Exploring of novel device functions by dynamic characterization of single-molecule junction

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With the development of various techniques to fabricate single molecular junctions, tremendous experimental efforts have been devoted to elucidate the transport property of single molecule. Previously we have developed a highly reliable technique for the fabrication of single molecular junction, called "STM point contact method". Currently we have been applying this technique to fabricate Si based single molecular junction (Fig.1) and investigate carrier transport through the junction as well as the influence of molecular conformation on it. STM tip and substrate surface made of a same n-type Si (001) wafer were used as electrodes. We used diethinylbenzene (DEB) molecules, whose triple bonds react covalently with Si electrodes. A single molecular junction was formed with approaching of a Si-STM tip toward an isolated DEB molecule adsorbed on a H-Si (001) substrate (Fig.1). After the molecular junction being formed, I-V curves were measured with the distance of the electrodes being controlled. Figure 2 shows current values obtained from each I-V curve for positive (+1.8V) and negative (-1.8V) sample bias voltages. Surprisingly, a binary conductance switching process was reproducibly observed around d=-0.28nm with hysteresis characteristics, accompanied with a gradual conductance change as a function of tip-sample distance. Since mechanically stable single molecular junction was formed by robust Si-C bonding between a molecule and electrodes, we could manipulate single molecular conductance reproducibly through the control of molecular conformation for the first time. The result clearly demonstrates the mechanical controllability of carrier transport in a single molecule-junction by changing molecular conformation. In the honors program, I will explore the novel single molecular device function by investigating the influence of molecular conformation and chemical nature of molecule on single molecule conductance.

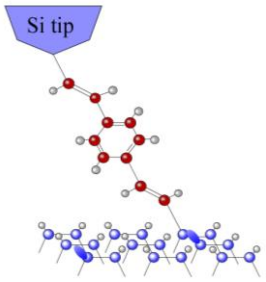

Fig.1 Formation of a Si/single molecule/Si junction.

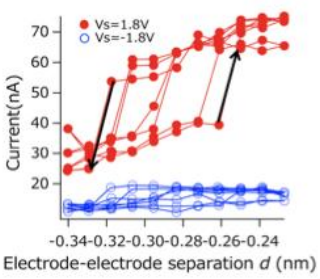

Fig.2 Conductance switching with electrode distance