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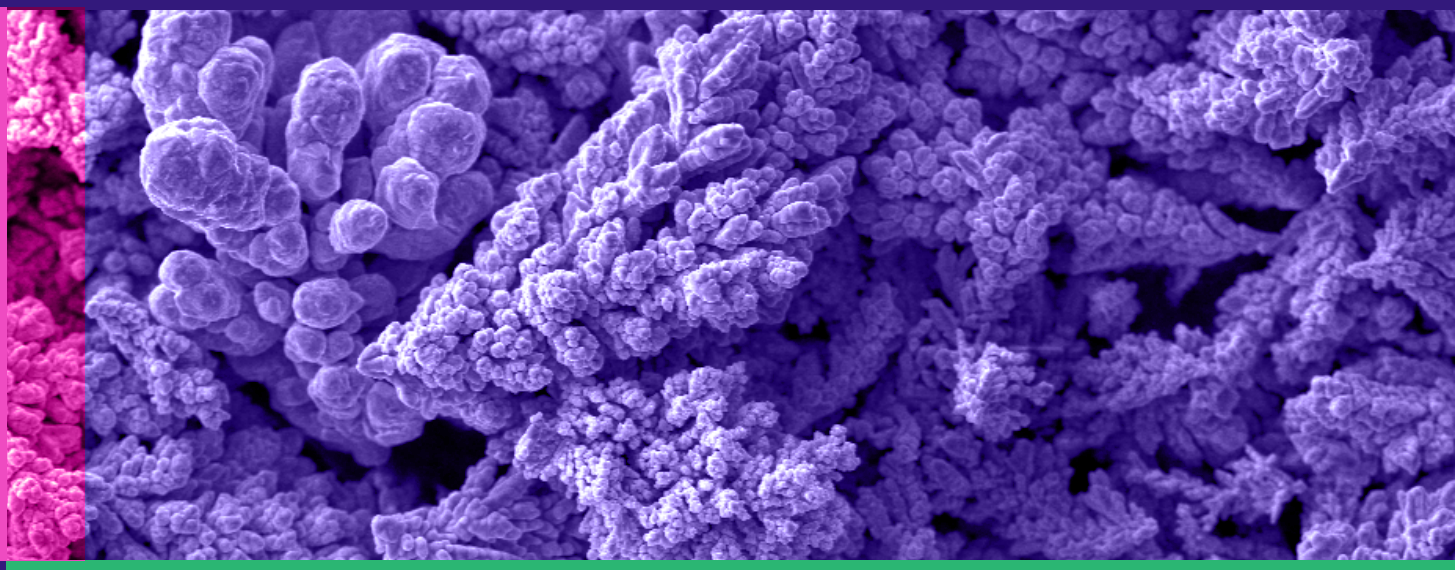

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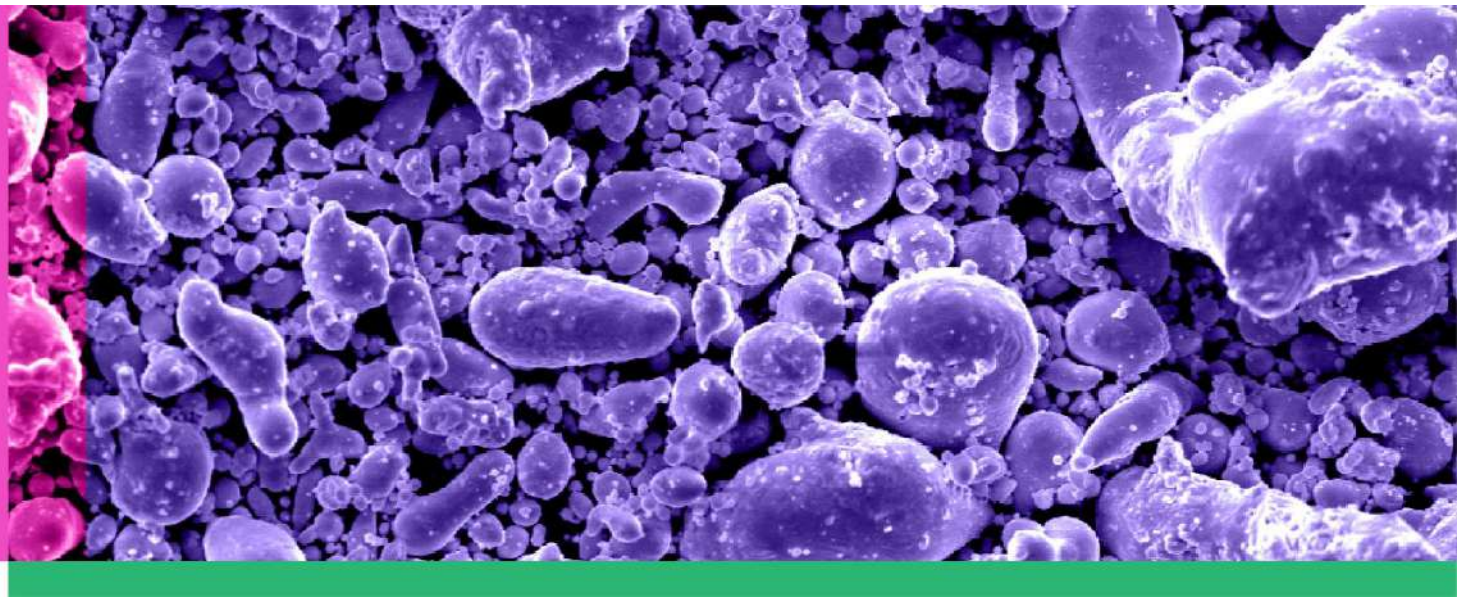

