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A Study on Magnetic, Optical and Dielectric Properties of Mg-Doped TiO_2(Anatase+ Rutile) from Spintronic Perspective

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Non-magnetic element doped d^0 ferromagnetic oxides have recently received a lot of attention because of their potential application in spintronic devices. In search of a novel ferromagnetic semiconductor oxide, this work extensively explored the crystal structure, elemental color mapping, magnetic, electrical, and optical properties of $Ti_{1-x}Mg_xO_2$ (x=0, 0.03, 0.06, 0.09 and 0.12) compounds which were produced using solid-state method. The rutile phase is prominent in all Mg-doped TiO_2 samples, according to X-ray diffraction patterns, although the anatase (A) phase increases as the Mg doping concentration increases. All elements such as Ti and Mg are distributed consistently throughout the sample, according to elemental color mapping, performed by using energy dispersive spectroscopy technique. All of the compounds show ferromagnetism with hysteresis loops, with Curie temperatures exceeding 400 K and coercivity values ranging from 355 to 750 Oe. The 6 percent doped sample demonstrated the highest saturation magnetization value. A hint of magnetic irreversibility is seen as there exists a bifurcation in the ZFC and FC magnetization curves. The optical band gap of these compounds increases up to 9% when Mg is added, then narrows when more Mg is added. Furthermore, with Mg doping, these materials demonstrate a zero value of loss tangent and an increase in dielectric constant. From this study we suggest that these compounds may find use in magnetic storage, spintronics, and high frequency optoelectronics.

References

Bouzerar, G., & Ziman, T. (2006), Model for Vacancy-Induced d^0 Ferromagnetism in Oxide Compounds, Physical Review Letters, Vol. 96, Issue 20.

Srivastava, S. K., Lejay, P., Barbara, B., Pailhès, S., Madigou, V., & Bouzerar, G. (2010), Possible room-temperature ferromagnetism in K-doped SnO_2: X-ray diffraction and high-resolution transmission electron microscopy study, Physical Review B, Vol. 82, Issue 19.

Liu, Y., Zhou, W., & Wu, P. (2014). Room-temperature ferromagnetism and optical properties in Mg-doped TiO_2: A density functional theory investigation, Journal of Applied Physics, Vol. 115, Issue 12, p. 123913.

Chouhan, L., Bouzerar, G., & Srivastava, S. K. (2021). Effect of Mg-doping in tailoring d^0 ferromagnetism of rutile TiO_2 compounds for spintronics application, Journal of Materials Science: Materials in Electronics, Vol. 32, Issue 8, pp. 11193–11201.

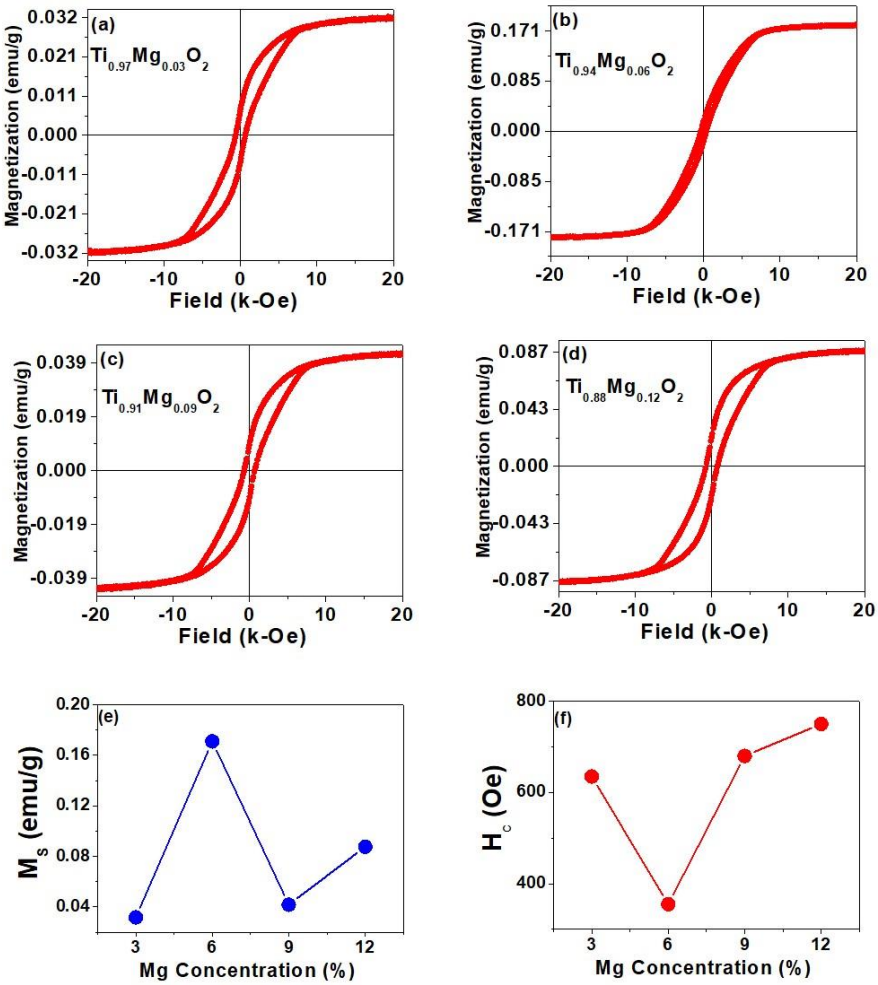

Figure 1: (a), (b), (c) and (d) represent M-H curves for $Ti_{1-x}Mg_xO_2$ (x=0.03, 0.06, 0.09 and 0.12) compounds obtained at 300K. (e) and (f) represent variation of saturation magnetization (M_S) and coercivity (H_C) with Mg concentration for the experimental samples obtained at 300 K.

Table 1: A few important parameters obtained in the study

Doping Concentration (%)	**M_S (emu/g)**	**H_C (Oe)**	**Optical band gap (eV)**
3	0.0317	635	3.42
6	0.1710	355	3.39
9	0.0417	680	3.34
12	0.0876	750	3.19