Nonthermal Photo-Switching Process of Phase-Change Memory Material revealed by Ultrafast Electron Diffraction

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ABSTRACT

Major applications for laser-induced solid-to-solid phase transitions involves nonvolatile optical storage devices, *i.e.*, phase-change memories. Among optical media materials, chalcogenide glass materials, *e.g.* $Ge_2Sb_2Te_5$, have been widely used due to their robust switching capability. The phase transition in this class of materials is usually achieved by continuous wave laser or nanosecond pulsed laser irradiation via thermal processes. Recent studies have suggested the potential of nonthermal phase transitions in the chalcogenide glass materials triggered by ultrashort optical pulses; however, a detailed understanding of the amorphization and damage mechanisms governed by nonthermal processes is still lacking. In this study, we performed ultrafast time-resolved electron diffraction measurement followed by femtosecond near-ultraviolet pulse irradiation to understand the structural dynamics of polycrystalline $Ge_2Sb_2Te_5$. The experimental results present a nonthermal crystal-to-amorphous phase transition of $Ge_2Sb_2Te_5$ initiated by the displacements of Ge atoms. The results are well consistent to the previous reports by the X-ray absorption spectroscopy.

Key words: Nonthermal Process, Material Characterization, Electron Diffraction, GeSbTe