Controllable crystallization and interface microstructure stability of new phase-change films

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Abstract

The new phase-change thin films with single element doping, pseudo-binary homogeneous phase, and nano-composite structure have beem investigated. It is found that together with well-documented results of Zn-doped Sb2Te3, Sb2Te, Sb7Te3, and Sb3Te systems, we plotted the ternary amorphous-phase forming-region of Zn-Sb-Te. Zn-doped Ge2Sb2Te5 and Sb:Te films exhibit excellent properties, such as nanocrystals uniform distribution, no phase separation, fast speed, reverse optical cycle. The addition of Mg into Sb7Te3 can increase the crystallization temperature, crystalline activation energy and change growth mode, while hindering grain growth and suppressing phase separation from Sb+Sb2Te, Sb2Te, to Sb phases. In nano-composite struture films with one-dimensional growth mode, the Sb2Te-rich nanocrystals, surrounded by TiO2 amorphous phases, are observed in the annealed Sb2Te-TiO2 composite films. The segregated domains exhibit obvious chalcogenide/TiOx interfaces, which elevate crystallization temperature, impede the grain growth and increase crystalline resistance. NiO-doped ZnSb can directly crystallize into a stable ZnSb phase at temperatures greater than 320 ∘C with suppression of a metastable ZnSb phase. These characteristics enlarge the amorphous/crystalline resistance ratio by approximately five orders of magnitude. The improved thermal stability, larger resistance ratio and direct transition to a stable phase with ultrafast one-dimensional crystal growth indicate the good potential of these materials in phase change memory applications. This work is helpful to explore a new generation of phase change storage film applied in phase-change memory.

Keywords: Phase change films, Crystallization, Thermal stability, Interface

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