SS209 Report

Making and Testing a Silver Reference Electrode

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Aim: To make a simple and low-cost Ag/AgCl reference electrode with the least overpotential.

Lab Requirements: Syringe, Silver wire, Agar solution, 3M KCl solution, other standard electrochemistry lab apparatus

Theory: A reference electrode is an important component of the electrochemical cell. It is built to have a stable and known electrode potential.

The silver/silver chloride reference electrode is composed of a silver wire, coated with a layer of solid silver chloride, immersed in a solution that is saturated with potassium chloride and silver chloride. The pertinent half reaction is

$$AgCl(s) + e^- \Leftrightarrow Ag(s) + Cl^-(saturated)$$

The actual potential of this half-cell is +0.197 V vs SHE.

Procedure

- The barrel of a 5 ml disposable plastic syringe was taken without the piston and needle and was used as the body of the reference electrode
- A solution of 1% agar-agar and 3M KCl was poured into the tip of the syringe, until it set enough to hold its weight
- The syringe was filled with 3 M KCl solution, and the tip with agar gel was dipped in the same solution
- A 4 cm Silver wire was taken as the electrode material, and was soldered to a length of galvanised copper wire for convenient electrical connection
- About 3 cm of the silver wire was dipped in an HCl solution, and the surface was reduced to AgCl, by passing a current of 200µA for 15 minutes, using a platinum wire as a counter electrode

- The wire was removed, rinsed, and the AgCl coated part was dipped in the KCl solution in the syringe
- The top was sealed with parafilm, with only the connecting wire coming out

Testing

The reference electrode was tested by performing a cyclic voltammetry in a Ferrocyanide/ferricyanide system.

The cyclic voltammetry was run for 10 cycles between 0 and 0.6 V (vs ref.), at a scan rate of 50mV/s.

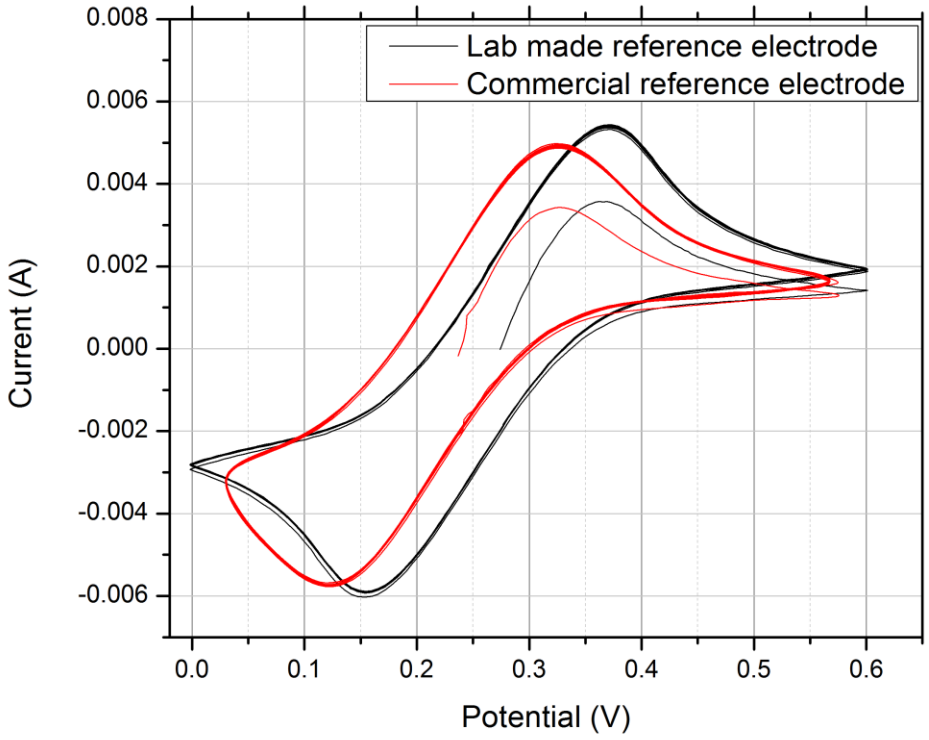
A similar experiment was run against a commercial Ag/AgCl reference electrode

The resulting cyclic voltammograms were compared for shift in peak positions and drift with time, if any.

^^ The set up with connecting wires

<= Aashish balancing the 3 electrodes which make up the electrochemical cell

Observations:



The Overpotential seen over 10 cycles = 27mV

Results/Conclusions:

The unique feature of our reference electrode is that it is made from syringes, which is low cost and can be reused. In addition, it is easy to make an agar frit (due to its narrow opening) and the whole set-up takes less than an a few of hours to assemble and use.

The cyclic voltammogram taken with the prepared reference electrode showed **no drift** with cycles.

The overpotential calculated from the difference in reduction peaks is extremely low. Hence it is a precise reference electrode. The reason for this overpotential could be due to the non-uniform deposition of AgCl on Ag (due to inherent surface roughness). This could have occurred as the charge and time combination may not be the best for making a uniform layer. We were also wary of using low current (long time scale) as it could result in domination by parasitic reactions.

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