Molecular-Selective Filtering Phenomenon at Nanogate

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Molecular manipulation at the nanometer scale is one of the key technological goals for ultra-sensitive purification and separation of a small number of molecules in ultra-small devices. Especially for bio-materials, manipulation on a lipid bilayer, a cell membrane, is a wildly acceptable candidate as a manipulation medium because of its ability to manipulate the bio-materials in their native environment. We have developed a novel approach for a molecular segregation on a self-spreading lipid bilayer [1] with the aid of a periodic array of metallic nanogates (Fig. 1A) [2], in which the bilayer continuously spread through the nanogate. Depending on the structure of the doped target molecule, molecular-selective segregation/filtering effect was appeared during spreading through the nanogate (Fig. 1B). The observed effect is though to be brought from a formation of a compressed lipid bilayer phase at the gate. This imposes a local chemical potential barrier at the nanogate, which lead to a reduction in the penetration ability (or molecular solubility) of the doped molecules at the nanogate region. The concept based on a chemical potential barrier enables us to manipulate molecules by distinguishing their size, charge, polarity, hydrophilicity, chirality, and so on. Furthermore, the self-spreading offers completely non-biased system. These advantages will open up a new generation of molecular manipulation, filtering, separation, and detection system working with ultra-low energy in ultra-small space.

Figure 1. (A) AFM images of nanogate with difference gate-width $d$ used in the present study. (B) 3-D images of fluorescence micrograph for the self-spreadong lipid bilayer doped with (left) NBD-PC and (right) NBD-PE.

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