≪연구논문≫ Journal of The Korean Magnetics Society, Volume 15, Number 2, April 2005

Electronic and Magnetic Properties of $Ti_{1-x}M_xO_{2-\delta}$ (M=Co and Fe) Thin Films Grown by Sol-gel Method

Kwang Joo Kim* and Young Ran Park
Department of Physics, Konkuk University, Seoul 143-701, South Korea

Geun Young Ahn and Chul Sung Kim
Department of Physics, Kookmin University, Seoul 136-702, South Korea

Jae Yun Park
Department of Materials Science and Engineering, University of Incheon, Incheon 402-749, South Korea

(Received 22 February 2005, in final form 28 March 2005)

Electronic and magnetic properties of $Ti_{1-x}M_xO_{2-\delta}$ (M=Co and Fe) thin films grown by sol-gel method have been investigated. Anatase and rutile $Ti_{1-x}Co_xO_{2-\delta}$ films were successfully grown on Al_2O_3 (0001) substrates and exhibited p-type electrical conductivity while the undoped films n-type conductivity. Room temperature vibrating sample magnetometry measurements on the anatase and rutile $Ti_{1-x}Co_xO_{2-\delta}$ films with same x (=4.8 at.%) showed quite similar magnetic hysteresis curves with the saturation magnetic moment of ~4 μ_B per Co ion despite their differences in structural and electronic properties. Such giant magnetic moment is attributable to the unquenched orbital moment of the Co^{2+} ions substituting the octahedral Ti^{4+} sites. Similar ferromagnetic behavior was observed for $Ti_{1-x}Fe_xO_{2-\delta}$ films that are highly resistive compared to the Co doped samples. Saturation magnetic moment was found to decrease for higher x, i.e., ~2 and ~1.5 μ_B per Fe ion for x=2.4 and 5.8 at.%, respectively. Conversion electron Mössbauer spectroscopy measurements predicted the coexistence of Fe^{2+} and Fe^{3+} ions at the octahedral sites of $Ti_{1-x}Fe_xO_{2-\delta}$.

Key words : ferromagnetism, TiO_2, magnetic moment, orbital moment quenching