Nanopore sensing in two immiscible electrolytes: current-voltage characteristics between ionic liquid and salt solution

阪大産研 [1] ○(M2)梁 逸偉 [1], 筒井 真楠 [1], 谷口 正輝 [1]

ISIR, Osaka Univ. [1], ○Iat Wai Leong[1], Makusu Tsutsui[1], Masateru Taniguchi[1]

E-mail: leong.iat.wai32@sanken.osaka-u.ac.jp

Measurement of translocation signals of single-particles with nanopore sensors have been used in many applications because of the high sensitivity and simple mechanism. Most studies have been performed with nanopore devices under the same electrolyte on both sides of a membrane. Nevertheless, salt and viscosity gradients across membranes truly exist in natural world such as cell membrane ion channels. In fact, many researchers reported that heterogeneous solution conditions can be utilized to retard the particles' translocation speed and enhance the signal-to-noise ratio [1]. Feng et al. showed that a viscosity gradient system based on room-temperature ionic liquids can be used to control the dynamics of DNA translocation through MoS_2 nanopores [2]. However, all existing researches focused so far on a gradient system without mentioning interface effect caused by the two immiscible phase. Hence, we attempt to first elucidate the interfacial effect on ion transport through a nanopore with an immiscible liquid-liquid system.

We employed room temperature ionic liquid ($BmimPF_6$) and PBS solution of various salt concentrations as a two immiscible phase. Current-voltage measurements through a nanopore formed in a 50 nm-thick Si_3N_4 membrane were carried out by adjusting voltage bias through a pair of Ag/AgCl electrodes. Furthermore, a two-phase model created in computational fluid simulation by COMSOL Multiphysics help us to know how the interface responding under voltage bias and estimate the ionic current and the change of contact surface movements. Experimental current-voltage curves through a single SiN pore 300nm diameter and 50 nm thick of different liquid-liquid pairs shown as Figure.1. Some special cases of abnormal electric current fragments only happened in two immiscible electrolytes at high voltage shown as Figure.2 will be discussed.

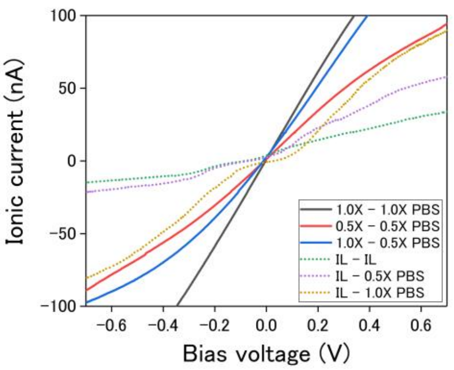

Figure.1 Experimental current-voltage graph;

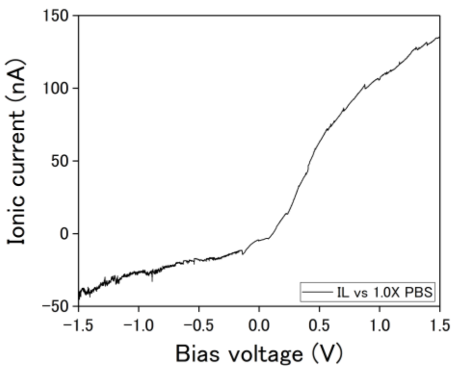

Figure.2 Special case of current fragment

References

1. Yinghua Qiu et.al., *Anal. Chem.*, 2019, 91, 1, 996-100
2. Jiandong Feng et.al., *Nature Nanotechnology*, 2015, 10, 1070–1076