Design of Memristive Devices Towards Neuromorphic Computing

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Current digital computing based on Von Neumann architecture suffers from several key bottleneck including von Neumann bottleneck, Moore's law, and the breakdown of Dennard scaling. Developing new computing platforms provide solutions towards Beyond Moore's computing. Recently, emergent devices such as memristive switching devices have been used to emulate some brain functions including synaptic behavior and neuronal behavior and therefore they have been proposed for developing low-power neuromorphic computing. Oxide-based memristive devices with excellent scalability have the potential to revolutionize not only the field of information storage but also neuromorphic computing.

In this talk, I will first discuss some basics of the brain, brain-inspired neuromorphic computing and artificial intelligence. In the second part of my talk, I will then discuss the roles of defects and interfaces on switching behavior in different types of memristive devices and their impacts on neuromorphic computing. Material systems have profound effects on switching behavior. For example, ferroelectric and non-ferroelectric systems show completely different switching behavior [1-2]. Defects also dominate the switching behavior. Figure 1 compared switching behavior in a variety of materials with different type of defects. Among different types of switching, filament-type switching and interface-type switching are two most distinct switching modes. I will focus on a specific interface-type switching we observed in Au/Nb:$SrTiO_3$ system [3]. It shows the switching is controlled by protons in the environment. We also explored the applications of such systems for neuromorphic computing applications [4].

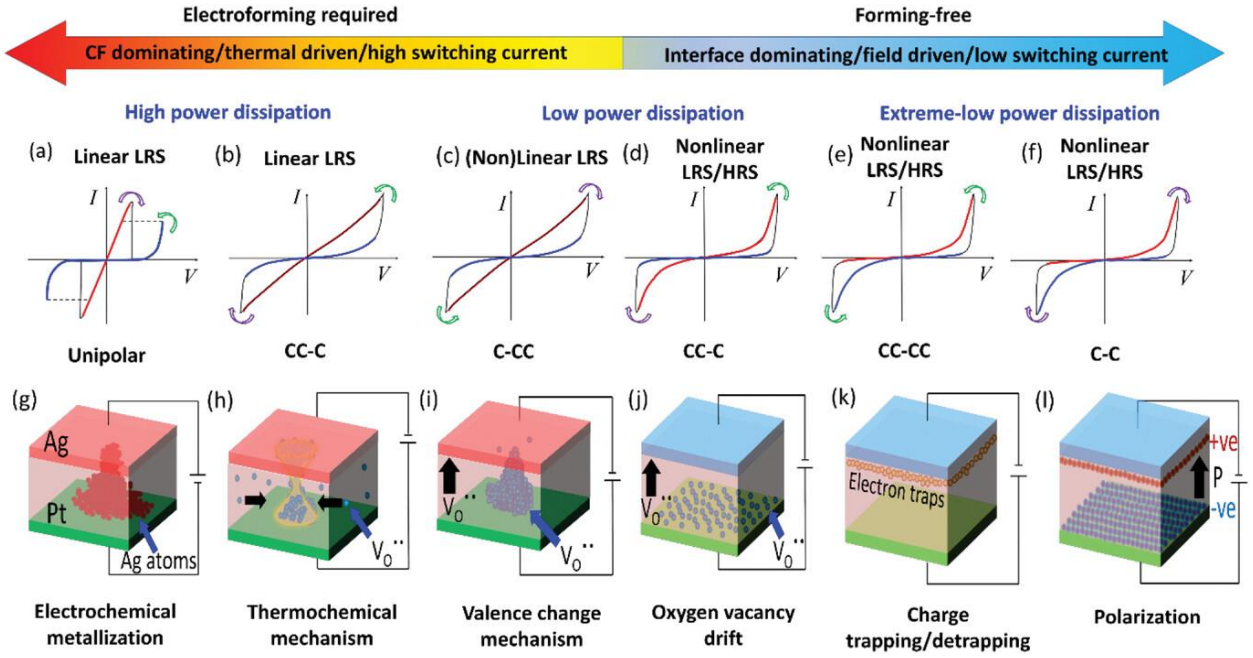

Figure 1. Schematic illustration of different types of resistive switching mechanisms observed in memristors using oxide materials as RS layers. From left (a) to right (f) shows filament-type and interface-type switching with different types of *I–V* characteristics along with the possible switching mechanisms (g-l).

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