Single Molecular Conductance Studied by "Point Contact Method" using Scanning Tunnelling Microscopy

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Precise measurement of single molecule conductivity has been one of the major focuses in molecular electronics. To realize a single molecule conductivity measurement, reliable fabrications of single molecular junction, in which a molecule is chemically connected with two electrodes to reduce contact resistance, has been the key point in recent research. Here, we propose a new reliable fabrication method of single molecular junction to form a low contact resistance by the combination of scanning tunnelling microscopy (STM) with self–assembled monolayer (SAM) technique. As a demonstration, we measured the conductance of bisthiol- and biselenol-terthiophene (3TS2, 3TSe2) molecules. By immersion of a Au(111) substrate into a mixed solution containing 3TS2 and Octanethiol (C8) molecules, a C8 film, in which isolated 3TS2 molecules were embedded, was formed as shown Fig .1(a). For STM observation, we first placed a Au STM tip over a single 3TS2 molecule, and subsequently the tip was brought to contact with the molecule. Since the thiol group of 3TS2 molecule is exposed toward the STM tip, a single molecular junction can be formed, by the chemical bonding of the thiol group with the Au tip (Fig. 1(b)). After the bonidng being formed, I-V measurement was performed several times to measure the conductance. All measurements were performed under UHV condition at room temperature. Figure 2(a) shows an I-Z curve on a 3TS2 molecule. Abrupt jump in tunnelling current was observed in the case of a single 3TS2 molecule. It is strongly suggested that the observed current jump in the case of 3TS2 molecule is caused by the formation of a Au tip-S chemical bonding which provides a single molecular junction. Fig. 2(b) shows all I-V curves of 3TS2 molecules obtained from single molecular junctions. The four bundles in Fig. 2(b) correspond to the conductance peaks shown in Fig. 2(c). Fig. 2(d) shows the histogram of 3TSe2 molecules, which shows distinct two peaks. Each of the peaks is obtained even for a single molecule, suggesting that the Au-S/Se-bonding has several states. Since we can directly fabricate a single molecular junction with confirmation of the characteristic of the target molecules by STM, we believe that our "point contact method" is the reliable and desired method to realize and analyze the single molecular conductance with bond fluctuation**.**

(http:/dora.bk.tsukuba.ac.jp)

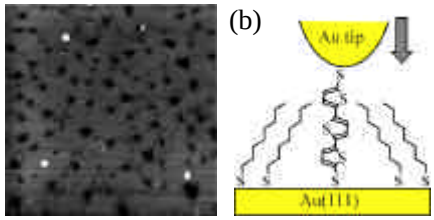

Fig. 1. (a) STM image of isolated 3TS2 molecules (bright spots) embedded in a C8 film (75nm?75nm). (b) Schematic of the "point contact method" by STM.

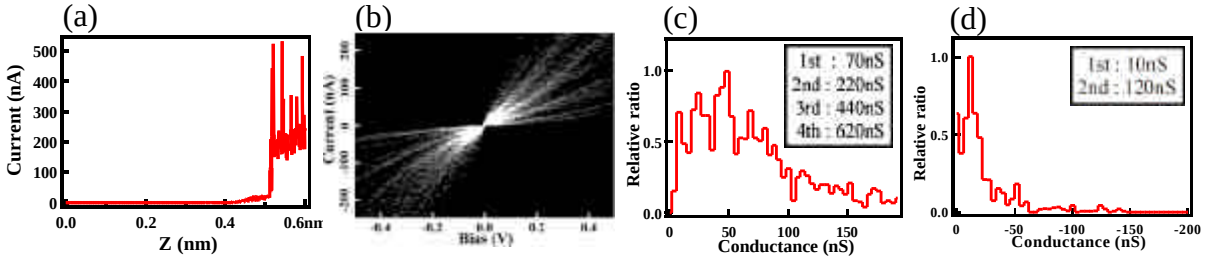

Fig. 2. (a) I-Z curve obtained from a 3TS2 molecule. (b) All I-V curves. (c), (d) Histograms of conductance obtained from 3TS2, 3TSe2 molecules.