# Multifunction Integrated Macromolecules for Molecular-Scale Electronics

**Research Center for Molecular Scale Nanoscience**
**Division of Molecular Nanoscience**

TANAKA, Shoji     Assistant Professor

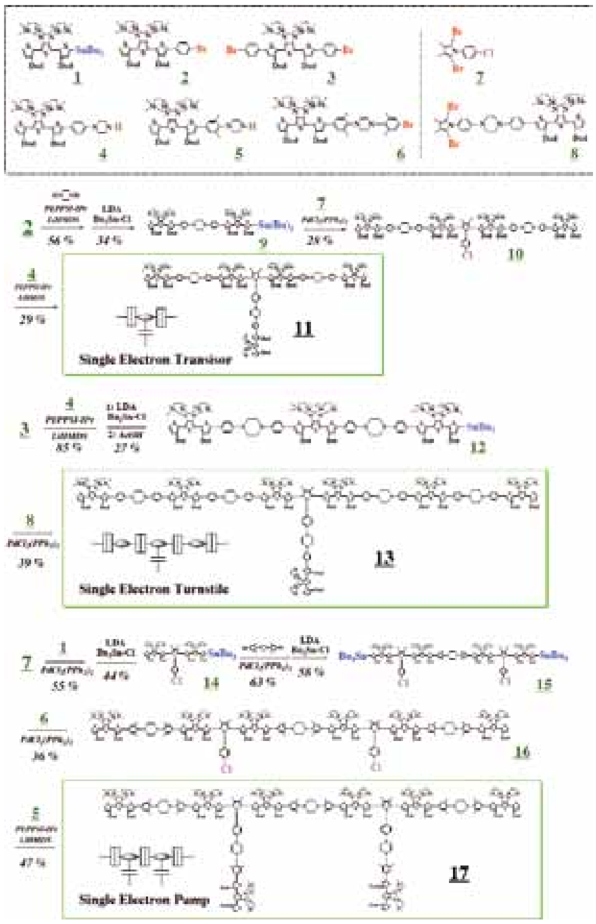
Recently a single electron tunnel (SET) device has attracted much attention due to the growing demand for ultra-low-power device. A SET device manipulates an electron by means of one-by-one electron transfer, resulting in ultimately low power consumption. However, for room temperature operation, the size of SET device must be as small as a few nm to overcome the thermal fluctuation problems. The process size of a few nm is out of the range of conventional micro-technology. In this project, to establish an innovative fabrication process for SET device systems, we have been developing step-wise synthetic protocols for monomolecular single-electron tunnel devices (**MOSET**) and their integrated circuits.

## 1. Universal Temperature Crossover Behavior of Electrical Conductance in a Single Oligothiophene Molecular Wire[1)]

We have observed and analyzed a universal temperature crossover behavior of electrical conductance in a single oligothiophene molecular wire. The crossover between the Arrhenius type temperature dependence at high temperature and the temperature-invariant behavior at low temperature is found at a critical molecular wire length of 5.6 nm, where we found a change from the exponential length dependence to the length-invariant behavior. We have derived a scaling function analysis for the origin of the crossover behavior. After assuring that the analysis fits the explanation of the Keldysh Green's function calculation for the temperature dependence, we have applied it to our experimental results and found successfully that our scaling function gives a universal description of the temperature dependence for all over the temperature range.

## 2. Fabrication of 3- and 4-Terminal Single-Electron Device Structures

To integrate Coulomb islands and tunnel/capacitive junctions in a single molecular skeleton, we have developed a series of molecular building blocks (**1**–**8**). These building blocks make possible to fabricate various type of 3- and 4-terminal monomolecular single-electron tunnel device structures (**11**, **13**, **17**).




### Reference

1) SK. Lee, R. Yamada, S. Tanaka, GS. Chang, Y. Asai and H. Tada, *ACS Nano* **6**, 5078–5082 (2012).