Ultrafast dynamics of phase transition in Chalcogenide Phase-Change Materials

P. Martinez[1], J. Gaudin[1], I. Papagiannouli[1], V. Blanchet[1], D. Descamps[1], C. Fourment[1], S. Petit[1], J. Y. Raty[2,3], N. Bernier[3], J.-B. Dory[3] and P. Noé[3]

[1]CEntre Lasers Intenses et Applications, 43 rue Pierre Noailles, 33405 Talence, France
[2] Université de Liège, Institut de Physique B,5B-4000 Sart-Tilman, Belgium
[3] Univ. Grenoble Alpes, CEA, LETI, MINATEC Campus, F-38054 Grenoble, France

Chalcogenide Phase-Change Materials (PCMs), mainly GeSbTe-based alloys, have already been widely used for optical data storage (DVD-RAM or CD-RW). Thanks to their unique reversible and very fast amorphous to crystalline phase transition which is characterized by an uncommon huge change in optical and electrical properties. PCMs are now extensively studied to produce phase-change memory or aiming at developing further innovative non-volatile memories such as or storage class memories (SCM). The interaction of PCMs with a fs light pulse has attracted significant attention since the possible non-thermal amorphous↔crystal phase transition could be used to drive the phase-change above the thermal "speed limits".

We used frequency domain interferometry (FDI), a pump-probe technique to investigate fs dynamics in highly excited amorphous GeTe films. A pump pulse (25 fs, 800 nm, 1kHz) is used to trigger the phase transition. The interference patterns of the two probe pulses (120 fs, 532 nm) are measured simultaneously along S and P polarization to give access to complex refractive index as well as the surface hydrodynamics. In the sub-ps time scale a very rapid switch to a metallic state mainly attributed to the real part of the refractive index is observed while the surface is clearly shrinking within few hundreds of fs. *Ab-initio* simulations show that the change of chemical bonding of GeTe amorphous structure explains the trends observed in the experimental results.