Conductance measurement of single molecular junction with Si electrode using STM

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With the development of various techniques to fabricate single molecular junctions, tremendous experimental effort has been devoted to elucidate the transport property of single molecule. Most studies of these systems have focused on thiol molecules attached on gold electrodes. However, the conductance obtained in this system is poorly reproducible and temporally unstable due to the stochastic switching of thiol adsorption site on gold surface. Since this behavior will lead to serious characteristic variation in molecular devices, stable electrode-molecule contact is crucial for practical device application. In this point of view, Silicon based molecular junction can be alternative candidate because they form rigid Si-C bond in electrode-molecule interface.

In this study, we have fabricated single molecular junction made of single diethinylbenzene (DEB) and bipyridine derivative (BPN) molecules covalently bonded with two-terminal Si electrodes by using STM. (fig.1) H-terminated n-type Si(100) surface was used as a substrate and Si STM tip was cut from highly doped n-type Si wafer. Target molecules adsorbed on isolated Si dangling bonds via chemical reaction of molecular triple bond and silicon. Fig.2 shows the STM image of isolated DEB molecules on H-Si(100) surface. Highly bright protrusions correspond to single DEB molecules. To form single molecular junction, we placed a Si STM tip above a DEB molecule and moved it toward the chosen molecule until an electric contact was achieved. Inset of figure.3 shows a plot of the I-Z curves obtained above DEB molecule. An abrupt jump in the current was observed because of chemical bonding between the Si tip and the DEB molecule. After a junction was formed, the bias voltage was swept repeatedly between -2 and +2 V, and the corresponding change in the current for each sweep was measured. Fig 3 shows I-V plots obtained from single Si-DEB junction. I-V curves show semiconducting characteristics due to the energy gap of silicon and the molecule. For BPN molecule, molecular junction exhibited lower conductance compared to DEB molecule. In addition, binary conductance fluctuation due to molecular conformation change during I-V measurements was frequently observed for BPN molecule.

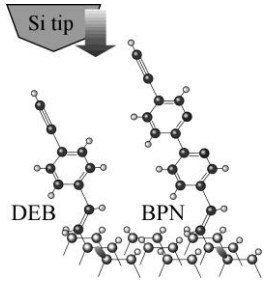

Fig.1 Structure model for molecules adsorbed on Si(100)

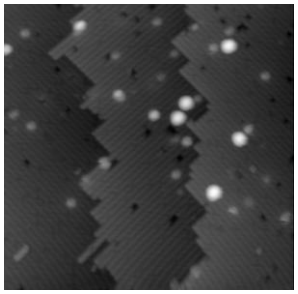

Fig.2 STM image of DEB on H-Si(100).

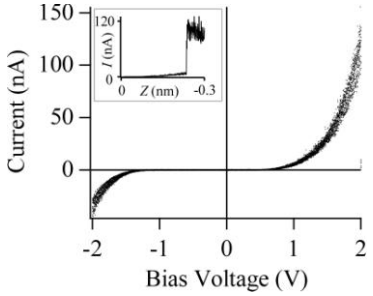

Fig.3 I-V plots measured Si-DEB junction.