Nanosecond switching in GeTe phase change memory cells

G. Bruns, P. Merkelbach, C. Schlockermann, M. Salinga and M. Wuttig
I. Physikalische Institut (IA), RWTH Aachen, 52056 Aachen, Germany

T. D. Happ[1], J. B. Philipp[2] and M. Kund[2]
[1)] Qimonda Dresden GmbH & Co. OHG, Königsbrücker Straße 180, 01099 Germany
[2)] Qimonda AG, Bibergerstr. 93, 82008 Unterhaching, Germany

The electrical switching behavior of GeTe-based phase change memory devices is characterized by time resolved experiments. SET pulses with a duration of less than 16 ns are shown to crystallize the material. Depending on the resistance of the RESET state, the minimum SET pulse duration can even be reduced down to 1 ns [1]. This finding is attributed to the increasing impact of crystal growth upon decreasing switchable volume. Using GeTe or materials with similar crystal growth velocities hence promises non-volatile phase change memories with DRAM (Dynamic Random Access Memory)-like switching speeds.

The dependency of the crystallization process on pulse length and pulse height was tested on GeTe memory cells, which were initialized into different RESET states. We found a clear correlation between the RESET resistance and the minimum SET pulse length, which is necessary to recrystallize the amorphous region. A higher RESET resistance is indicative for a larger amorphous region. The decrease of the necessary pulse length to crystallize cells with lower RESET resistances can hence be explained by a recrystallization mechanism employing growth from the crystalline rim. This conclusion demonstrates the increasing importance of crystal growth for shrinking cell size.

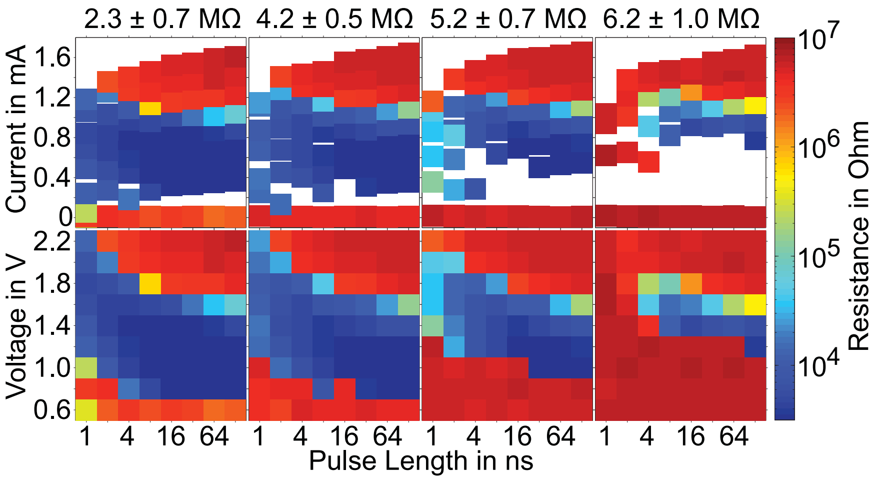

Figure: The crystallization behavior of GeTe was tested for four different RESET states. top: current versus pulse length. Moderate currents (<0.9 mA) can crystallize the cell while higher currents (>1.1 mA) reamorphize the cell. bottom: voltage versus pulse length. The lower border (from red to blue) shows how the threshold voltage depends on the RESET resistance.

[1] G. Bruns, P. Merkelbach, C. Schlockermann, M. Salinga, M. Wuttig, T. D. Happ, J. B. Philipp and M. Kund, App. Phys. Lett., **95**, 043108 (2009).