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Phase Change Memory – The Interplay Between Thermal and Electrical Effects

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Conventional memories such as SRAM, DRAM, and FLASH have set a very high performance/cost standard. Yet, recent advances in new materials, device technologies and circuits have made many emerging memories attractive candidates for a new generation of memories. Phase change memory is one such candidate that has advanced to manufacturing and deployment in practical applications.

This talk gives an overview of our recent works in phase change memory [1-8]. The phase change memory is an electronic device that capitalizes on the thermal properties of phase change materials [9]. As such, the interplay between thermal and electrical effects in phase change memory is of paramount importance in understanding the physics of the phase change memory, including threshold switching, crystallization, drift, and thermoelectric effect. Controlling the electron and phonon transport in phase change materials and across material boundaries is key to designing phase change memory devices for the best performance. By integrating an on-chip heater and temperature sensor (the Micro Thermal Stage) with the phase change memory, we are able to characterize the threshold switching, crystallization, drift, and thermoelectric properties of phase change memory up to the melting temperature and down to hundreds of nanoseconds time scale that is much closer to the operating regimes of practical phase change memories. We will present new findings on the gradual set and gradual reset properties of phase change memory characterized by the Micro Thermal Stage.

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