（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014A0172 実験課題名 Title of experiment Neutron reflectivity measurements on the ionic multilayer structures at ionic liquid|electrode interface 実験責任者名 Name of principal investigator Naoya Nishi 所属 Affiliation Kyoto University	装置責任者 Name of responsible person Norifumi Yamada 装置名 Name of Instrument/（BL No.） BL16 実施日 Date of Experiment 2014. 11/30-12/3

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Four ionic liquids were used as samples:

DEMEC1C1N(C10H10F6N2O5S2, liquid)

TOMAC4C4N(C33H54F18N2O4S2, liquid)

TOMAC1C1N(C33H54F18N2O4S2, liquid)

THTDPC4C4N(C33H54F18N2O4S2, liquid)

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Bi film on a polished silicon substrate was used as conductive electrode film. The surface of the electrode film was covered by an ionic liquid (IL). The IL was sandwiched by the electrode film and another electrode film that was formed on the surface of an as-sliced silicon and that acts as a counter electrode. Neutron beams were irradiated from the edge of the polished silicon to the Si/Bi/IL interface. The reflected neutron beams from the interface were measured.

Before going to the buried Bi/IL interface, we measured neutron reflectivity at Si/Bi/air interface in order to investigate the characteristics of the Bi film. The reflectivity profiles (logR vs Q plot where R is the reflectivity and Q is the surface normal component of the scattering vector) showed fringes whose period reflects the thickness of the Bi film (27 nm). The profiles were fitted with a box model. The fitting result suggests that the density of the Bi film becomes lower as going from the Si side to the air side.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

For the buried Si/Bi/THTDPC4C4N interface, the fringes in the reflectivity profiles depended on the electrode potential. When positive (negative) potentials was applied to the electrode, the period of the fringes became longer (shorter) compared with that in open circuit condition, corresponding to thinner (thicker) Bi film. This change in the fringe period reflect the change in the local concentration of the IL-ions at Bi/IL interface. For example, anions are accumulated to the positively-charged electrode interface because anions have scattering length density (SLD) higher than cations and comparable to Bi, leading to apparent thicker Bi film in the reflectivity profile. Each reflectivity profile was fitted with a box model to extract the apparent thickness of the Bi film depending on the potentials. The difference in the apparent Bi thickness between +2.0 V and −3.0 V was 38 angstrom. This is 2.5 ionic layers of THTDPC4C4N when remembering that THTDPC4C4N forms ionic multilayer at THTDPC4C4N surface whose ionic layer thickness is 15 angstrom. This layer number means that the electrical double layer at THTDPC4C4N interface resembles the Helmholtz model (one layer model) rather than the Gouy-Chapman model (diffuse double layer model).