

Optical switching of epitaxial Ge₂Sb₂Te₅ films

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The optically induced switching of epitaxial GeSbTe (GST) films between the crystalline and amorphous phase has been demonstrated. The approximately 30-nm-thick film with a composition close to Ge₂Sb₂Te₅ has been grown by molecular beam epitaxy on a GaSb(001) substrate and is found to be crystalline by reflection high-energy electron diffraction (RHEED) during growth and electron backscatter diffraction (EBSD) after growth. Using a high-power pulsed Nd:YAG laser with a pulse duration of 60 ps and a repetition rate of 20 Hz, the as-grown crystalline film can be transferred into an amorphous state using a single pulse or up to five laser pulses separated well in time depending on the energy per pulse. After amorphization, the reflectance of the film is reduced up to 30% as shown in Fig. 1. Subsequently, by application of several hundred pulses with half the energy per pulse, the film can be re-crystallized again. The structural changes resulting from the switching have been investigated by Raman spectroscopy. In Fig. 2, we compare the Raman spectra from three different locations on the GST film, as-grown crystalline (top), amorphized (middle), and re-crystallized (bottom). The Raman spectrum obtained from the as-grown part reveals a rather broad band between 80 and 180 cm⁻¹ with the strongest intensity at 100 cm⁻¹, while the spectrum from the amorphized part exhibits a clear maximum at 150 cm⁻¹.

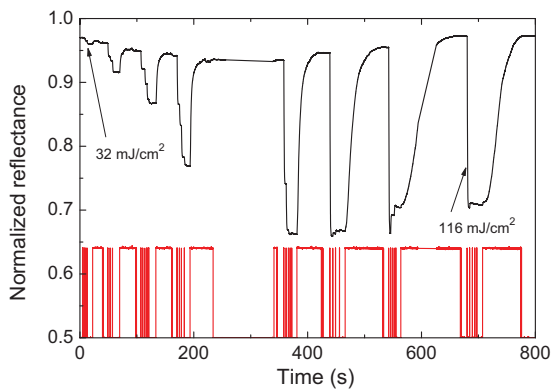


Figure 1: Reflectance of the GST film for eight switching cycles with an amorphization energy density between 32 and 116 mJ/cm² per pulse. Re-crystallization is performed with 25 mJ/cm² per pulse. The lower part of the figure displays the shutter control signal.

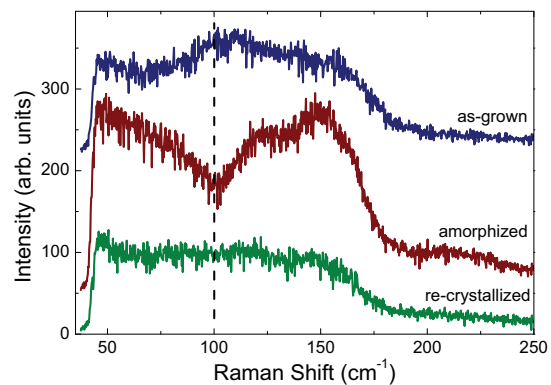


Figure 2: Raman spectra for the as-grown crystalline, amorphous, and re-crystallized part of the film. The sharp cutoff near 40 cm⁻¹ is due to the filter function of the Raman spectrometer.