Magnetic properties thin films of TiO_2 – Mn

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Titanium dioxide (TiO_2) is a large band gap semiconductor with many interesting properties. This material possesses high refractive index and low absorption coefficient in visible light, which makes it an excellent optical coating material. TiO_2 films have many other unique properties which make them highly attractive for a variety of applications such as photovoltaic devices, gas sensors, electrochromic displays and photocatalysts. Optical gap of TiO_2 is 3.2 eV that belongs in the ultraviolet region of solar spectrum. However, the peak of solar spectrum is in the visible region. Many methods have been proposed to solve these problems, but doping TiO_2 with foreign ions, such as Fe, Cr and Ni, is one of the most promising strategies for sensitizing TiO_2 to visible light and also for forming charge traps to keep electron–hole pairs separate. In photovoltaic, the ability of tuning the band gap energy (E_g) of the absorbing films is of prime importance in order to cover the maximum of the solar spectrum. Moreover, detailed knowledge of the optical properties (i.e., refractive index (n) and extinction coefficient (k)), of the absorbing passive (or active) oxide layer is a prerequisite for the design of highly efficient photovoltaic [1].

Among these, Mn seems to be one of the most promising dopant in TiO_2 as it shifts the optical absorption spectrum towards the visible range and improves the photocurrent density of TiO_2. However, an excess of chromium leads to the recombination of charge carriers. Most of the experimental work on TiO_2–Mn system has been carried out on single crystals, polycrystalline ceramics or powders with few exceptions concerning thin films [2].

Titanium dioxide thin films doped with manganese (Mn – 1; 3; 5 mol%) were deposited onto the silicon in a universal coating system Leybold – Heraeus L560 by electron-beam evaporation in a vacuum.

Before the deposition process started, the vacuum chamber was pumped down to a residual pressure of 5×10^{-5} mbar. Prepared tablets were placed in a copper crucible with water cooling and gradually heated up by electron beam in vacuum chamber. The substrate temperature was 673 K. The deposition process lasted for 15 min.

Magnetic properties of titanium dioxide thin films doped with manganese (Mn – 1; 3; 5 mol%), studied in the temperature rang T = 77 ÷ 300 K under magnetic field H = 0,25 ÷ 4 kOe. We have established that the paramagnetic component χ increases with decrease of temperature and with the increase of Mn content in the films. The contribution of the silicon substrate on the total magnetic susceptibility was taken into account during the determination of χ of the pure and doped with manganese (Mn – 1; 3; 5 mol%) TiO_2 thin films.

[1] A. Hajjaji, M. Gaidia, B. Bessaisa, M.A. El Khakanib, *Applied Surface Science* **257**, 10351 (2011).

[2] M. Radecka, K. Zakrzewska , M. Wierzbicka, A. Gorzkowska, S. Komornicki, *Solid State Ionics* **157**, 379 (2003).