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Phase change in stacked chalcogenide layers

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Phase change materials (PCM) are promising substitutes for existing flash memories which have almost reached their miniaturization limit. The PCM memory storage is based on modification of optical and electrical properties at the transition from an amorphous to a crystalline state. Here, we report on single and bi-layer thin films of GeTe, SnSe and GaSb prepared by pulsed laser deposition on glass substrates. GeTe has been chosen because is one of the fastest phase change material with the switching speed of less than 10 ns. SnSe is very similar with GeTe, it has the same average number of valence electrons and almost the same band gap. Unlike GeTe which crystalizes in the rombohedral structure, SnSe crystalizes in the orthorombic structure. On the other hand, in the amorphous phase, SnSe is highly resistive which results in a lower current necessary to reset the memory cell. The third material, GaSb, is characterized by a remarkably high thermal stability and it crystalizes in a cubic structure. The variation of single layer resistance as function of temperature was measured by four-probe method in inert atmosphere. The bi-layer samples were annealed at different temperatures below and above their transition temperature. All the films have been investigated by Extended X-ray absorption fine structure (EXAFS) and X-ray diffraction (XRD). The EXAFS analysis at the Ga, Ge and Se K-edges reveals information about the changes in local atomic environments as a function of temperature. Complementary to EXAFS analysis, X-ray diffraction spectra of the as-deposited and annealed samples were recorded in transmission at 17 keV. At specific annealing temperatures, discrete changes in the atomic long range order of bi-layers were detected. In the case of GeTe/SnSe bilayers we observed that SnSe increases the crystallization temperaure of GeTe. The formation of SbSn alloys in GaSb/SnSe bilayers at high annealing temperatures was evidenced.

Primary author: VELEA, Alin (Paul Scherrer Institut)

Co-authors: BORCA, Camelia (Paul Scherrer Institut); Dr GROLIMUND, Daniel (Paul Scherrer Institute, Swiss Light Source); Dr SOCOL, Gabriel (National Institute for Laser, Plasma and Radiation Physics, RO-077125, Magurele, Ilfov, Romania); Prof. POPESCU, Mihai (National Institute of Materials Physics, RO-077125, Magurele, Ilfov, Romania)

Presenter: VELEA, Alin (Paul Scherrer Institut)

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