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Magnetic and Electronic Properties of Reduced Rutile $Ti_{1-x}Mn_xO_{2-\delta}$ Thin Films

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Magnetic and electronic properties of reduced rutile titanium dioxide ($TiO_{2-\delta}$) thin films doped by Mn have been investigated. The present sol-gel-grown semiconducting $TiO_{2-\delta}$:Mn films exhibit a ferromagnetic behavior at room temperature for a limited range of Mn content. The Mn-doped films have p-type electrical conductivity with the carrier concentration near 10^{19} cm^{-3}. The observed room-temperature ferromagnetism is believed to be intrinsic but not related to free carriers such as holes. Oxygen vacancies are likely to contribute to the room-temperature ferromagnetism−trapped carriers in oxygen vacancies can mediate a ferromagnetic coupling between neighboring Mn^{3+} ions. The energy band-gap change due to the Mn doping measured by spectroscopic ellipsometry exhibits a red-shift compared to that of the undoped sample at low Mn content. It is explainable in terms of strong spin-exchange interactions between Mn ion and the carrier.

Key words : ferromagnetism, titanium dioxide, oxygen vacancy, Mn-doping