Effect of Sn and Zn doping on phase-change materials for optical and electrical memories

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Abstract

Phase change materials are widely used for rewritable optical recording disks and recently they show good potential also for the application in nonvolatile random access memories. The influence of tin and zinc doping on the properties of GeSbIn and $Ge_2Sb_2Te_5$ (GST) phase-change materials has been investigated for application in optical recording and electrical memory respectively. The structural transformations and transformation kinetics of tin and zinc doped GST (GST:Sn and GST:Zn hereinafter) were studied to determine the feasibility of applying this material in phase change nonvolatile random access memories. Temperature-dependent sheet resistance measurements and x-ray diffraction were used to observe the structure and transformation kinetics of the GST:Sn and GST:Zn films. The crystallization temperature (T_x), melting point (T_m) and electrical resistance of GST are greatly influenced by Sn and Zn addition. Sn and Zn doped GST are found to possess higher T_x and one order of magnitude higher sheet resistance of the crystalline state than pure GST, combined with lower T_m, all these beneficial for electrical memory application. Non-tellurium based phase change materials are proposed for high-speed optical recording as well as improved archival stability. High-speed (5X HD-DVD) reversible optical recording using blue laser (λ = 405 nm) and 0.65 NA is performed in Sn and Zn doped GeSbIn phase-change materials. The influence of the different doping concentration on the writing/erasing performance was investigated. CNR and DC erasability with practical levels (CNR > 47 dB and erasability > 25 dB) are measured. Sn and Zn doping are effective for improving the amorphous state stability of GeSbIn as well.