Experimental report

31/05/2016

Proposal: 9-12-379 **Council:** 10/2014

Title: Ion Adsorption On Planar Graphene Electrochemical Double Layer Capacitor Electrodes

Research area: Chemistry

This proposal is a new proposal

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Samples: C2H3N, C2D3N, C16H36NBr, Al2O3/Ni/C substrate

Instrument	Requested days	Allocated days	From	To
FIGARO	3	3	06/07/2015	09/07/2015

Abstract:

From small backup power supplies in hand held electronics to regenerative braking in heavy good vehicles, electrical energy storage is becoming more important, and more pervasive within modern technology. Electrochemical double layer capacitors (EDLCs) are a high power energy storage device that operate by charge separation across the double layer at the electrode/electrolyte interface. To continue improving these devices we must further our understanding of the structure of the electrolyte ions at the electrode surface.

Graphene is one of a number of carbons used for EDLC electrodes. This proposal aims to investigate the interactions and absorption of ions on graphene substrates utilising the unique capability of neutron reflection to study surface structures of organic molecules on carbon surfaces. The structures adopted with and without applied potential will be studied.

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This experiment aimed to use a graphene supported electrode for neutron reflection and to then study the electrochemical behaviour of an ionic liquid at this surface.

The graphene supported electrode was a significant challenge to produce, requiring the deposition of a very flat Ni layer on a silicon wafer followed by graphene growth. At the last minute we were somewhat let down by the group who had indicated they were to help us. However, by a Herculean effort by some colleagues we got the samples deposited elsewhere and were able to arrive with the samples we wished. (Based on this experience we have now identified several sources for these graphene layers for subsequent experiments to prevent similar issues in the future – however, they are very expensive).

The alignment and reflectivity measurement of the graphene was very good. The substrate in this experiment was 5mm thick, somewhat thicker than a previous experiment, which enabled us to get to high Q without problems.

The experimental challenge came from an unexpected source, the glue used to stick the electrodes to the conducting wires. Here we used a conducting paste.. however although the conductivity was good, after some diagnostic time, we identified that there was electrochemistry going on and not the perfectly polarised electrode we had intended.

This has led to a complete redesign of our reflection cell to facilitate electrical connection without any adhesives at all (using sprung loaded connections).

Summary

Hence this experiment has demonstrated that graphene electrodes can be studied by neutron reflection. The improved electrode design and graphene substrate are the subject of a follow up experiment and we have every expectation of obtaining insightful data.