

Effects of Azides on Detection of Hydrogen Peroxide in Electrochemical Glucose Sensors

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Electrochemical glucose sensors to monitor the glucose concentration in human urine have received much attention because of increasing interests to diabetes. The important components of the urine glucose sensor are an enzyme membrane, through which urine is oxidized so as to produce hydrogen peroxide, and three-electrode system to detect the generated hydrogen peroxide under the membrane. The glucose concentration is determined by monitoring the oxidation current of hydrogen peroxide on a platinum electrode kept at an appropriate potential. In the actual use, urine is diluted with a carrier solution to flow to the sensor. The carrier solution is based on a neutral buffer solution, containing sodium azide as a preservative. Sodium azides provide azide ions, which are expected to be oxidized on the platinum electrode and may affect the hydrogen peroxide detection. This study aimed to investigate the effects of azide ions on the electrochemical oxidation of hydrogen peroxide on platinum.

A conventional three-electrode cell was used in all experiments. The working electrode was a platinum film formed on an alumina substrate by screen printing and calcination method. The platinum plate counter electrode and the KCl saturated Ag/AgCl reference electrode were used. The electrolyte was based on a phosphate buffer solution (pH=6.74), and reagent grade hydrogen peroxide solution and/or sodium azide were added into the electrolyte. Cyclic voltammetry was performed at room temperature.

Figure 1 shows the cyclic voltammograms of the buffer solution with and without hydrogen peroxide. The oxidation of hydrogen peroxide on the platinum electrode started at ca. 0.3 V. The current became almost constant in the potential region from 0.45 V to 0.65 V on each of the forward and reverse scans, which suggests that the current in the potential region is under diffusion control. Therefore, the oxidation current in the region apparently depends on the concentration of hydrogen peroxide. The cyclic voltammograms of the basic electrolyte with and without sodium azide are also presented in Fig. 2. The addition of sodium azide into the basic electrolyte produced a new and broad oxidation wave, of which the current began to increase at ca. 0.1 V. It was also found that the cathodic wave at around 0.1 V observed in the voltammogram of the basic electrolyte, which corresponds to the reduction of platinum oxide, disappeared by the addition of NaN₃. The oxidation and reduction processes of azide ions in an aqueous solution have been reported [1, 2], in which the first oxidation process of N₃⁻ involves a one-electron transfer, resulting in the

formation of N₃ adsorbates. Therefore, the disappearance of the reduction wave of platinum oxide is related to the adsorption of N₃ on the platinum electrode, in which the adsorbed N₃ would suppress the oxidation of platinum, since the oxidation of N₃⁻ precedes that of platinum. This means that the adsorption of N₃ makes the platinum electrode's surface to be inactive for other oxidation processes expected at higher potentials.

The comparison of the results shown in these figure implies one important feature on the effects of azides on the detection of hydrogen peroxide: Since the oxidation of N₃⁻ to produce N₃ adsorbates also precedes that of hydrogen peroxide, the electrode surface after the N₃ adsorption is possible to become inactive to the hydrogen peroxide oxidation. This means that the existence of azide ions in the carrier solution of human urine would disturb the correct detection of hydrogen peroxide, which may provide the concentration of hydrogen peroxide lower than the true value. In this study, the effects of azide ions on the oxidation of hydrogen peroxide at different detection potentials will be also discussed.

References

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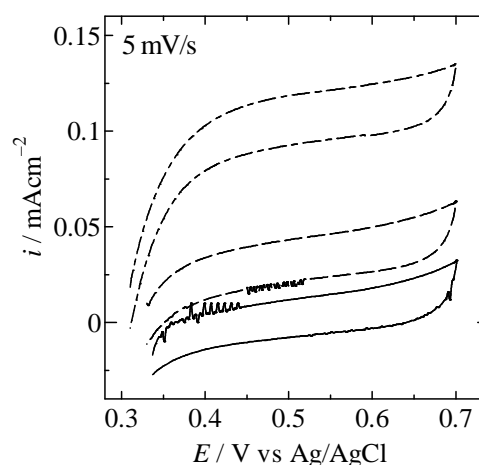


Fig.1 Cyclic voltammograms of the buffer solution with H₂O₂.
— : no H₂O₂, - - - : 0.5 mmol dm⁻³ H₂O₂,
- · - · : 0.1 mmol dm⁻³ H₂O₂.

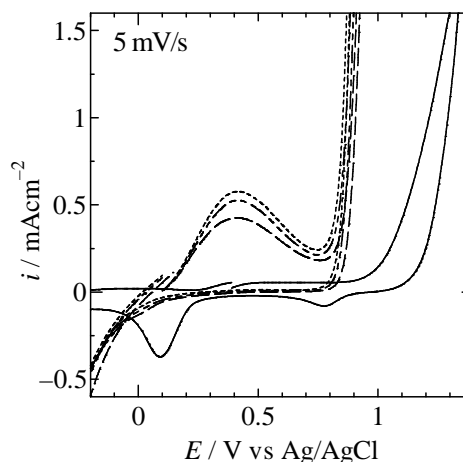


Fig. 2 Cyclic voltammograms of the buffer solution with NaN₃.
— : no NaN₃, - - - : 1 % NaN₃,
- · - · : 2 % NaN₃, : 3 % NaN₃.