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Three-Dimensional Multiscale Modeling of Stable Intermediate State Formation Mechanism in a Single Active Layer– Phase Change Memory Cell[1] ONUR DINCER, IBRAHIM CINAR, VEDAT KARAKAS, OZGUR BURAK ASLAN, AISHA GOKCE, Bogazici University, Department of Physics Bebek, 34342 Istanbul, Turkey, BARRY STIPE, JORDAN A. KATINE, HGST, A Western Digital Company, 95135 San Jose, California, USA, GULEN AKTAS, OZHAN OZATAY, Bogazici University, Department of Physics Bebek, 34342 Istanbul, Turkey — Phase change memory (PCM) appears as a potential memory technology with its superior scalability which could be enhanced by a boost in storage density via multiple-bit per cell functionality. Given the large contrast between set and reset states of a PCM cell it is yet unclear whether it is possible to create intermediate logic states reproducibly and controllably in a device with a single active phase change layer. Here we report the results of a 3D finite element model that pinpoints the direct effect of current distribution and the indirect effect of device top contact fabrication induced defects through modification of phase change kinetics (crystallite nucleation and growth rates) on stabilization of intermediate states. A comprehensive picture of the electrical, thermal and phase change dynamics is obtained using a multiphysics approach. Our study shows that homogeneous and heterogeneous phase transition can be induced in the active region such that nonuniform temperature distribution and modification of switching dynamics with various contact shapes and sizes play a major role in the stabilization of a mixed phase state.

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