Compact Modeling of a PCRAM Cell

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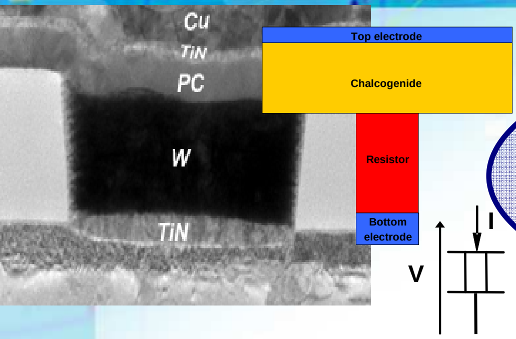


Context

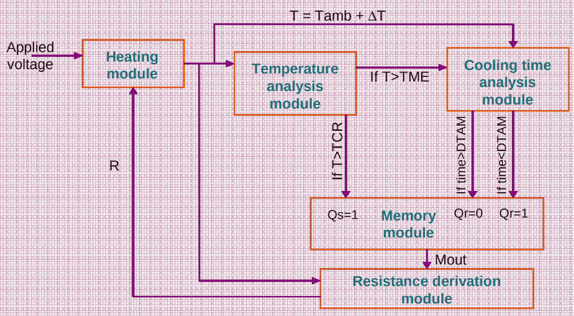
Phase Change RAM : very promising non-volatile memory

good scalability + high programming velocity

Compact model Static part: reading the cell thanks to I/V
Dynamic part: programming set and reset

Behavioral compact model

Assumptions
✓Threshold voltage constant
✓No partial set and reset
✓Two access resistances



T is the temperature of the cell, Tamb, the ambient temperature and ΔT the heating. TME is the melting temperature and TCR the crystalline one. DTAM is the maximum time of cooling to the cell becomes amorphous. Rgst is the resistance of the material.

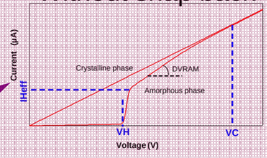
Included Effects

✓ Temperature derivation from thermal impedance

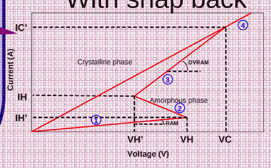
✓ Amorphous phase (reset)
- quenching time
- snap back
- resistance

✓ Crystallization (set)
- resistance (can be not ohmic)

Without snap back



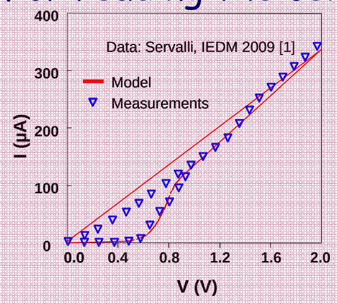
With snap back



All these modules are unified thanks to smoothing functions and described in Verilog-A in a unique file

DC results

For reading the cell



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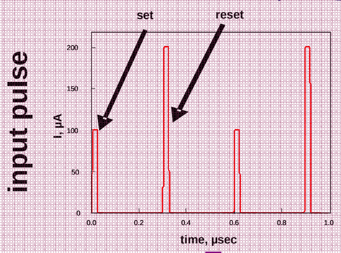
Prove the validity and the accuracy of the developed model

[1] G. Servalli, "A 45nm Generation Phase Change Memory Technology", Proc. IEDM Tech Dig, pp. 113-116, 2009.

Dynamic results

To programm the cell



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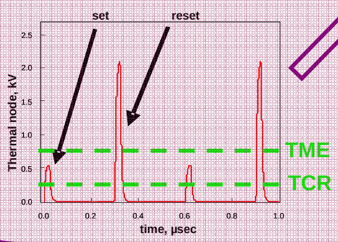
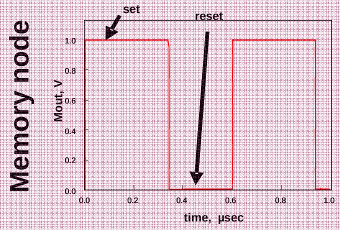
Derivation of the temperature of the cell





Memory node (Mout) equals 1 for crystalline state and 0 for amorphous one

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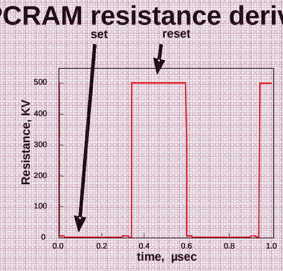
PCRAM resistance derivation



The model fit well with measurements, run under Eldo simulator
Further improvements: crystallisation time and partial set and reset

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