Non-enzymatic Glucose Sensors: Effect of Binder-Particles Interactions in Drop-Casted Suspensions on Electrodes Performance

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Nowadays, as a response to the growing demand for convenient, point-of-care measuring systems for diabetics, new technologies are developed, which enable continuous glucose monitoring (CGM). One of the most important roles in this field is being played by electrochemical sensors, which enable precise and accurate measurement, giving a fast response to the patient. The possibility to provide continuous information about glucose level in blood without any time lag aids in notification of all cases of hyper- or hypoglycaemia during the day. Moreover, it allows to obtain data for the estimation of glucose level in the future and subsequently avoid high fluctuations. However, currently utilized CGM systems based on enzymes suffer from autoimmune organism reactions due to the large size of the devices but also poor stability (short storage lifetime). To overcome these drawbacks, more efforts are presently concentrated on developing sensors, which utilize nanomaterials for direct glucose oxidation to minimalize the required for the detection working area.

This work aims to broaden the understanding of the secondary factors influence on nonenzymatic sensor output. The main focus is placed on the investigation of binder-particles interactions in drop-casted suspensions and their implications for evaluating material perspectives for glucose detection. For this purpose, flower-like copper sulfides were chosen as a model material. As a binder, three different polymers commonly encountered in the reports on non-enzymatic glucose sensors were chosen, i.e., Nafion (anionic polymer), chitosan (cationic polymer) and polyvinylpyrrolidone (PVP, nonionic polymer). Detailed characterization of copper sulfides was conducted. Furthermore, nanosuspensions based on above-mentioned polymers were prepared and their rheological parameters were measured. Subsequently, glassy carbon electrodes (GCE) were modified using drop casting technique and their characteristic sensing parameters were measured, i.e., glucose oxidation potential, electrochemically active surface area, limit of detection and quantification, sensitivity, linear range and chemical stability. It was proved that in the case of positively charged copper sulfides, the best stabilization and therefore the most uniform GCE coverage was obtained when using PVP as a binder (Figure 1).

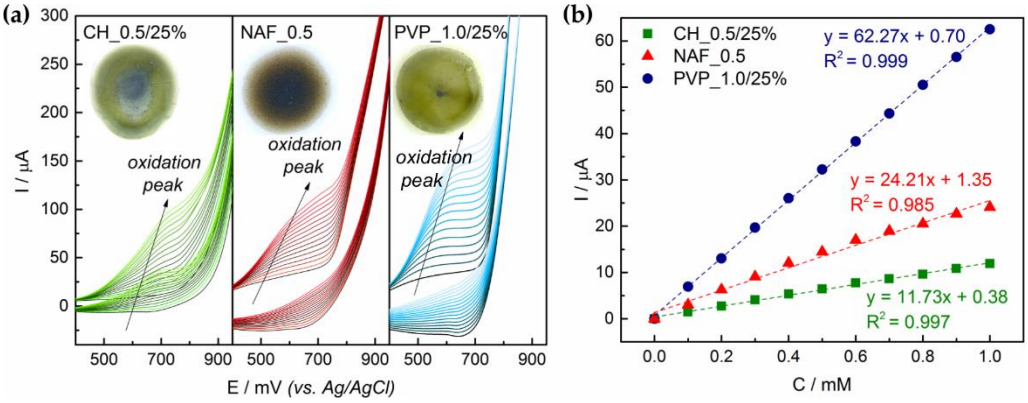

Figure 1 . Electrochemical performance of the modified GCE electrodes based on chitosan (CH_0.5/25%), Nafion (NAF_0.5), and polyvinylpyrrolidone (PVP_1.0/25%): a) voltammograms for glucose concentration range 0–1.5 mM, (b) regression lines glucose concentration versus generated current (step 0.1 mM).

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