FORMATION OF $ZnFe_2O_4$/ZnO:Al THIN FILM HETEROSTRUCTURE WITH THE PEROXIDASE MIMETIC PROPERTIES BY RF-MAGNETRON SPUTTERING METHOD

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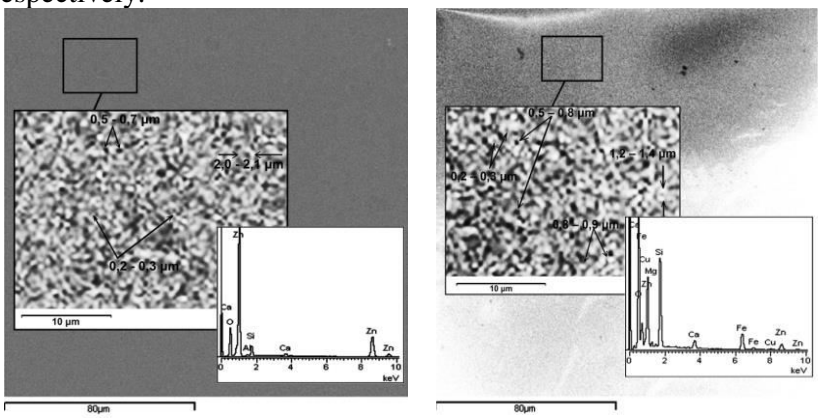
In recent years analytical methods based on the catalytic activity of nanoparticles with the properties of the peroxidase mimetic, such as palladium nanoparticles, porous cobalt oxide nanostructures and others, have been successfully used to detect pollutants in the environment [1]. In our work we propose $ZnFe_2O_4$/ZnO:Al film heterostructures that were obtained by magnetron sputtering in an argon atmosphere as a mimetic of the peroxidase enzyme for the detection of hydrogen peroxide in model experiments. The morphology and chemical composition of $ZnFe_2O_4$/ZnO:Al thin films were studied using a Zeiss Sigma scanning electron microscope and Tescan Vega TS 5130MM equipped with an Oxford Instruments INCA energy dispersive X-ray system operating at a voltage of 20 kV. The study of the chemical composition obtained using X-ray spectroscopy (EDX) shows in the case of thin layer of ZnO:Al, along with the main elements Zn, O, Al, elements similar to glass (Ca, Si, Mg, O) as well as Zn, Fe, O, for $ZnFe_2O_4$/ZnO:Al film nanostructures. In Fig.1 (a) and (b) are presented SEM EDX of ZnO:Al thin film and $ZnFe_2O_4$/ZnO:Al heterostructure respectively.



(a) (b)

Figure 1. SEM EDX of ZnO:Al/glass thin film (a) and $ZnFe_2O_4$/ZnO:Al heterostructure (b).

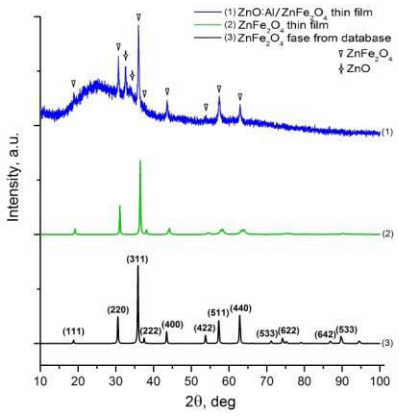


Figure 2. XRD of $ZnFe_2O_4$/glass thin film (2) and $ZnFe_2O_4$/ZnO:Al/glass heterostructure (1).

The comparison of the X-ray diffraction (Desktop X-ray diffractometer Miniflex 600 Rigaku) of the obtained thin films in Fig.2 (2) with a diffraction pattern from the JCPDS database No. 22-1012 presented in Fig.2 (3) shows the presence of peaks corresponding to (111), (220), (311), (222), (400), (422), (511), (440) phases of cubic spinel (Franklinite). In Fig.2 (1) specific peaks related to ZnO in the $ZnFe_2O_4$/ZnO:Al/glass heterostructure are presented. The ZnO sample shows the specific peaks at 2θ = 31.7° (100), 34.4° (002) and 56.5° (110) corresponding to the hexagonal structure of wurtzite type (ICDD No.01-078-2585). The peroxidase activity of the $ZnFe_2O_4$/ZnO:Al/glass films structure was studied using 3,3', 5,5'-tetramethylbenzidine (TMB) as a peroxidase substrate in the presence of H_2O_2 according to the procedure described in [2].

[1] Patent No: AU2020100704. Date of Filing: 2020.05.05. A method of synthesis of ultrathin palladium nanosheet with peroxidase mimetic activity for the colorimetric detection of H_2O_2.
[2] L. Gao, M. Liang, X. Yan. *Nature Protocols* 2018 **13** 1506−1520.