The use of metal nanoparticles of the platinum group to improve the analytical characteristics of enzyme biosensors for application in biotechnological industries

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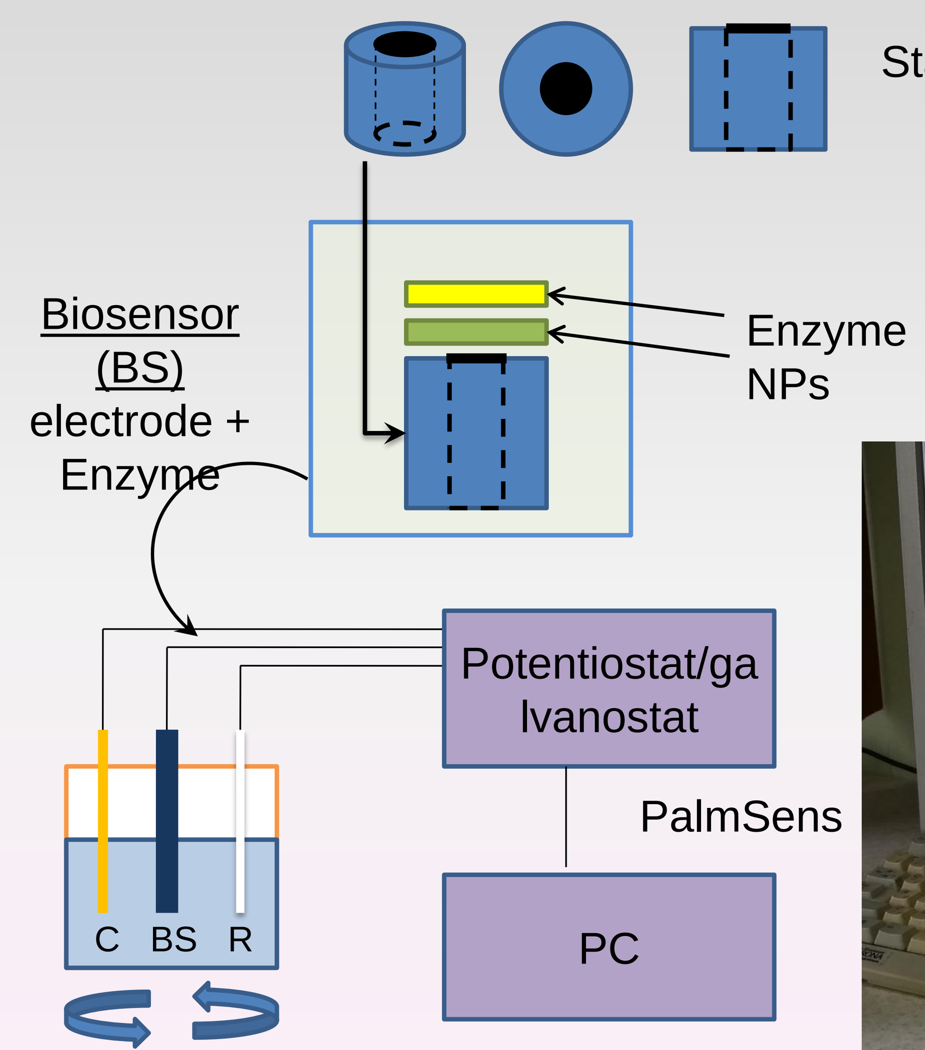
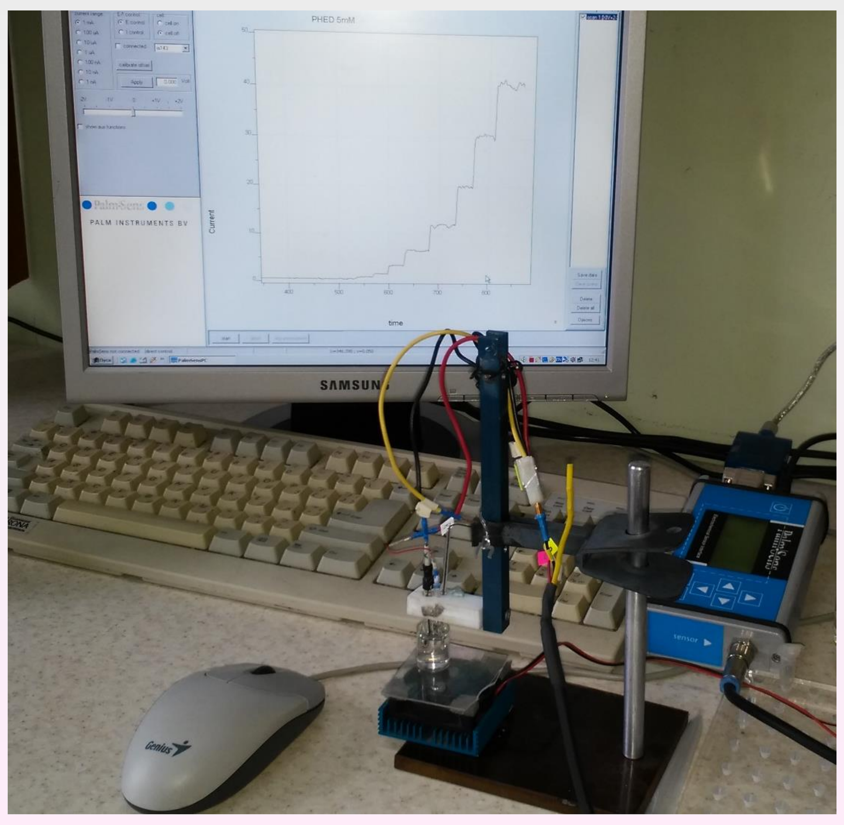
Nanomaterials have attracted much attention due to their electronic properties. In electrochemical biosensors, where the enzymes are integrated with electrodes, the direct electron transfer is difficult since the enzyme active sites are deeply buried in the protein matrix [1]. Nanomaterials are suitable for acting as “electronic wires’’ to shorten the electron transfer distance, enhance the electron transfer between the redox centers of enzyme and electrode surface and simultaneously retaining the biological activity of the redox enzymes, which allows the development of stable sensors [2].

