

Atom/ion movement controlled three-terminal atomic switch, 'Atom Transistor'

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Atomic switch is a nanoionic-device that controls the diffusion of metal ions/atoms and their reduction/oxidation processes in the switching operation to form/annihilate a conductive path [1-3]. Since metal atoms can provide a highly conductive channel even if their cluster size is in the nanometer scale, atomic switches may enable downscaling to smaller than the 11 nm technology node, which is a great challenge for semiconductor devices. Atomic switches also possess novel characteristics, such as high on/off ratios, very low power consumption and non-volatility. Although two-terminal devices work as logic devices such as the crossbar circuit, three-terminal devices, in which signal line and control line are separated, are advantageous for the logic applications.

We recently developed an atom movement controlled three-terminal device: 'Atom Transistor' [4]. It operates by bringing metal cations from the gate electrode, which form a conductive channel between the source and drain electrodes. Schematic illustration of the operation is shown in Figure 1. It possess novel characteristics, such as the dual functionality of selective volatile and nonvolatile operations, very small power consumption (pW), and a high on/off ratio (10^6 (volatile operation) to 10^8 (nonvolatile operation)), in addition to being compatible with CMOS processes, which enables their use in the development of computing systems that fully utilize highly-integrated CMOS technology. It is also expected to achieve the nonvolatile logic operations.

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References

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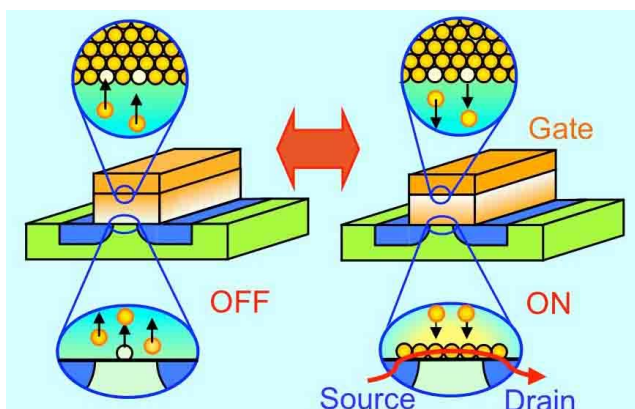


Figure 1 Operating mechanism of the Atom Transistor.