THE ROLE OF STRUCTURAL DEFECTS IN MAGNETISM FORMATION IN TiO_2 THIN FILMS DOPED VANADIUM

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The idea about defect-induced ferromagnetic long-range order at RT in some semiconducting materials is not new, but still needs to be further proved. In the case of TiO_2 doped by 3d transition atoms the most interesting situation within this thought is with doping by Vanadium. The amount of defects was measured by Positron Annihilation Spectroscopy (PAS). The correlation between the saturation magnetization of the TiO_2:V samples (SQUID-measurements) and the total amount of defects was established.

Titanium dioxide is in the focus of research activity for several decades since it is considered as a perspective material for a wide range of applications in optoelectronic devices, transparent conductors, gas sensors, photocatalytic devices, *etc*. Being a wide band gap semiconductor it became a very promising candidate for the special class of materials called as Diluted Magnetic Semiconductors (DMS) which exhibits room temperature ferromagnetism (RTFM) phenomenon after doping of 3d transition metals. Nevertheless, the origin of RTFM in this material is still a controversial issue.

Many recent published results declare the strong dependence of RTFM on the preparation method, thus, the influence of different defects created during the sample preparation should not be ignored. The most obvious types of defects that could be considered are: oxygen vacancies and their complexes [1], type of the crystal structure (anatase or rutile) [2] and negatively charged point defects created by Ti^+ or 3d ions [3,4] when they are leaving the correct site positions in the host matrix.

Among different preparation techniques the ion implantation has some privileges: by variation of the ion energies the different implantation depths could be achieved allowing the creation of a homogeneous profile of ion distribution inside the host matrix. But this process *a priory* bears a lot of defects, which could be only partially removed by annealing afterwards. So, the quantitative and qualitative analysis of different defect distributions would be valuable. A successful application of ion implantation for creation of other DMS materials is already confirmed [5].

We have analyzed the amount of different defects created during 3d ion implantation in the TiO_2 semiconducting matrix. As a result, the Ti and O defect depth profiles as well as 3d ions interstitials and ion fluences have been calculated for five different energies needed to create a box-like profile of implanted ions. The analysis has been done with the help of the TRIM program package [6]. The amount of defects is compared with results of Positron Annihilation Spectroscopy (PAS) performed on the TiO2 thin films doped with Co and V (1÷3at%) and SQUID magnetometry data. The average distances between 3d impurities in the host matrix are estimated.

Recently we found that in 1at% and 3at% V-doped TiO2 thin films prepared by magnetron sputtering the saturation magnetization correlates well with an amount of negatively charged defects estimated by Doppler-Broadening technique of (PAS) and only slightly depends on the film conductivity. Meanwhile the magneto-optical (MO) spectroscopy showed a principal difference between these two doping levels and strong dependence on film resistivity. So, negatively charged defects and free carriers have to be taken into account separately from each other for the explanation of RT ferromagnetism in titanium dioxide films.

Support by a German-Russian joint research group HRJRG-314 & RFBR 12-02-91321-SIGa is acknowledged.

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