Synthesis and magnetic properties of Fe, Ni, Co-doped tin oxide films

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Metal oxide semiconductors doped by ferromagnetic metals have attracted essential interest amoung scientists during last decades due to possibility of applications of their magnetic and electric properties for spintronic devices fabrication [1]. Tin dioxide films doped with ferromagnetic ions are considered as a promising candidate for spintronic applications [2].

We propose method for fabrication of tin oxide films codoped by magnetic metals (Fe, Ni, Co). Reactive DC magnetron sputtering of tin target with nickel–cobalt ferrous alloy inserts in argon-oxygen plasma (with oxygen content within range 0–8 vol. %) onto glass substrates with subsequent 2-stage thermal oxidation of the synthesized layers in air (isothermal annealing at 200 °C during 2 hours followed by high temperature annealing at the temperatures within range 300–450 °C during 1 hour). X-ray diffraction (XRD) analysis and Raman scattering was used to control phase composition and crystalline structure of the synthesized films. Magnetization measurements were done using vibrating magnetometer installed in the closed-cycle Helium refrigerator CFHF Cryogenics Ltd. in the temperature range of 2–300 K and in magnetic field up to 8 T.

XRD analysis and Raman scattering of the synthesized films shown that doped by ferromagnetic metals tin oxide films are characterized by more disordered crystalline structure in comparison with undoped tin oxide films fabricated using the same technological procedure [3]. Broad lines inherent to SnO_2, SnO crystalline structure and to nonstoichiometric phases Sn_2O_3 и Sn_3O_4 were detected on the XRD patterns for samples synthesized in argon plasma and in argon-oxygen plasma (with 2 vol. % of oxygen content). Amorhous tin oxide films doped with Fe, Ni, Co were fabricated at the oxygen content ≥4 vol. % in argon-oxygen plasma.

Magnetization measurements were made both for undoped and doped with Fe, Ni, Co tin oxide films. It was found that magnetization behavior of doped by ferromagnetic metals samples is paramagnetic in the whole investigated temperature range (2–300 K). In contrast for undoped $SnO_{2-\delta}$ paramagnetism only at low temperatures (within range 2–4 K) at low magnetic fields ≤2T was observed due to existence of oxygen vacancies in the samples. At the higher temperatures $SnO_{2-\delta}$ films were diamagnetic. The further investigations will be focused on the optimization of the technological parameters of the synthesis procedure of doped by ferromagnetic metals tin oxide films in order to fabricate samples characterized by high-temperature ferromagnetism.

Acknowledgement

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References

[1] K. Nomura, Croat. Chem. Acta 88 (2015) 579–590.
[2] K. Gopinadhan, S.C. Kashyap, D.K. Pandya, and S. Chaudhary, Journ. Appl. Phys. 102 (2007) 113513.
[3] D.V. Adamchuck, and V.K. Ksenevich, Dev. Meth. Meas. 10 (2019) 138–150.