School of Electrical, Computer and Energy Engineering

PhD Final Oral Defense
Cu-Silica Based Programmable Metallization Cell: Fabrication, Characterization and Applications

by
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Abstract

The Programmable Metallization Cell (PMC) is a novel solid-state resistive switching technology. It has a simple metal-insulator-metal “MIM” structure with one metal being electrochemically active (Cu) and the other one being inert (Pt or W). An insulating film (silica) acts as solid electrolyte for ion transport. PMC resistance can be altered by an external electrical stimulus. The change of resistance is attributed to the formation or dissolution of Cu metal filament(s) within the silica layer which is associated with electrochemical redox reactions and ion transportation. In this dissertation, a comprehensive study of microfabrication methods and their impact on PMC device performance is demonstrated, gamma-ray total ionizing dose (TID) impact on device reliability is investigated, and the materials properties of doped/undoped silica switching layers are illuminated by impedance spectroscopy (IS). Due to the inherent CMOS compatibility, Cu-silica PMCs have great potential to be adopted in many emerging technologies, such as non-volatile storage cells and selector cells in ultra-dense
3D crosspoint memories, as well as electronic synapses in brain-inspired neuromorphic computing. Cu-silica PMC device performance for these applications is also assessed in this dissertation.