

Snapback and Overprogramming Modeling in ANSYS

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Abstract

We present a new model for the simulation of negative differential resistance (“snapback”) in a phase-change memory cell using an electro-thermal finite-element iterative calculation implemented in ANSYS. This model improves upon our previous models by applying a double Arrhenius temperature-dependent resistivity for the amorphous chalcogenide, and a JMAK ($n=3.5$) model to describe the phase-change kinetics. As a result, the model captures the possibility of partial crystallization during typical pulsed heating conditions, a crucial factor in determining the abruptness of snapback. In addition to fitting our experimental data, the model is capable of predicting and characterizing the onset of overprogramming. Overprogramming occurs when the process of crystallizing some parts of the initially amorphous region leads to other parts heating above the melting point, leading to a remnant amorphous portion that limits the reduction of the cell’s resistance. The paper also explores the impact of initial amorphous size as well as the presence of a defect breaking the symmetry of the amorphous hemisphere.

