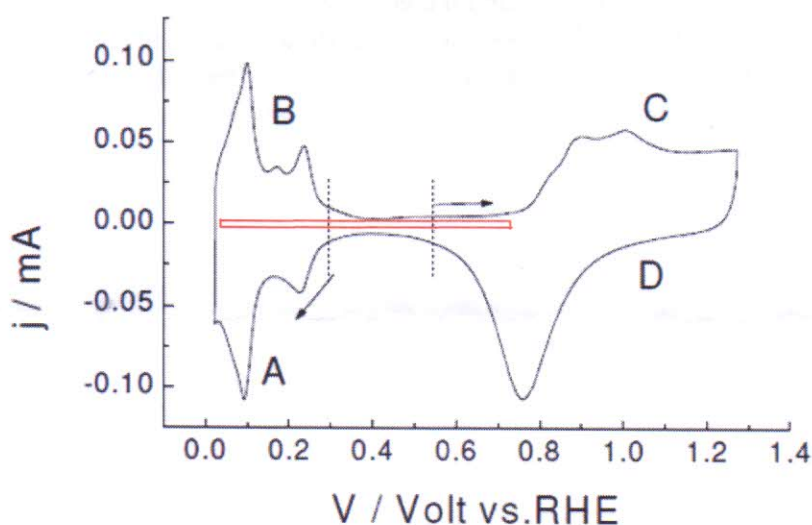


Electrochemistry Exam 6 March 2017, 13:30 – 15:30, room DM1.19

Question 1 (10 points)

- (a) Given that the standard equilibrium potentials for the Cu^{2+}/Cu and the Cu^+/Cu redox couples are 0.38 and 0.52 V vs. NHE, calculate the standard equilibrium for the $\text{Cu}^{2+}/\text{Cu}^+$ redox couple.
- (b) The solubility product of $\text{Cu}(\text{OH})_2$ is 2.2×10^{-20} . Draw a potential-pH diagram showing the stability regions of Cu , Cu^{2+} and $\text{Cu}(\text{OH})_2$, at standard conditions.

Question 2 (10 points)



The figure shows the “blank voltammetry” of a platinum electrode in sulfuric acid. Describe what happens in regions A, B, C and D, and in which potential window you would determine the double-layer capacity of platinum.

If we adsorb a monolayer of carbon monoxide onto the platinum electrode, we observe that the voltammogram changes to the red curve in the figure. Explain why the CV looks like this in the presence of adsorbed CO.

Question 3 (10 points)

From Tafel plots of the hydrogen evolution reaction on a platinum electrode, we find Tafel slopes of 31 mV/dec and 123 mV/dec in acidic and alkaline media, respectively. Write mechanisms that explain these two Tafel slopes in the two different media.

Question 4 (10 points)

The reduction of oxygen ($\text{O}_2 + 4 \text{H}^+ + 4 \text{e}^- \rightarrow 2 \text{H}_2\text{O}$) is studied at a platinum rotating disk electrode in a perchloric acid solution. The solubility of oxygen in water is 1.3 mM, the diffusion coefficient of oxygen in water is $2.10^{-5} \text{ cm}^2 \text{ s}^{-1}$, and the kinematic viscosity of water is $1.10^{-6} \text{ m}^2 \text{ s}^{-1}$ (all at 25°C).

- (a) Calculate the expected cathodic limiting current density due to oxygen reduction at 1500 rotations/minute of the disk electrode.
- (b) On a gold electrode, the same oxygen reduction does not lead to water, but to hydrogen peroxide. Write the corresponding redox reaction. What will be cathodic limiting current be on a gold electrode?
- (c) Which electrochemical technique would you use to verify the formation of hydrogen peroxide on the gold electrode?

Question 5 (10 points)

During the oxidation of ethanol on a platinum electrode, the following products and intermediates are formed: adsorbed carbon monoxide, dissolved acetaldehyde, and gaseous carbon dioxide. Which techniques would you use to detect these species? Explain why you would use a specific technique for each intermediate/product.