

Atomic Switch for making new type of electronic devices and systems

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Abstract :

We have developed an atomic switch [1], in which formation and annihilation of a metal atomic bridge is controlled by solid electrochemical reaction. Since it has noble characteristics such as small size, small ON-resistance, non-volatility and low power consumption, it has possibility for overcoming the limitation of the downsizing of the present-day semiconductor devices. Not only the performance of a single atomic switch but the configurability such as for making logic circuits have been confirmed.

By using the characteristics, new type of electronic devices can be developed. Actually we are developing new type of a programmable logic device by using atomic switch as a programmable switch for interconnecting logic cells, which can reduce the chip size to 1/10 compared with conventional one using Si transistor [2]. That recently we succeeded in making an atomic switch using Ta₂O₅ [3] can accelerate the commercialization of the device, since the atomic switch was first developed using Ag₂S, which is not suitable for the integration with Si transistors.

New types of atomic switch have been also developed, such as three terminal type atomic switch, which controls the formation and annihilation of a metal atomic bridge using a gate electrode. Operation of photo-responsive atomic switch was also confirmed. Namely light irradiation is required to turn on the photo-responsive atomic switch. These newly developed atomic switches also enable development of new type of devices and systems. In the presentation, fundamentals and applications of the atomic switch will be introduced.

[1] K. Terabe, T. Hasegawa, T. Nakayama and M. Aono, Nature 433 (2005) 47.

[2] S. Kaeriyama, T. Sakamoto, H. Sunamura, M. Mizuno, H. Kawaura, T. Hasegawa, K. Terabe, T. Nakayama and M. Aono, IEEE J. Solid-State Circuits, 40(1) (2005) 168.

[3] T. Sakamoto, K. Lister, N. Banno, T. Hasegawa, K. Terabe and M. Aono, Appl. Phys. Lett., 91 (2007) 092110.