Atomic and molecular electrochemical structure control*

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Local electrochemical reactions that can be controlled at the atomic and molecular scales in a reversible manner by changing the voltage applied to the local area are of great interest, since such reactions may be used to realize novel atomic and molecular devices for data processing and storage. In the present paper, we discuss the following three atomic and molecular local electrochemical reactions of interest:

1) Reversibly controlling the chemically unbound and bound states of a few neighbouring C_{60} molecules by changing the polarity of applied voltage [1]. Its application to single-molecule-level ultradense data storage (~200 Tbit/in^2) is discussed.
2) Creation of a single conductive linear polymer chain (polydiacetylene) at any designated position and its reversible control between non-metallic and metallic states by changing the magnitude of applied voltage [2]. The application of the nonmetal-metal transition to various novel electronic devices is also discussed [3].
3) The growth and shrinkage of a metallic atom cluster that can be controlled reversibly by changing the polarity of applied voltage; this reversible solid electrochemical reaction is the switching mechanism of the atomic switch. [4]. The application of the atomic switch to realize a novel field-programmable LSI (in collaboration with NEC Corp.) is discussed [5]. More important application to the realization of neuromorphic computational circuits using atomic switches is also discussed [6].

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