

Magnetic and Electronic Properties of Reduced Rutile

$\text{Ti}_{1-x}\text{Mn}_x\text{O}_{2-\delta}$ Thin Films

Kwang Joo Kim*, Young Ran Park*, Geun Young Ahn**, and Chul Sung Kim**

*Department of Physics, Konkuk University, Seoul, Korea

E-mail: kjkim@konkuk.ac.kr

** Department of Physics, Kookmin University, Seoul, Korea

Magnetic and electronic properties of Mn-doped rutile $\text{TiO}_{2-\delta}$ thin films grown on $\text{Al}_2\text{O}_3(0001)$ substrates by a sol-gel method have been investigated. Rutile $\text{Ti}_{1-x}\text{Mn}_x\text{O}_{2-\delta}$ thin films with $x = 3.9$ at.% were found to exhibit ferromagnetism at room temperature by vibrating sample magnetometry (VSM) with a saturation magnetic moment (M_S) of about $0.75 \mu_B$ per Mn ion as shown in Fig. 1. The films with $x = 5.6$ at.% also showed room-temperature ferromagnetism but with reduced M_S compared to $x = 3.9$ at.%. However, the films with $x = 2.5$ at.% showed no ferromagnetic behavior. Hall measurements revealed that all the Mn-doped films are p-type semiconductors with the hole concentration of about 10^{19} cm^{-3} while the undoped films n-type with electron concentration of about 10^{18} cm^{-3} . The electrical conductivity of the Mn-doped films were found to decrease with increasing Mn content. Thus, the ferromagnetism in the present rutile $\text{Ti}_{1-x}\text{Mn}_x\text{O}_{2-\delta}$ films is not attributable to the hole carriers but to a direct ferromagnetic coupling between neighboring Mn ions via an electron trapped in nearby oxygen vacancy.

This work was supported by grant No. R01-2003-000-10293-0 from the Basic Research Program of the Korea Science & Engineering Foundation.

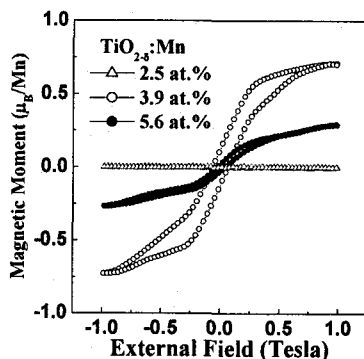


Figure 1. VSM measurement result of rutile $\text{TiO}_{2-\delta}:\text{Mn}$ films at room temperature.