Nian, Yibo, "Non-Volatile Memory Based on Transition Metal Perovskite Oxide Resistance Switching,"

Advisor: Alex Ignatiev

Driven by the non-volatile memory market looking for new advanced materials, this dissertation focuses on the study of non-volatile resistive random access memory (RRAM) based on transition metal perovskite oxides. Pr0.7Ca0.3MnO3 (PCMO), one of the representative materials in this family, has demonstrated a large range of resistance change when short electrical pulses with different polarity are applied. Such electricalpulse-induced resistance (EPIR), with attractive features such as fast response, low power, high-density and non-volatility, makes PCMO and related materials promising candidates for non-volatile RRAM application. The objective of this work is to investigate, optimize and understand the properties of this universal EPIR behavior in transition metal perovskite oxide, represented by PCMO thin film devices. The research work includes fabrication of PCMO thin film devices, characterization of these EPIR devices as non-volatile memories, and investigation of their resistive switching mechanisms. The functionality of this perovskite oxide RRAM, including pulse magnitude/width dependence, power consumption, retention, endurance and radiation-hardness has been investigated. By studying the “shuttle tail” in hysteresis switching loops of oxygen deficient devices, a diffusion model with oxygen ions/vacancies as active agents at the metal/oxide interface is proposed for the non-volatile resistance switching effect in transition metal perovskite oxide thin films. The change of EPIR switching behavior after oxygen/argon ion implantation also shows experiment support for the proposed model. Furthermore, the universality, scalability and comparison with other non-volatile memories are discussed for future application.