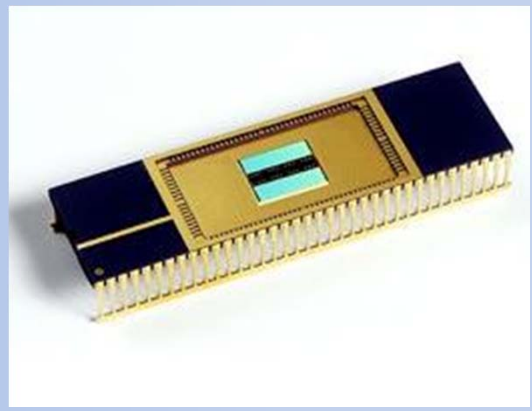
PCM

Phase Change Memory

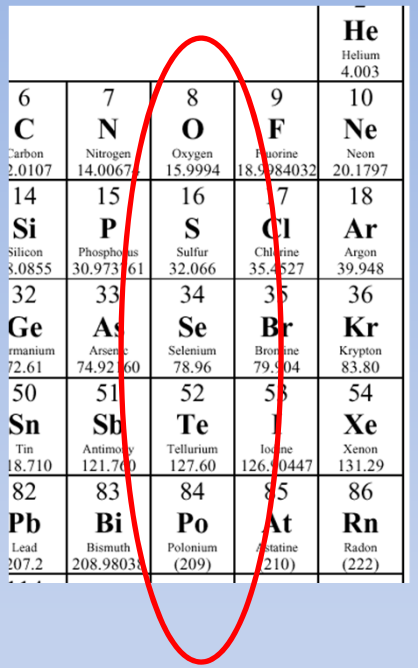


Theory of Operation

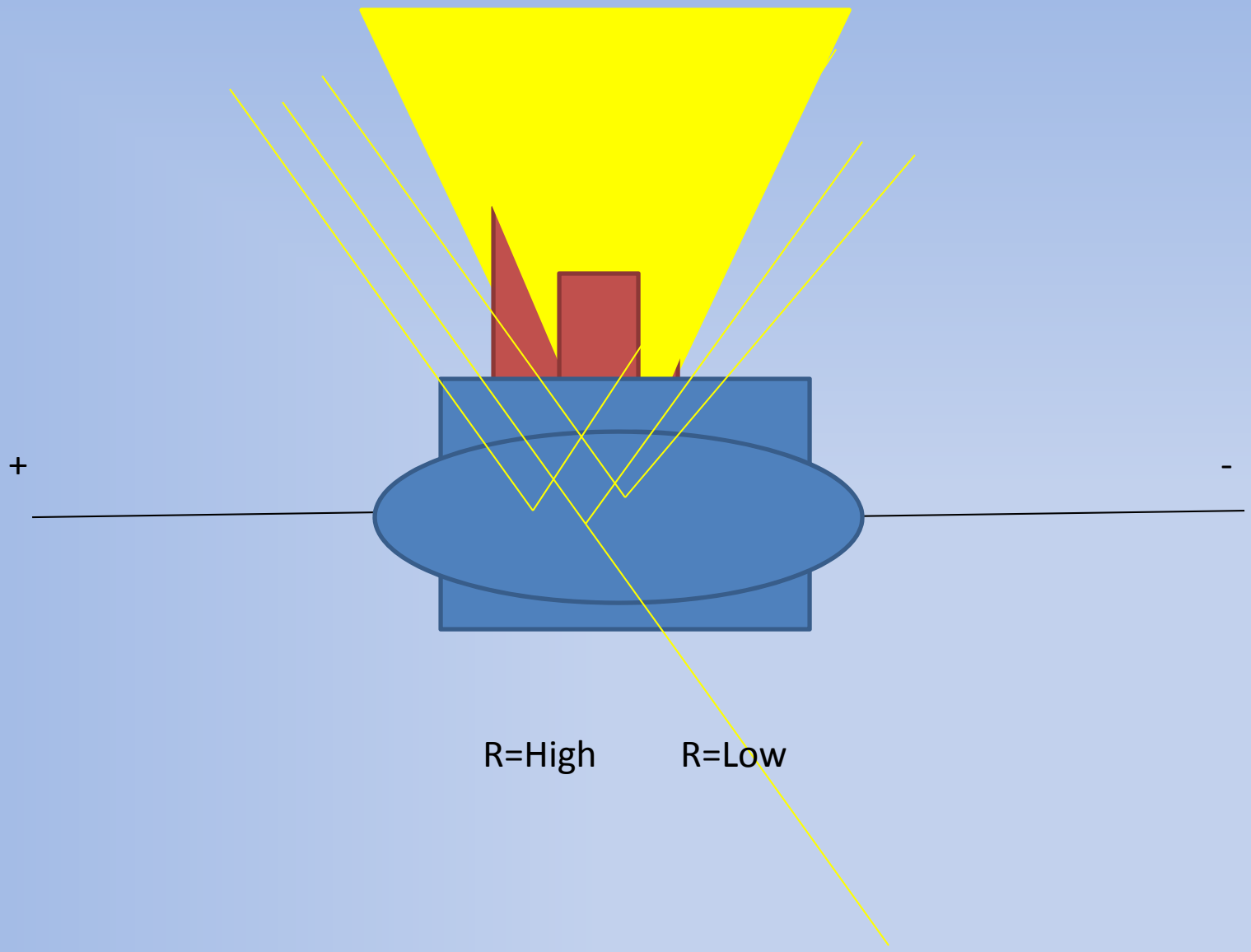
- Uses states of materials to represent bits instead of elections
  - Amorphous = “0”
  - Crystalline = “1”
- Other traits of the materials change with the states such as :
  - Resistivity
  - Reflectivity

