Preparation of $ZnFe_2O_4/ZnO:Ga/SnO_2$ Heterostructure with Peroxidase-Like Activity for the Detection of Hydrogen Peroxide

Anatolie Sidorenko [1], Tatiana Gutsul [1], Igor Belotserkovskii [1], Maria Lupu [1], Dilara Öztürk [2], Oleg Zoteev [3]

[1] Technical University of Moldova, Institute of Electronic Engineering and Nanotechnologies "D. Ghitu", Chisinau, Moldova, anatolie.sidorenko@iien.utm.md, tatiana.gutul@iien.utm.md, igori.belotercovschi@iien.utm.md, maria.lupu@iien.utm.md, ORCID: 0000-0001-7433-4140, 0000-0002-6528-285X, 0000-0003-3741-3530, 0000-0001-6768-9357

[2] Gebze Technical University, Kocaeli, Turkey, dilaraozturk@gtu.edu.tr, ORCID: 0000-0002-7211-2162

3 Odessa National Polytechnic University, Odessa, Ukraine, zoteevoleg@i.ua, ORCID: 0000-0002-5377-6342

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Abstract. The study is devoted to the creation of effective nanocatalysts based on semiconductor heterostructures with the property of peroxidase mimetic enzymes. These substances can be used in the colorimetric determination of hydrogen peroxide, participate in various catalytic processes, and also be used in photodestructive reactions of harmful and toxic organic water pollutants (dyes of the textile industry, pesticides, antibiotics and other pharmaceuticals).

New heterostructures of the $ZnFe_2O_4/ZnO:Ga/SnO_2$ composition were obtained by magnetron sputtering [1]. The $ZnFe_2O_4/ZnO:Ga/SnO_2$/glass film heterostructure was studied in accordance with the standards [2]. Gallium-doped zinc oxide (ZnO:Ga) films were grown on SnO_2 substrates by a similar magnetron sputtering method at direct current using a target and a substrate temperature of 200°C. The magnetron power was 1.2 W. The target (consisting of pressed $ZnFe_2O_4$ nanoparticles) was sputtered discretely at a supply voltage frequency of 13.56 MHz and a magnetron power in the range of 40-100 W.

At the second stage, at a substrate temperature of 200°C, $ZnFe_2O_4$ films were formed, and the temperature in the sputtering (erosion) zone reached 700°C. The obtained $ZnFe_2O_4$/ZnO:Ga/SnO_2/glass layers were studied and characterized by such physico-chemical methods as SEM, EDX, AFM, XRD, UV-VIS. The chemical composition was determined using X-ray spectroscopy (EDX), which made it possible to detect the main elements of the structure (O, Fe, Zn, Ga, Sn). The study of the morphology of the layers made it possible to reveal the formation of flexible chain and ring-shaped aggregates with a ribbed structure.

This structure leads to the creation of a developed surface with a roughness level of 15 nm. This in turn leads to an increase in the area of the active contact surface, which leads to an increase in catalytic activity. It is shown that the resulting film heterostructure $ZnFe_2O_4$/ZnO:Ga/SnO_2/glass has the property of a mimetic peroxidase enzyme and participates in catalytic processes.

References

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