Mössbauer Study and Magnetic Properties of $Ti_{0.99}Fe_{0.01}O_2$

Eng Chan Kim*[1], Su Ho Moon[1], Seung Il Woo[1], Jong Ho Cho[1], Yung Gull Joh[1] and Dong Ho Kim[1]

[1] Department of Physics, Yeungnam University, 214-1 Dae-dong, Gyeongsan-si, Gyeongsangbuk-do, Korea

*Corresponding author: e-mail: eckim@yu.ac.kr, Phone: +82 53 810 2343, Fax: +82 53 814 6141

There has been much attention paid to diluted magnetic semiconductors (DMS) in the last decade, but the origin of ferromagnetism in semiconductor remains an issue of discussions[1,2]. The purpose of this study is to carry out Mössbauer, X-ray and magnetic-susceptibility measurements on the mixed-crystal $Ti_{0.99}Fe_{0.01}O_2$ to examine magnetic properties and separated contribution of the ferromagnetic and paramagnetic phases to the magnetization. Synthesis of the $Ti_{0.99}Fe_{0.01}O_2$ sample was accomplished by the direct-composition method.

The X-ray diffraction pattern for $Ti_{0.99}Fe_{0.01}O_2$ showed a pure rutile phase with tetragonal structures, without any segregation of Fe into particulates within the instrumental resolution limit.

Magnetic properties have been investigated using the vibrating sample magnetometer (VSM) and Mössbauer spectroscopy with 30mC$_i$ ^{57}Co(Rh) source.

Room temperature magnetic hysteresis (M-H) curve showed an obvious ferromagnetic behavior and the magnetic moment per Fe atom under the applied of 1T was estimated to be about 0.72μ_B, proved by Mössbauer experiment.

Mössbauer spectra of $Ti_{0.99}Fe_{0.01}O_2$ prepared with ^{57}Fe enriched iron have been taken at various temperatures ranging from 87 to 298K.

The Mössbauer spectrum of $Ti_{0.99}Fe_{0.01}O_2$ consists of a ferromagnetic (six-Lorentzian) and a paramagnetic phase (doublet) over all temperature ranges. Separation of six-Lorentzian and doublet of Mössbauer spectrum was achieved using least-squares computer program. Isomer shifts indicate Fe^{3+} for the $Ti_{0.99}Fe_{0.01}O_2$ sample. It is noted that the magnetic hyperfine field of ferromagnetic phase had the value about two times as large as that of α-Fe.

This result indicates that the Fe impurities substituted into Ti atoms instead of the formation of iron clusters.

References

[1] Y.Matsumoto et al., science 291 (2001) 854

[2] Y.L.Soo et al., Appl. Phys. Lett., 81 (2002) 655

Fig.1. Logo of SOMMA conference.