

## Electrocatalytic oxidation of glucose at Au(111) and Au(100) electrodes modified with ad-metals

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### 1. Introduction

Electrocatalytic oxidation of sugars has been examined extensively from various points of view such as wastewater treatment in food industry, blood sugar sensing for medical use and application to fuel cells. We have been interested in sugars as a fuel for fuel cells. To develop a 'sugar-air' battery, more effective electrodes on which sugars can be oxidized at more negative potential, glucose oxidation in an alkaline media at Au(111) and Au(100) single crystal electrodes modified with various ad-metals by underpotential deposition (upd) was investigated.

### 2. Experimental

Au(111) and Au(100) single crystal electrodes were prepared using the flame-annealing-quenching method with successively polishing mechanically to obtain enough surface areas for electrochemical measurements (cyclic voltammetry).

### 3. Results and discussion

There are no significant catalytic activity when glucose was oxidized at Au(111) and Au(100) single crystal electrodes modified with various ad-metals (Cu, Ru, Pd and Cd). On the other hand, Ag ad-metal modified electrodes were found to show excellent catalytic behavior for oxidation of glucose. Fig.2 shows the cyclic voltammogram obtained with a bare Au(111) electrodes in a 0.1 M NaOH solution with 10 mM glucose. Oxidation of glucose started around -0.55 V (vs. Ag/AgCl/KCl(sat)) on a bare Au(111) electrode and this potential shifted to around -0.65 V at an Ag 1/3 monolayer (ML) modified electrode (so-called Au(111)-( $\sqrt{3} \times \sqrt{3}R-30^\circ$ )-Ag electrode) (Fig.1b). The oxidation peak potential also shifted from ca. -0.27 V to ca. -0.40 V. On the other hand, deposition of 1 ML Ag ad-atoms (i.e., Au(111)-(1 x 1)-Ag electrode) (Fig.1c) led to a decrease in the oxidation peak current.

By using an Au(100) electrode, similar catalytic effect of the Ag ad-layer was observed on glucose oxidation. Fig. 4 shows the cyclic voltammogram obtained with a bare Au(100) electrode in a 0.1 M NaOH solution with 1 mM glucose. Oxidation of glucose started around -0.58 V on a bare Au(100) electrode and this potential shifted to around -0.71 V at an Ag 2/5 ML modified electrode (so-called Au(100)-( $\sqrt{2} \times 5\sqrt{2}R-45^\circ$ )-Ag electrode) (Fig.3b), which is slightly more negative than at Ag ad-layer modified Au(111) electrodes. The oxidation peak potential also shifted from ca. -0.30 V to ca. -0.54 V. Similarly, oxidation potential of glucose shifted negative direction at an Ag 1 ML modified electrode (i.e., Au(100)-(1 x 1)-Ag electrode) (Fig.3c) as well as Ag 2/5 ML modified electrode.

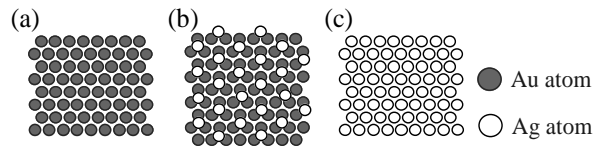


Fig. 1. Schematic presentation of Ag ad-layer modified Au(111) surfaces for (a) bare, (b) ( $\sqrt{3} \times \sqrt{3}$ )R30° Ag-Au(111), (c) (1 x 1)Ag-Au(111) surfaces.

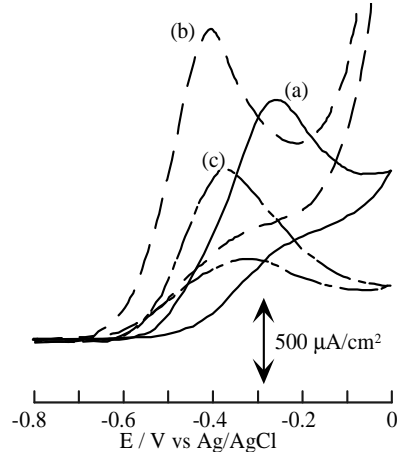


Fig. 2. Cyclic voltammograms of 10 mM glucose in 0.1 M NaOH solution at (a) Au(111) single crystal (solid line), (b) Au(111)-( $\sqrt{3} \times \sqrt{3}$ -R30°)-Ag (dashed line) and (c) Au(111)-(1 x 1)-Ag electrodes (dash-dotted line). Scan rate was 50 mVs<sup>-1</sup>.

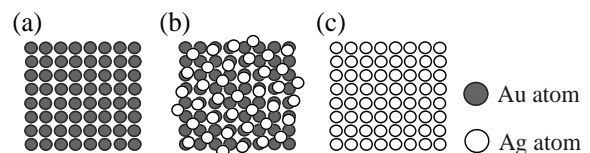


Fig. 3. Schematic presentation of Ag ad-layer modified Au(100) surfaces for (a) bare, (b) ( $\sqrt{2} \times 5\sqrt{2}$ -R45°)-Ag-Au(100), (c) (1 x 1)Ag-Au(100) surfaces.

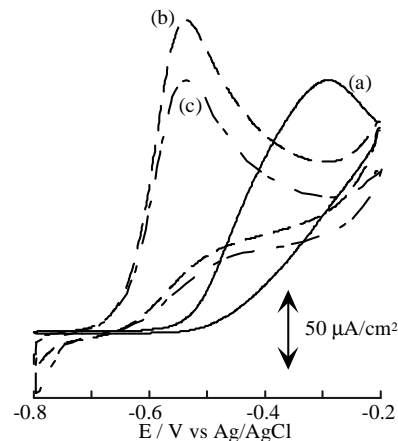


Fig. 4. Cyclic voltammograms of 1 mM glucose in 0.1 M NaOH solution at (a) Au(100) single crystal (solid line), (b) Au(100)-( $\sqrt{2} \times 5\sqrt{2}$ -R45°)-Ag (dashed line) and (c) Au(100)-(1 x 1)-Ag electrodes (dash-dotted line). Scan rate was 50 mVs<sup>-1</sup>.