Ionic Liquid Gating of Metal Contacts: Effect of Cation Size

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Electric-double-layer (EDL) gating with ionic liquids has been attracting considerable interests owing to its tremendous gating power.[1] Since the EDL formed at liquid/solid interfaces functions as a huge capacitance and can induce large charge accumulation, it is used for gating not only organic materials, oxides, and semiconductors, but also metal systems.[2]

In this work, we have used a liquid-gated EDL transistor geometry for gold nanojunctions to control the conductance of metal contacts. The ionic liquid we used was DEME-TFSI. Figure 1(a) shows the V_G-dependence of the conductance of a gold junction when $G \sim 100G_0$, where $G_0 \equiv 2e^2/h$. The conductance of the gold junction increases with increasing V_G from 0V, but the conductance increase saturates for $V_G > 1$ V. Furthermore, hysteresis appears when the gate voltage is swept up and down. Figure 1(b) plots the capacitance of the sample as a function of V_G. The curve shows only one peak for the sweep-up but two peaks appear for the sweep-down. This behavior is attributed to a geometrical reason: since the ionic structure of a DEME cation can be viewed as a charged head with a neutral tails (while a TFSI anion is regarded as a single charged bead), these neutral beads play the role of latent voids that can cause reorientations of the ions[3] and causes different ion arrangement for sweep-up and down (Fig. 1(a)). This result gives a new insight when EDL gating is used for atomic scale systems. In the presentation, comparison with another kind of cation will also be presented.

References: [1] H. Shimotani, et al., Appl. Phys. Lett., **92,** 242107 (2008). [2] H. Nakayama et al., Appl. Phys. Exp. **5,** 023002 (2012). [3] M.V. Fedorov et al., Electrochemistry Communications 12 (2010) 296–299

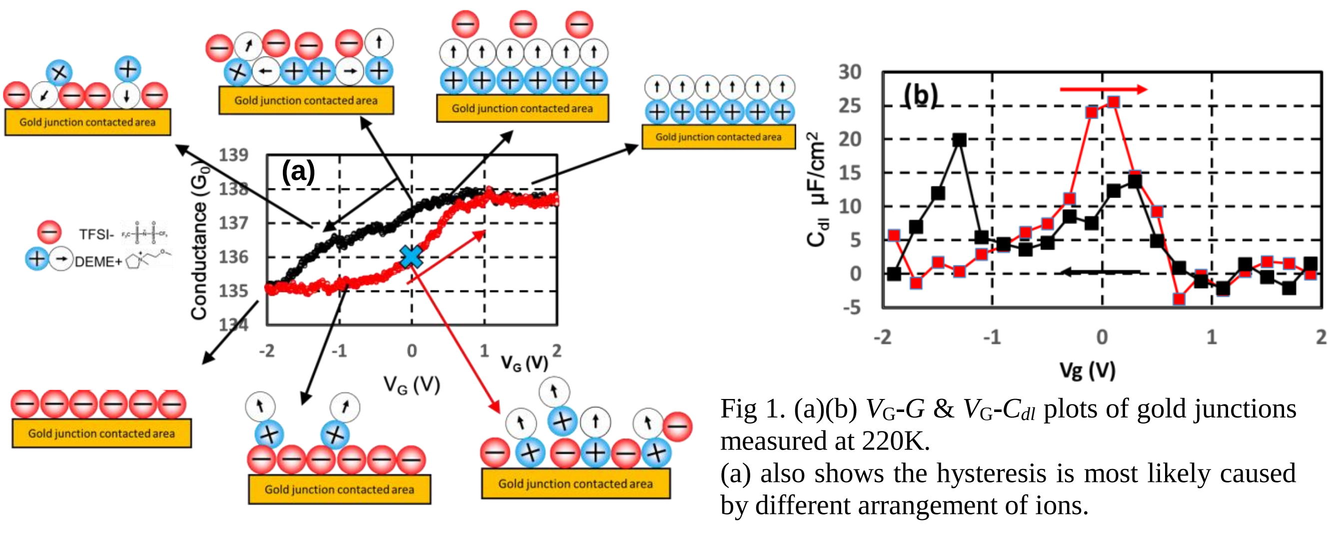

Fig 1. (a)(b) V_G-G & V_G-C_{dl} plots of gold junctions measured at 220K.
(a) also shows the hysteresis is most likely caused by different arrangement of ions.