hall Effect (AHE) and Superparamagnetism in Diluted Magnetic Semiconducting (DMS) Oxides

Anomalous Hall Effect (AHE) has been suggested to be one of the three signature tests of carrier induced ferromagnetism (FM) in DMS systems. We have conclusively demonstrated however that AHE can result even in samples with an array of superparamagnetic clusters, thereby questioning the strength of this test as a sufficient proof of the intrinsic nature of DMS FM. In this study, epitaxial anatase TiO_2 films dilutely doped with cobalt and grown under highly reducing conditions were used. These conditions ensured suppression of normal Hall signal and enabled observation of good AHE signal.

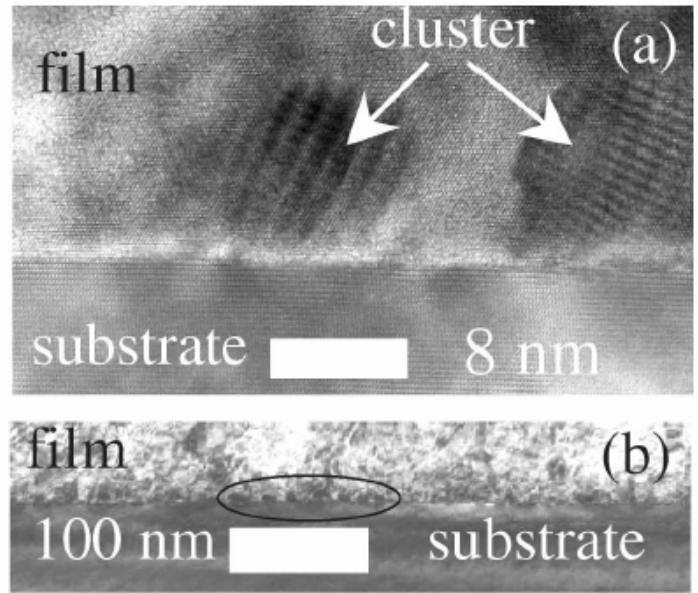
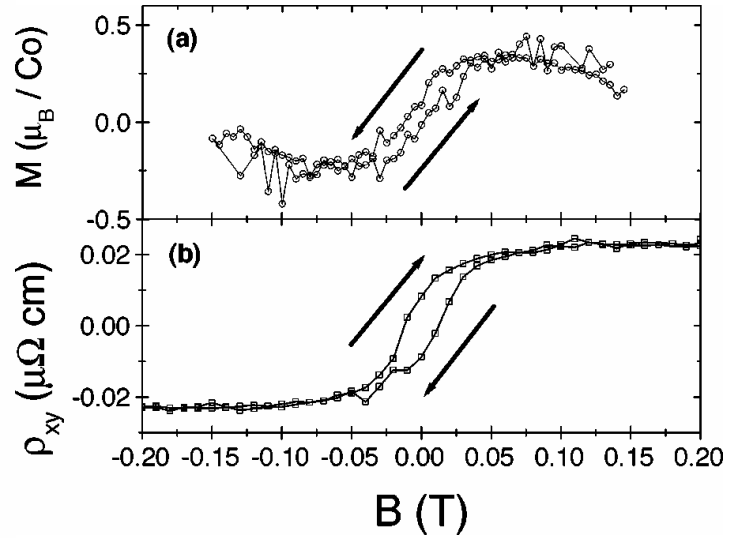
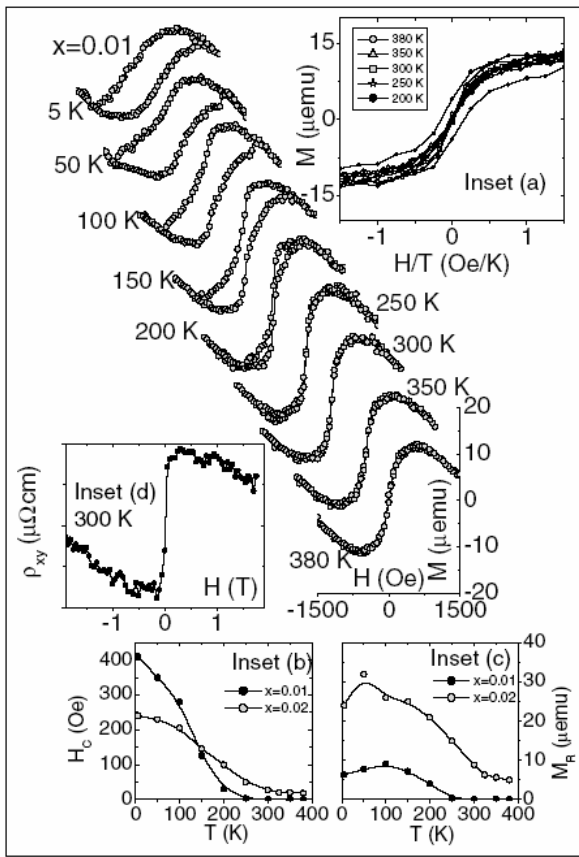


FIG. 2. M - H curves for $\text{Ti}_{0.99}\text{Co}_{0.01}\text{O}_{2-\delta}$ film measured at different temperatures. Inset (a) shows magnetization as a function of H/T for different temperatures. In insets (b) and (c) are plotted the temperature dependence of H_C and M_R for $\text{Ti}_{0.99}\text{Co}_{0.01}\text{O}_{2-\delta}$ and $\text{Ti}_{0.98}\text{Co}_{0.02}\text{O}_{2-\delta}$ films. Inset (d) shows the magnetic field dependence of Hall resistivity of the $\text{Ti}_{0.99}\text{Co}_{0.01}\text{O}_{2-\delta}$ film.

S. R. Shinde, S. B. Ogale, J. S. Higgins, H. Zheng, A. J. Millis, V. N. Kulkarni, R. Ramesh, R. L. Greene, and T. Venkatesan, *Phys. Rev. Lett.* 92, 166601-1 (2004).
 J. S. Higgins, S. R. Shinde, S. B. Ogale, T. Venkatesan, R. L. Greene, *Phys. Rev. B* 69, 073201 (2004).