Mixed-Mode Electro Optical Properties of $Ge_2Sb_2Te_5$

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1. Introduction

$Ge_2Sb_2Te_5$ (GST), a phase change material, has been broadly used as rewritable optical data storage media [1]. Recently GST has also been commercially used for data storage in the electrical domain using the change in resistance that occurs as a consequence of the phase change [2]. Thus, it can be used in both optical and electrical domains; the combined use of optical and electrical properties of GST ("mixed-mode") opens a new set of potential applications ranging from optical modulators to electrical read-out of all-optical memories. In this talk we present some preliminary work on this "mixed-mode" read-out [3].

2. Experimental

For testing mixed-mode read-out of our devices, a test device was fabricated by creating of a pair of TiN/Pt electrodes in contact with a 50nm thin film of amorphous as deposited GST covered with SiO_2 as a capping layer, both the GST and the SiO_2 were deposited by RF magnetron sputtering on a thermally oxidized Si wafer substrate. The electrodes confine a region in the GST substrate as shown in Fig. 1.
Our experiment consists of iteratively applying a series of optical pulses at increasing power (0.5 - 5.5 mW), followed by measuring the changes in the device resistance. During each iteration a series of 20 identical high energy pulses of 1μs duration is applied at first to partially induce the crystallization of the material. The reflectivity is then measured as the amount of reflected power by applying a continuous wave low power laser beam (0.3mW). Finally the electrical resistance of the device is measured. Reflectivity maps shown in Fig. 3 and Fig. 4 were made by the reflected power measurements obtained by scanning an area around the PCM with a low power continuous wave laser beam. The same 405nm laser was used for the pulse and reflected power measurements.

3. Results & discussion

We studied the amorphous to crystalline transition of GST225; our observations are presented in Fig. 2. As the PCM is exposed to consecutive series of pulses, the reflected power increases which indicate an increment in reflectivity characteristic of the crystalline phase [4], at the same time the electrical resistance decreases. Correspondence between the behaviors of both curves can be observed, which confirms the feasibility of using GST in a electro-optical domain, optically inducing the phase change and performing the read out electrically. The change of reflectivity of the PCM can be observed in Fig. 3 and Fig. 4 before and after applying the set of optical pulses.

4. Conclusions

In the presented work we have experimentally demonstrated the operation of the phase change material GST in the Mixed-Mode electro-optical domain. These are very preliminary results and require further characterization; however this indicates the first such measurements on GST, and shows the potential for devices based on these materials in the combined optical and electrical domain, especially in photonic devices.

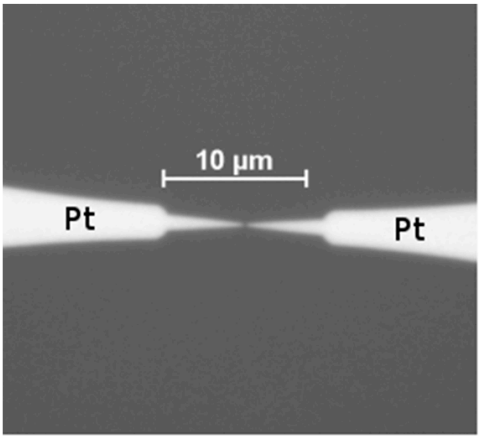

Fig. 1. Phase Change Memory Cell

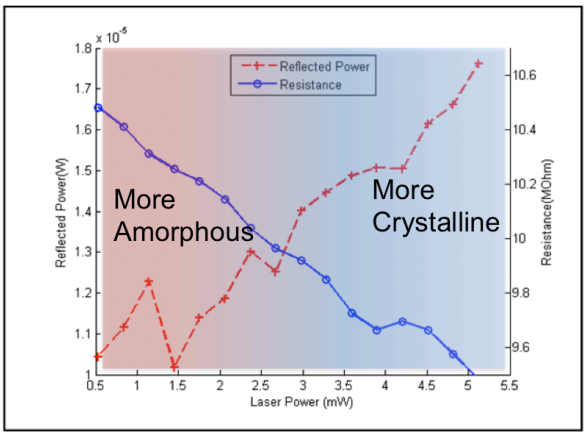

Fig. 2. Resistance and Reflectivity change

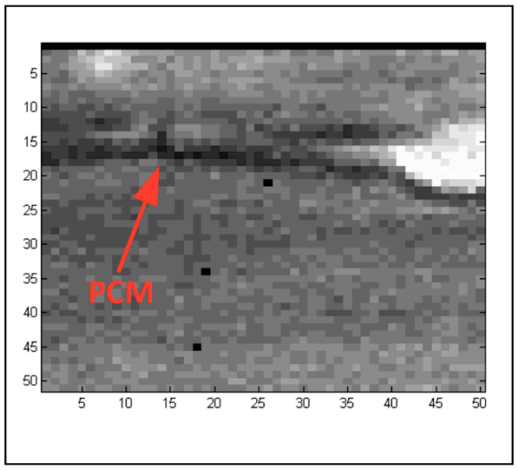

Fig. 3. Initial reflectivity map

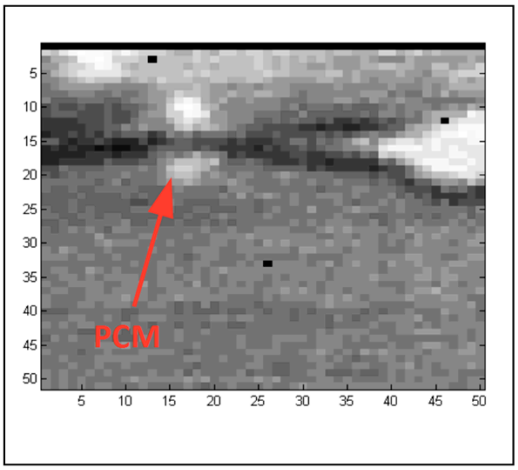

Fig. 4. Final reflectivity map

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