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Elastic and Thermal Properties of Ge₂Sb₂Te₅ by Surface Brillouin Scattering

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Ge₂Sb₂Te₅ (GST225) is a chalcogenide phase change alloy widely used in optical storage media and electronic memory devices. It has been studied in the past two decades due to its optical and electrical properties driven by fast and reversible structural phase transformation. However, its elastic properties have not been thoroughly investigated. Since thermal energy can be stored in vibrational modes, surface Brillouin scattering (SBS) has been used to determine the elastic properties and correlate them with thermal properties. RF-magnetron sputtering was used to deposit films of thickness varying from 50-500 nm on a Si/Si₁O₂ substrate. The crystalline (c) phase was obtained by annealing the samples at a temperature of 150 ⊠C for one hour. Since the transition between the amorphous (a) and crystalline phases is associated with a volume change, we studied this by measuring the densities of the two phases using x-ray reflectivity. Rutherford Backscattering was used to investigate the films chemical composition and atomic density, which was found to be n˜3.05×⊠10⊠ˆ22 and 3.01×⊠10⊠ˆ22 atoms cmˆ(-3) for a-GST225 and c-GST-225. The elastic constants for the amorphous (a) and crystalline (c) phases obtained are C₁₁=37.9/37.0 GPa, C₁₂=17.6/13.1 GPa and C₄₄=10.2/12.0 GPa respectively. The corresponding longitudinal and transverse velocities are v_l=2558/2499 m/s and v_t=1325/1421 m/s. Lastly the calculated minimum lattice thermal conductivities of a- and c-GST225 were found as κ_{min}=0.283 and 0.287 Wmˆ(-1) Kˆ(-1). Such low thermal conductivities are desirable for improving thermal management in memory devices during programming.

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