SINGLE-MOLECULE-LEVEL CONTROL OF LOCAL CHEMICAL REACTIONS FOR MOLECULAR NANOWIRING AND ULTRADENSE DATA STORAGE*

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Two novel methods of single-molecule-level control of local chemical reactions are reported. Both methods are of importance not only for the basis of nanochemistry but also for the realization of molecular nanoelectronic devices.

1) Electrical wiring of a single functional molecule using conductive linear polymer chains through firm chemical bonding

In the development of molecular electronics using functional molecules, the most important problem to be solved is the electrical wiring of the functional molecules. Numerous studies have been reported concerning the use of microfabricated metal wires for this purpose. However, functional molecules that can make firm chemical bonding with a metal wire are limited and the use of microfabricated metal wires limits the density of integration of created nanoscale molecular devices. We have developed a method to wire a single functional molecule with conductive linear polymer chains through firm chemical bonding. For this purpose, the polymer chains are grown by chain polymerization with its direction pointed to the functional molecule. The front end of the chain polymerization is in a radical state inherently, so that when it encounters the functional molecule, it makes firm chemical bonding with the molecule, as confirmed by the first principles theoretical calculation.

2) Reversible control of the chemically unbound and bound states of a few adjacent C_{60} molecules at designated positions

It has been found that the reversible switchover between the chemically unbound and bound states of adjacent two or three C_{60} molecules can be controlled at any designated position in a thin film of C_{60} molecules at room temperature by simply changing the polarity of electric field applied to the position using the tip of a scanning tunneling microscope. By using this method, we have succeeded to create single-molecule-level, nonvolatile, rewritable, ultradense memory bit array with a bit density of 190 Tbit/in^2, which is about 10^2-10^3 times greater than that of today's conventional data storage. It has also been demonstrated that three-state multistate bit operation is also possible.

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