The work is aimed at the development of a sensitive element of the biosensor, based on enzymes and amperometric electrodes modified with nanoparticles of the platinum group. The voltamperometric characteristics of the modified sensors were studied, the working characteristics of the biosensors were thoroughly analyzed, their stability and selectivity were investigated.

Methods

Scheme of amperometric plant





Results

The work was aimed at the development of a sensitive element of the amperometric biosensor, based on enzyme and amperometric electrodes modified nanoparticles of the platinum group. The voltamperometric characteristics of the modified sensor were studied, the enzyme stabilization was carried out. An influence of the medium parameters on the biosensor operation was comprehensively investigated. The working characteristics of the biosensor were thoroughly analyzed, its stability and selectivity were investigated.

Amperometric biosensor	Sensitivity, µA/mM cm^2						
	modified IrNPs	without modification	modified Pd/Pt NPs	without modification	modified AuNPs	without modification	**increased sensitivity, times**
			79	49			**1,6**
					5,655	1,255	**4,5**
					2,828	0,925	**3**
	1,56	0,30					**5,2**

An increase in the bioselective membrane activity as a result of using nanoparticles was shown (Table 1.). The developed biosensors are characterized by the linear range of 0.05–0.8 mM and sensitivity of 3.03 mA • M^{-1} • $см^{-2}$ (Pt/Pd NPs) ; 0.05–4 mM and sensitivity of 123,75 mA • M^{-1} • $см^{-2}$ (AuNPs); 0.05–4 mM and sensitivity of 106 mA • M^{-1} • $см^{-2}$ (IrNPs); the lower detection limit of all biosensors 0.1 µM

Conclusion

The developed biosensor based on metal nanoparticles demonstrated significantly higher sensitivity; thus, it can be used in further experiments with real samples.

Application of bionanocomposites with promising properties opens new possibilities for the enzyme immobilization and the development of new electrochemical biosensors.

1. *Lu Q., Dong X., Li L.J., Hu X.* Direct electrochemistry-based hydrogen peroxide biosensor formed from single-layer graphene nanoplatelet-enzyme composite film // Talanta.-2015.-**82**, N 4.-P. 1344-1348.
2. *Wang X., Zhang X.* Electrochemical co-reduction synthesis of graphene/nano-gold composites and its application to electrochemical glucose biosensor // Electrochimica Acta.-2013.-**112**, N 1.-P.774–778.

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