Understanding phase-change phenomenon in undoped and Nitrogen doped GeTe thin films using curvature measurements

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Abstract:

Herein, we study the crystallization of undoped and nitrogen doped sputter deposited amorphous GeTe thin films using substrate curvature measurements to understand the underlying mechanisms controlling stress evolution in the film throughout the phase transformation. At temperatures below crystallization temperature, amorphous films showed stress relaxation and the stress gradually became tensile with annealing time. The GeTe samples show a two-step crystallization wherein amorphous GeTe crystallized first at the crystallization temperature (T_x) followed by crystallization of excess Ge (Ge precipitation) at ~T_x+50°C. Upon GeTe crystallization, a sharp increase in the tensile stress is explained using a coalescence mechanism. The precipitation of excess Ge (from amorphous to crystalline) along grain boundaries in GeTe leads to compressive stress build-up. The nitrogen doping affects both the GeTe and Ge crystallization events leading to lesser tensile and compressive stress. The models for stress relaxation in the amorphous phase, stress build-up due to GeTe, and excess Ge crystallization are discussed.

Keywords: Phase-change materials, GeTe, Nitrogen doping, crystallization, Stress