Experimental report

03/03/2021

Proposal: CRG-2420 **Council:** 10/2016

Title: Electroresponsiveness of interfacial layers of ionic liquids and their solutions

Research area: Chemistry

This proposal is a new proposal

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Samples: Acetone
benzene
tetrahydrofuran
[P6614] [BMB]

Instrument	Requested days	Allocated days	From	To
SUPERADAM	8	8	04/03/2017	08/03/2017
			07/06/2018	11/06/2018

Abstract:

Electro-responsiveness is currently "hot" in the soft-matter and interfaces community. The ability to control the composition, or conformation and structure of an interfacial layer via application of an electric field is important in nanofluidics and drug delivery as well as in tribology where the goal would be to control the friction in a metallic contact. Similarly, Ionic Liquids (IL) are still in principle novel materials which are receiving great interest for interface intensive applications such as batteries and solar cells. This application builds on a recent successful visit to SUPERADAM where improvements in our surface preparation and predictive simulations led to high resolution data that unambiguously showed that the SLD of the interfacial layer (and thus its composition) was varying as a function of the surface potential. This application marks a change in focus - there are currently two publications in pipeline demonstrating electro-responsiveness of the ILs and their solutions respectively. The next phase is to implement technical improvements (cell, surface) and perform systematic studies integrated with a suite of other measurements.

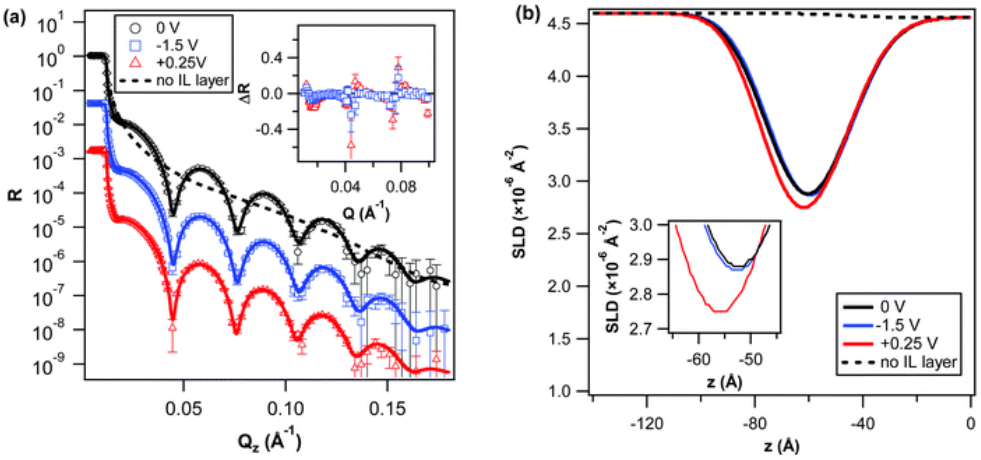
Report CRG2420

SUPERADAM From 04/03/2017 to 08/03/2017 and From 07/06/2018 to 11/06/2018

04/03/2017 to 08/03/2017

The data from this beamtime has been used in the following publication

Pilkington, G.A., A. Oleshkevych, P.P. Carrasco, S. Watanabe, M. Radiom, A.B. Reddy, A. Vorobiev, S. Glavatskih, and M.W. Rutland, Electroresponsive structuring and friction of a non-halogenated ionic liquid in a polar solvent: Effect of concentration. Physical Chemistry Chemical Physics 2020(22): p. 19162-19171. https://doi.org/10.1039/D0CP02736G
(example figure below)



1 (a) Experimental neutron reflectivity, R, of 5% w/w [$P_{6,6,6,14}$][BMB] in PC for different applied potentials (0, −1.5, and +0.25 V) plotted as a function of the momentum transfer vector Q_z at different applied potentials. The symbols show experimental data whilst the solid lines represent best-fits to the data for each potential. The error bars represent the statistical error (standard deviation) in the experimental reflectivity data. For clarity, the curves have been offset in the y-axis. For comparison, the dashed line shows the predicted reflectivity for the same surface and solution without an interfacial IL layer. The inset shows asymmetry plots $\Delta R = [R^V(Q_z) - R^0(Q_z)]/[R^V(Q_z) + R^0(Q_z)]$, obtained from the experimental data, highlighting the changes in the non-zero potential reflectivities (R^V) with respect to 0 V (R^0). (b) Corresponding model SLD profiles obtained from the best-fits to the reflectivity profiles as a function of distance (z), where $z = 0$ represents the gold-solution interface. The inset shows an expanded area of the main figure around the SLD minima corresponding to the IL interfacial region.

07/06/2018 to 11/06/2018

The data is in manuscript form in the following manuscript which is planned for submission during Spring 2021

Long alkyl chain ionic liquid interfacial layers on charged interfaces: Combined atomic force microscopy and neutron reflectometry study, M. Radiom, G. A. Pilkington, P. Pedraz, A. Oleshkevych, S. Watanabe, A. B. Reddy, G. Palsson, A. Vorobiev, A. Nelson, S. Glavatskih, M. W. Rutland, in preparation.
(See next page)

Example figures and data

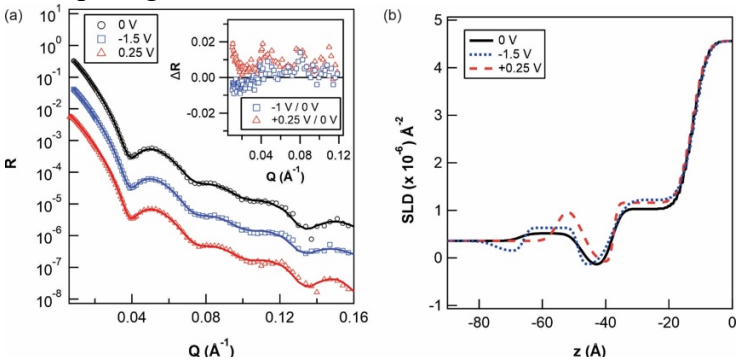


Figure 1: (a) Reflectivity measured for the pure IL $[P_{6,6,6,14}][BOB]$ at different applied potentials at a gold electrode interface. The symbols represent the experimental data, whilst the solid lines represent best-fits to the data. (b) SLD profiles for different applied potentials obtained from the best-fits presented.

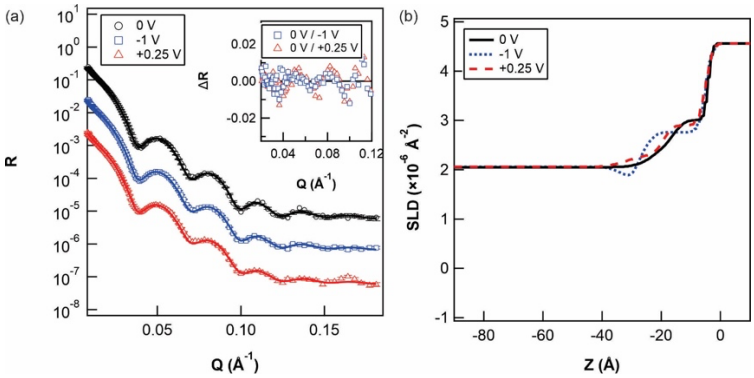


Figure 2: (a) Reflectivity measured for the pure IL $[C_6C_1Im][BOB]$ at different applied potentials at a gold electrode interface. The symbols represent the experimental data, whilst the solid lines represent best-fits to the data. (b) SLD profiles for different applied potentials obtained from the best-fits presented.