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Enhanced optical properties of Sn-doped $Ge_2Sb_2Te_5$ thin film with structural evolution

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Abstract:

The microstructure, texture and optical properties of Sn doped $Ge_2Sb_2Te_5$ thin films were investigated in this work. The correlation between grain orientation and optical reflectivity of Sn doped $Ge_2Sb_2Te_5$ thin films has been obtained. Thin films with different compositions were deposited on SiO_2/Si (100) wafer using magnetron sputtering method. Both the composition and thickness of thin films were determined using Rutherford backscattering spectrometry (RBS). It appears that face-centered-cubic (fcc) and close-packed-hexagonal (hcp) structure coexisted in Sn doped $Ge_2Sb_2Te_5$ thin films. Rietveld structure refinement indicates that the lattice constant of the fcc structure increased with increasing Sn content, while the lattice constant of the hcp structure remains nearly unchanged. Sn doping also leads to the appearance of defects and disordered local arrangement in $Ge_2Sb_2Te_5$ films. Furthermore, the crystalline optical reflectivity of Sn doped $Ge_2Sb_2Te_5$ thin films increased, which is attributed to texture formation. The texture component of the hcp structure $Ge_2Sb_2Te_5$ thin films transformed from cylindrical {01-10} to basal {0001} during the addition of Sn atoms. Accordingly, we proposed a model of texture and optical reflectivity, that is, the basal texture facilitates the high crystalline optical reflectivity of $Ge_2Sb_2Te_5$ thin films thanks to the six-fold rotational symmetry in the hcp structure.

Keyword: phase change materials, $Ge_2Sb_2Te_5$ thin films, texture, optical reflectivity

1. Introduction

Even though the first phase change memory (PCM) was documented by Ovshinsky already in 1968 [1], it still represents a state of the art technology for rewritable optical storage. PCMs require a reversible transition between crystalline and amorphous phases [2-4]. PCM applications started with CD-RW discs and progressed to rewritable Blu-ray discs, which are currently used for high-density