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Nucleation switching in phase change memory. Y.A. KRYUKOV, V.G. KARPOV, Department of Physics and Astronomy University of Toledo, S.D. SAVRANSKY, I.V. KARPOV, Intel Corporation — We propose a simple physical model of threshold switching in phase change memory cells (PCM), based on the electric field induced nucleation of conductive cylindrical crystallites in amorphous media. We consider a flat plate capacitor filled with the high resistive amorphous material $Ge_2Sb_2Te_5$ (GST). When the voltage $V$is applied the corresponding field lowers the free energy and nucleation barrier for the amorphous/crystalline transition. This increases the probability of creating crystalline nuclei, which are much less resistive than the amorphous ones. Hence the low resistive crystalline path between two electrodes is created, causing the memory switching. The model is solved analytically and leads to a number of predictions. They include correlations between the threshold voltage V_{th} and material parameters, such as the nucleation barrier and radius, amorphous layer thickness, as well as V_{th} versus temperature and switching delay time. In particular our calculations show linear dependence between threshold voltage and thickness of a memory cell and that the threshold voltage inversely proportional to the temperature to the power 1.5. We have carried out verifying experiments: good agreement is achieved.

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