Time and temperature dependence of the amorphous resistance of phase-change line cells

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Temporal drift of the amorphous resistance of PRAM cells is a well-known effect. Directly after a high-energy (RESET) pulse the amorphous phase is produced via melt-quenching, the resistance subsequently increases with time according to a power law. The dependence of the amorphous resistance on both time and temperature (after the RESET pulse) has however not been studied extensively and is not understood well.

As the Fermi level of the amorphous phase is pinned at mid-gap the activation energy of conductance (E_c) is half the value of the band gap. We show that the activation energy for conductance, which is obtained from the dependence of the amorphous resistance on temperature, is typically assessed incorrectly. In principle E_c cannot be properly determined by raising the temperature without taking into account the resistance drift that occurs during the measurement. We present extensive work done on the intricate time and temperature dependence of the amorphous resistance of phase-change line cells from which a relation between the amorphous resistance and E_c is obtained. A numerical model is provided that allows us to predict to a great accuracy the resistance from the temperature and time profile.