Conductance Measurement of Silicon-Molecule-Silicon Junction

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Recently silicon-based molecular electronics has been proposed from various research groups. The idea combining organic chemistry with semiconductor technology could bring new advances and/or applications. Although many approaches for building silicon based molecular devices have been proposed so far, Si-molecule-Si junction has not been experimentally realized because appropriate fabrication technique does not exist.

In this paper, we, for the first time, report the fabrication and conductance measurement of Si-molecule-Si junction realized using STM point contact method. Diethinylbenzene (DEB) was used as a prototypical simple molecule forming a single molecular bridge between two Si electrodes (Fig.1) Triple bonds at the both ends of molecule covalently bind to silicon electrodes making a stable molecular junction. A H-terminated n-type Si(100) surface was used as a substrate and Si STM tip was cut from a highly doped n-type Si wafer. DEB molecules adsorbed on isolated Si dangling bonds via chemical reaction of the molecular triple bond with silicon. Figure 2 shows an STM image of isolated DEB molecules on a H-Si(100) surface. Highly bright protrusions correspond to single DEB molecules. To form Si-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. After a junction was formed, the bias voltage was repeatedly swept between -2 and +2 V, and the corresponding change in current for each sweep was measured. Figure 3 shows I-V plots obtained from a single Si-DEB junction and a H-Si(100) surface. Conductive I-V characteristics were observed for the Si-DEB junction as compared to the H-Si(100) surface. This result is considered to be due to the formation of a pi-conjugated system by the Si-DEB-Si junction.

Fig.1
DEB (Diethinylbenzene)

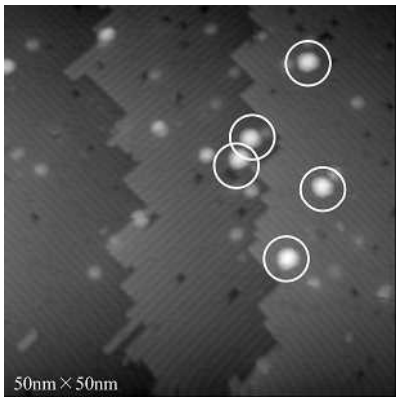

Fig.2
STM image of DEB on H-Si(100)

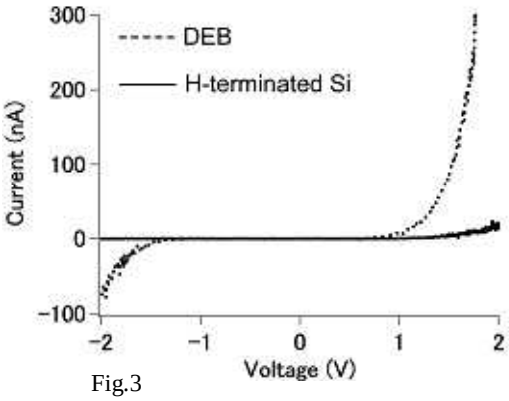

Fig.3
I-V plots obtained from single Si-DEB junction and H-Si(100) surface