

Conversion of urea to nitrogen and carbon dioxide by electrode oxidation of urea solution containing urease

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The exchange of electrons between the active centers in proteins and electrode has been successfully carried out. However, the direct electrochemical methods for studying enzyme activity change have been limited to the studies on redox enzymes and there has not been reported that the catalytic function of enzyme is dramatically changed by electrolysis. Urease catalyses the hydrolysis reaction of urea and ammonia and carbon dioxide were produced via enzyme-substrate (ES) complex. This research describes the first observation on the electrode oxidation of electrically denatured urease-urea complex, resulting in the production of nitrogen from urea. Fig.1 shows the constant potential amperometric results of urea with and without urease, and this result indicates that the oxidation rate of urea gradually increases when urease is dissolved in an electrolyte although no distinct increase of the oxidation current was observed when urease is not contained. The main reason why the oxidation current gradually increases may be based on the oxidation of urease and its adsorption to the electrode surface. The oxidation current decreased to nearly zero when the temperature was decreased to 4 °C, and this fact strongly supports that this oxidation was catalyzed by enzyme. If the oxidation of urea produces hydrazine as an intermediate, the oxygen concentration in electrolyte should be decreased. We found that oxygen concentration of electrolyte decreases during electrolysis of urea, as shown in Fig. 2. This result suggests that the produced intermediate reacts with oxygen to produce final product. The species produce during an electrolyte and the evolved gas at carbon felt electrode were detected by GC-MS, and it was found that hydrazine and nitrogen were produced by electrooxidation of urea catalyzed by urease.

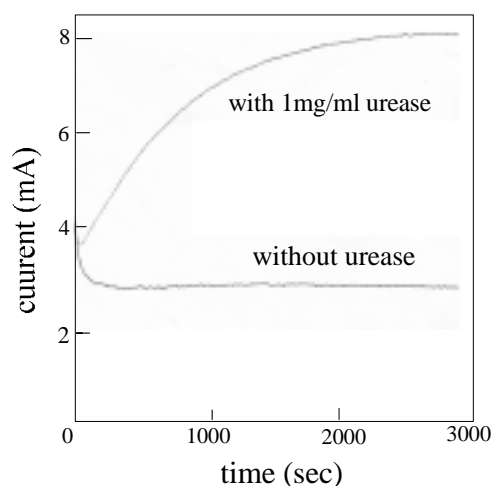


Fig.1 Constant potential amperometric results of the electrooxidation of 0.05M urea at pH 9

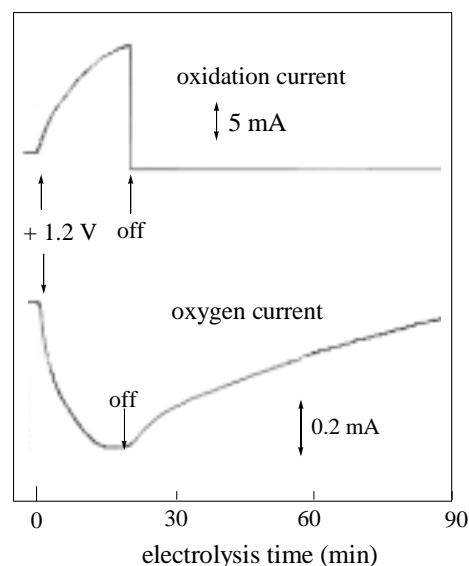


Fig.2 Change of oxidation current of urea and oxygen concentration during electrolysis of urea solution containing urease

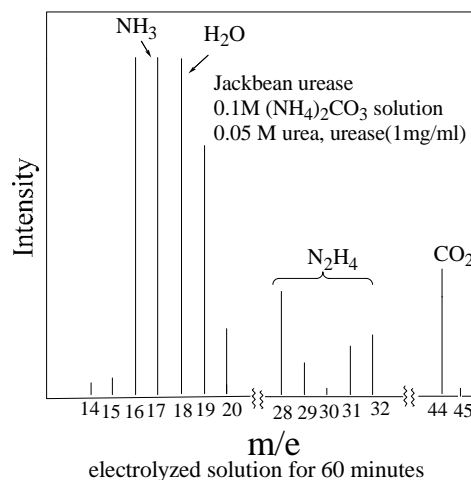


Fig.3 MS Fragment patterns of electrolyzed solution