

### Ultrafast measurements of optically induced linear birefringence in GeSbTe films

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GeSbTe alloys possess a most interesting and useful combination of structural, electrical, and optical properties [1]. The amorphous and crystalline states exhibit a very large difference in optical reflectivity and electrical resistance, while the transition between the two phases may be achieved on very short timescales. GeSbTe alloys have been widely used as optical phase change recording media, and have great potential for use in a new generation of random access memory devices. However, understanding of the phase transition is surprisingly limited due to the scarcity of dynamic studies performed with sufficiently high temporal resolution. In order to satisfy the demand for increased recording density and transition speed, a much deeper understanding of the dynamic processes that occur during the phase transition is now required. The response of phase change materials to the polarization of an ultrafast optical pulse is of particular interest, since the observation of optically induced birefringence may provide a better understanding of any non-thermal aspects of the phase transition.

An optical pump-probe measurement technique [2] has been used to study the linear birefringence and change in optical reflectance induced in GeSbTe thin films by a femtosecond optical pulse. Measurements were performed upon three samples with chemical composition close to  $\text{Ge}_2\text{Sb}_2\text{Te}_5$ , and with amorphous, polycrystalline and epitaxial structure. The pump fluence of  $1.2 \text{ mJ/cm}^2$  was insufficient to induce the phase transition between the amorphous and crystalline states. The transient reflectivity response was found to depend strongly upon the structural state of the sample, while a linearly polarized pump beam was found to induce a large birefringence that was detected by the optical rotation and ellipticity induced upon a linearly polarized probe pulse. A large peak is observed in the rotation and ellipticity signal within the temporal overlap of the pump and probe pulses. The initial optical response results from the repopulation of electrons/hole states induced by the pump pulse, and the birefringence effect is expected to be short-lived due to the short momentum relaxation time of the excited carriers. However a longer-lived tail is also observed, suggesting that the optical polarization can induce a distortion of the lattice that relaxes more slowly [3]. The birefringence effect is found to vary weakly as the amorphous and polycrystalline films are rotated about the film normal, whereas the epitaxial film exhibits a clear anisotropy, suggesting that the birefringence effect results from excitation of electrons within well-defined orbitals.

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