Abstract

Resistance Switching and Memory in a Metal-Dielectric Nanocomposite System

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We observe electrically driven switching between stationary resistance states in a metal-dielectric composite system with hopping conduction, confined to a small volume. Sample preparation includes two main stages. First, a metal column consisting of Co and Cu layers is deposited in a via (channel) of dimensions 50×50, 100×100, 250×250, or $500 \times 500\text{nm}^2$, etched by focused ion beams in a SiO_2 film. Then the microstructure is transformed irreversibly by application of a controlled high density current to the metal column. The transformation is manifested in both a considerable increase of resistance and a transition from metallic type of conduction to thermally activated tunneling. The resulting system is characterized by non-linear I–V curves with hysteresis. The resistance state can be switched by positive or negative voltage greater than 1.3 V. The minimum switching time is less than 1 ns. For interpretation of the switching and memory effects we apply the Simmons-Verderber model of charge trapping and release to a narrow dielectric gap containing metal granules.

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