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Diluted Ferromagnetism in Titanium Dioxide thin Films Containing No Magnetic Impurities

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Titanium dioxide (TiO_2) has drawn attention recently due to its diluted ferromagnetism at room temperature. Magnetic ordering in this wide-band-gap oxide appeared to be sensitive to the existence of defects such as vacancies and interstitials as well as the doped magnetic ions.

In this work, the magnetic and electronic properties of pure and Sb-doped $TiO_{2-\delta}$ thin films prepared on $Al_2O_3(0001)$ substrates by a sol-gel method were investigated. As Sb content increases, the anatase $TiO_{2-\delta}$ films exhibited n-p conductivity transition at which the unit-cell volume started to increase rapidly while the rutile ones maintained n-type character with slowly-varying unit-cell volume. These findings can be explained in terms of a multi-valence character of Sb ion, Sb^{3+} and Sb^{5+}.

Although the samples contain no magnetic element, they exhibited ferromagnetic hysteresis at room temperature with the saturation magnetization increased by Sb doping as shown in Fig. 1. The rutile films exhibited larger saturation magnetization than the anatase one for both undoped and Sb-doped cases. Existence of oxygen vacancies is believed to be a necessary condition for the observed ferromagnetic behavior. Possible interactions responsible for the diluted ferromagnetism are predicted.

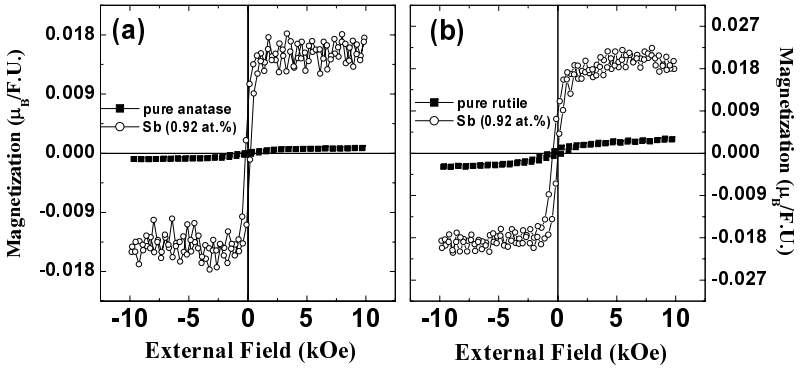

Fig. 1. Magnetic hysteresis data for pure and Sb-doped $TiO_{2-\delta}$ thin films at room temperature; anatase phase (a) and rutile phase (b).

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Characterizations of (Mn, Co)-codoped ZnO Nanorods Prepared by Thermal Diffusion

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We have prepared (Mn,Co)-codoped ZnO nanorods by thermal diffusion using pure ZnO nanorods, Mn and Co chips as precursors. The detailed investigations by means of X-ray diffraction, transmission electron microscopy, Raman scattering and photoluminescence spectra revealed the incorporation of Mn and Co into the ZnO host matrix. This did not change much in the lattice parameters of the ZnO wurtzite structure, and no secondary phase related to the dopants was observed. Having compared to magnetic behaviors of the two reference samples of Mn- and Co-doped ZnO nanorods, we believe that interactions between Mn and Co ions in (Mn,Co)-codoped ZnO nanorods is antiferromagnetic.