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Abstract

Electrocatalytical Chemical Sensor for Hydrogen Peroxide †

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Abstract: The fast and selective determination of hydrogen peroxide (H_2O_2) is of importance not only because of strong interest in this widely applied analyte, but also because of the development of enzymatic biosensors for glucose or other metabolites where the sensor for H_2O_2 can be used as the transducer. Here, we report on an electrocatalytical amperometric sensor for the detection of H_2O_2. It is a sensor that consists of a gold electrode covered by a self-assembled monolayer (SAM) with immobilized p-benzoquinone. To provide highly stable immobilization of p-benzoquinone at the distance of effective electron tunneling, a new anchor compound—1,3-dimercaptopropan-2-ol—was synthesized and used for preparation of the SAM. Due to two thiol groups binding gold surface, this compound provides high stability of the SAM. The surface concentration of p-benzoquinone obtained from cyclic voltammetry is $2.5 \pm 0.2 \times 10^{-10}$ mol·cm^{-2}. Cyclic voltammetry and chronoamperometry experiments proved that the immobilized benzoquinone exhibited high electrocatalytic activity towards the decomposition of H_2O_2. Depending on the used potential range, different sensing modes can be realized. For example, one can measure electrochemical response due to the oxidation of H_2O_2 at anodic potentials, or due to the reduction of oxygen formed during oxidative decomposition of H_2O_2. Also, amperometric response at fixed potential of +0.4 V vs. Ag/AgCl corresponding to the oxidation of benzoquinone to hydroquinone was studied. The sensor exhibited a linear response over a concentration range of 0.1–2 mM with a low detection limit of 4.24 µM. The reproducibility of three different electrodes prepared was examined at the H_2O_2 concentration range from 0.1 till 3 mM, which resulted in a relative standard deviation below 4.2%.

Keywords: self-assembled monolayer; p-benzoquinone; electron transfer; cyclic voltammetry; chronoamperometry; hydrogen peroxide; electrocatalysis; chemical sensor

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