Enhanced ferromagnetism in Co-doped TiO_2 powders

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Recent development in spintronics directed much attention to the ferromagnetic semiconductors considering their possible application to spintronic devices. Room temperature ferromagnetism has been observed for various type of dilute magnetic semiconductors (DMS) including GaN:Mn[1], GaN:Cr[2], TiO2:Co[3], and ZnO:Co[4]. Among these, TiO_2:Co has been widely studied due to its unique optical and electronic properties.

TiO_2:Co powder samples were prepared by sol-gel method using titanium isopropoxide ($Ti[OCH(CH_3)_2]_4$) as the source for titanium and cobalt acetate tetrahydrate ($Co(CH_5CO_2)_24H_2O$) as the source fof cobalt in presence of a 2-methoxyethanol solution. The starting sol-gel samples were annealed under a pressure less than 10^{-6} Torr at temperature of 500 ℃ for 5 hours. X-ray diffraction (XRD) was employed for structural characterization. The hysteresis loops and magnetization of the anatase TiO_2:Co powder for different concentration of Co (1, 3, 5, 10 %) were obtained using a commercial vibrating sample magnetometer at temperatures from 50 to 800 K. Microscopic analysis was performed using scanning electron microscope (SEM) and transmission electron microscope (TEM).

For all Co concentrations, the anatase TiO_2 phase but sometimes with minor rutile phase were observed from XRD experiment. The magnetization measurement showed room temperature ferromagnetism for these materials with the Curie temperatures much higher than the room temperature. The magnetic moment per Co atom was higher than the previously reported value and was significantly increased as Co concentration got higher. In conjunction with the earlier results of solid-state reaction method, we attribute this enlarged magnetization to the lack of the formation of Ti-Co-O complexes. To check the existence of Co metal clusters, TEM experiments are being under study.

References

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