



**Title of Project : Molecular Architectonics
Orchestration of Single Molecules for Novel Functions**

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【Purpose of the Research Project】

Since the first report on molecular diodes by Aviram and Ratner in 1974, a variety of experimental studies on electrical conductance measurements of single molecules have been carried out. There had been a lot of reports concerning the electrical conductivity of sandwich structures composed of mono-molecular layers and metal electrodes until around 2000 (the 1st stage of molecular electronics). The development of break-junction methods had enabled us to discuss the carrier injection and transport in single molecules quantitatively in the 2nd stage from 2000 until around 2012. The studies in this stage have highlighted the thermal instability of molecular junctions that causes an undesirable variation in electrical properties. There are also some concerns about the degradation of molecular junctions during the operation. In the 3rd stage of molecular electronics from now on, we have to introduce novel concepts to overcome these issues.

The aim of this project is to develop a new academic field of “molecular architectonics” in which we design and construct “architectures” based on single molecules for novel operations utilizing the thermal instability and structural fluctuations of molecules and molecular junctions.

【Content of the Research Project】

Each member in this project designs and prepares molecules, molecule-substrate interfaces, molecule-molecule junctions, and functions of components and whole devices, like an “architect” who designs and constructs “architectures” as well as “posts”, “beams”, and “bases”. We have four teams as follows:

Team A01 is responsible for design and synthesis of organic molecules with unique properties including asymmetric and/or non-linear current-voltage characteristics which are essential for stochastic resonance studied in this project.

Team A02 studies the electronic structures of the interfaces between the molecules

synthesized by the team A01 and substrate surfaces in an atomic scale by various methods such as scanning tunneling microscopy. The team A02 is responsible for providing a set of guiding principles how to design and prepare the molecule-substrate interfaces.

Team A03 studies the carrier injection and transport properties of molecular junctions designed in cooperation with the teams A01 and A02. A set of guiding principles for novel operations in the molecular system is provided.

Team A04 studies the effect of orchestration of single molecules in aggregates. The effect of electrical noise onto the properties of molecular junctions and molecular aggregates is investigated.

【Expected Research Achievements and Scientific Significance】

This project will provide a set of guiding principles to design and develop novel molecular electronic devices such as stochastic resonance devices and artificial neurons by integration of molecules having non-linear current-voltage characteristics.

【Key Words】

stochastic resonance: a phenomenon where a signal is boosted by adding noise to signal. The nonlinear device or system is essential to have a stochastic resonance.

【Term of Project】 FY2013-2017

【Budget Allocation】 1,119,300 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.molarch.jp>