Molecular Single-Electron Transistor Device using Sn-Porphyrin Protected Gold Nanoparticles

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Charging energy of the single-electron transistor is adjusted by the size of quantum dot[1]. Our previous work shows the capability of quantum dot size to tune the value of capacitance hence decide the operating temperature of single-electron transistor device. However, reducing the size of quantum dot itself cause another problem of small gate capacitance between a pair of nanogap. Here, we present single-electron transistor using the combination of Sn porphyrin protected gold nanoparticle and 3-legs phenol. 1.4 nm gold nanoparticle was protected by four Sn porphyrins in cubical shape and bridged to the electroless-plated Au nanogap electrodes via 3-legs phenol as shown in Figure 1. Three disulfide group are chemically bonded on the Au electrodes substrate. O-H legs in 3-legs phenol are expected to be bonded with center atom of Sn porphyrin. Sn porphyrin are firstly synthesized; we introduce the 3-legs phenol molecule between the gap using SAM process, and then Sn porphyrin protected Au nanoparticle is chemisorbed between the gap via O-H leg. I – V characteristic was obtained at 9 K. Based on I-V characteristic as shown in Figure 2, Coulomb blockade behavior are clearly observed. The circuit parameters (R_1, R_2, C_1, C_2, and Q_0,) of the device are then obtained using orthodox model by theoretical fitting. Based on the results, the Au nanoparticle that protected by Sn porphyrin molecules demonstrated the capability to applied in single electron-transistor device.

Reference
1) S. Kano, et al. Nanotechnology, **26**, 045702 (2015)

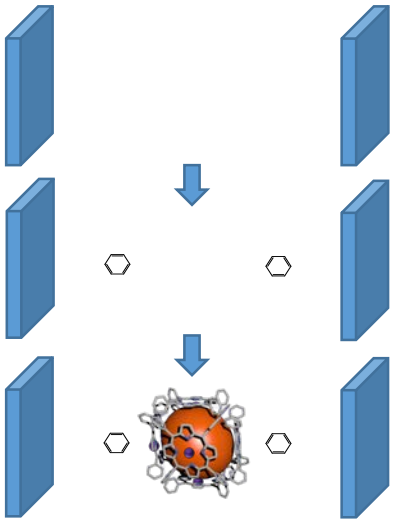

Figure 1. Schematic representation of Sn-por-Au SET

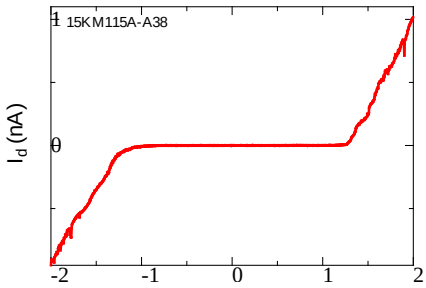

Figure 2. I-V measurement of the device

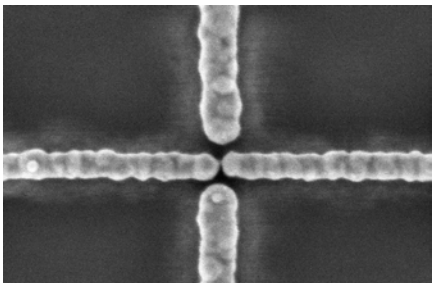

Figure 3. SEM image of Sn-por-Au SET