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Title: Group III-Sb alloys for multilevel phase change memory (PCM)

Abstract: Phase change materials are actively being explored as analog resistive memory devices for neuromorphic applications due to their fast switching time, high endurance and excellent scaling properties. Among various phase-change memory materials (PCMs), $Ge_2Sb_2Te_5$ (GST) is an outstanding representative, widely used in both optical storage and electronic memories. Tellurium volatility and low amorphous phase stability of GST hinder it from being a perfect candidate. The potential of Te-free Al-Sb and Ga-Sb binary alloys thin films for applications in multilevel phase change memory will be discussed. Thin films deposited under UHV conditions using molecular beams demonstrated crystallization temperature between 160°C -280°C and data retention of up to 150-160 °C projected to 10 years. Annealing of bilayer stack showed two crystallization temperatures indicating that the alloys with different composition can be assembled into multilayer structures for multilevel memory operation. X-Ray Diffraction (XRD) analysis shows crystallization into rhombohedral doped Sb (A7) and cubic zinc-blende AlSb or GaSb phases with almost linear dependence of phase volume ratio upon increasing composition Measurements of single and multilayer stack based mushroom cells with ~100nm TiN heater demonstrated reversible switching with comparable resistance drift to GST. The reset/set resistance ratio of ~300 for Ga-Sb and ~4000 for Al-Sb alloy has been demonstrated with low drift power coefficient ranging from 0.003 (set) to 0.015 (Reset). The controllable high crystallization temperature, study of phase structure and preliminary switching of mushroom cells reveal a path toward developing multilevel PCM devices.