New functions achieved by an atomic switch

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Atomic switch is one of the nanodevices, which is based on the different operating mechanism from the conventional semiconductor transistors. It has been developed as a two-terminal device, where the formation and annihilation of a metal filament is controlled in a nanogap between two electrodes using a solid-electrochemical reaction [1]. The formation and annihilation can be also controlled in an ionic conductive material [2]. The atomic switches show noble characteristics such as small size, low power comsumptiuin, low on-resisitance, and nonvolatility. These characterisitics are useful for developing new types of electronic devices. For instance, it has been used to develop a new type of programmble logic deveices 'programable cell based integrated circuits' which can achieve many functions by a single chip [3]. Because of the unique mechanism, atomic switch can achieve many functions. For instance, 'volatile' atomic switch can be made by controlling materials and device structures. The formation and annihilation of a metal filament can be controlled by the third electrode, namely three-terminal type atomic switch can be made. Recently, 'memristive operation' has been demonstrated using TiO_2-based resistive switch by controlling oxygen vacancies [4]. Similar operation can be achieved by an atomic switch, where cations are controlled. These functions of atomic switches are shown in the figure. Since the atomic switches are made by metals and metal oxides, they can be formed in metal layers of CMOS devices to configure three-dimensional circuits. Thus, the many functions are useful to make high-performance crossbar circuits [5]. Atomic switch also has learning abilities. The functions of atomic switches will be introduced with their applications.

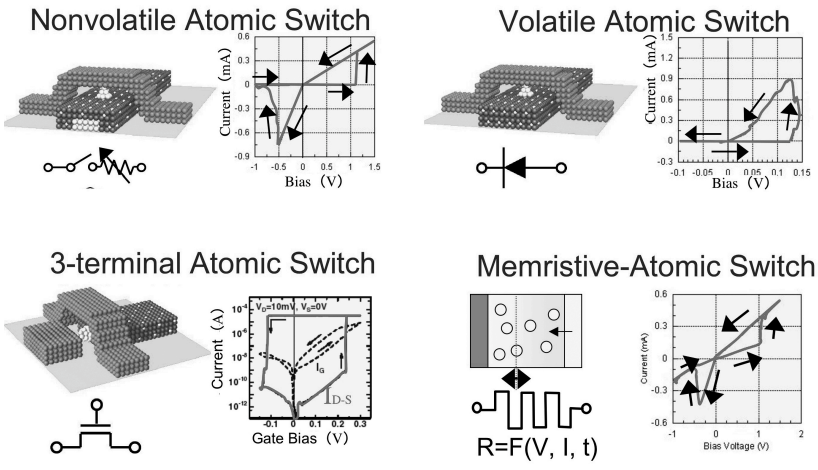

Fig.1. Variety kinds of functions achieved by atomic switch

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