Simulation of Transport and Resistance Drift in amorphous $Ge_{15}Sb_{85}$

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Phase change random access memory has become one of the most promising candidates for future non-volatile memory applications. Hence the search for suitable phase change materials with optimized properties is at present one focus of attention. While significant progress has been made in recent years regarding a systematic understanding of the relationship between stoichiometry and the resulting physical properties of the crystalline phase, two important characteristics of the amorphous phase are less well understood. One is the threshold switching effect which is mandatory for the operation of phase change memories and occurs at electric fields of about 10 V/µm to 100 V/µm. The second one is the drift of the resistance in the amorphous phase with time. This drift is a concern since it might be detrimental for concepts employing multilevel storage.
To understand these phenomena it is necessary to understand the electrical transport in amorphous phase change materials. In this work the electrical transport has been simulated using a trap limited band transport and a thermally activated variable range hopping model. The simulations are based on a density of states obtained from modulated photocurrent measurements. It is shown that the dark conductivity can be reproduced over a temperature range from 50 K to 300 K with a band transport model in good agreement with measurements of the thermoelectric effect.
Furthermore, by fitting simulated conductivities to experimental data obtained from temperature dependent Van-der-Pauw measurements, evidence is found that the resistance drift arises from an increase of the bandgap and not as commonly believed from a decrease of the defect density within the bandgap. These results are verified by Fourier transform infrared spectroscopy, where a similar increase of the bandgap has been observed upon annealing.