Type of Material

- Chalcogenide glass
- $Ge_2Sb_2Te_5$ (GST)
  - AgLnSbTe, InSe, SbSe, InSbSe



Structure	Sample	Properties
Amorphous		• Short-range atomic Order • High reflectivity • High resistivity
		
Polycrystalline		• Long-range atomic Order • Low reflectivity • Low resistivity
		

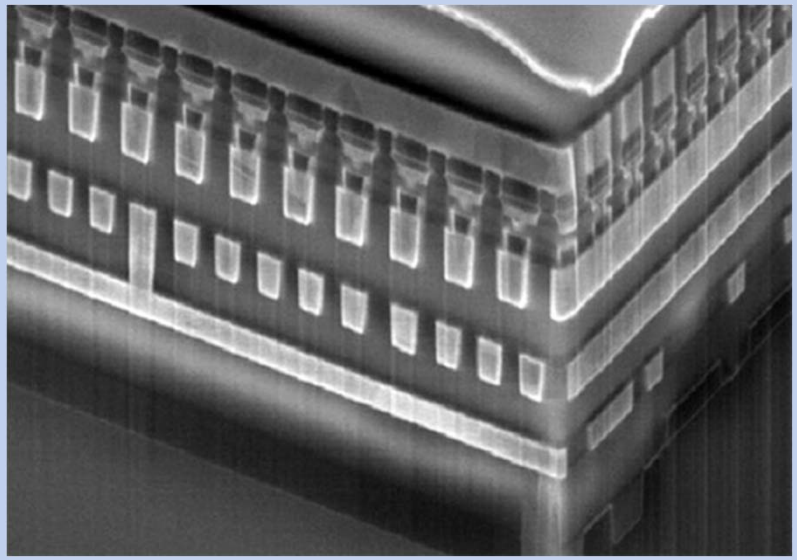

+
-
R=High
R=Low

Rewritable DVDs

- Uses optical lasers to change state of alloy
- Uses the change in its reflectivity to measure bits

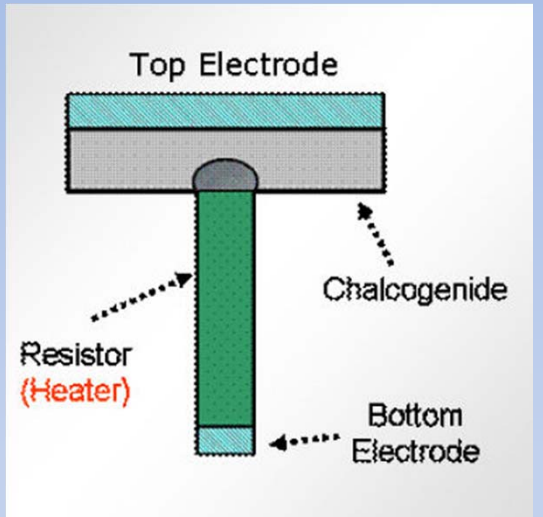
Phase Change Memory

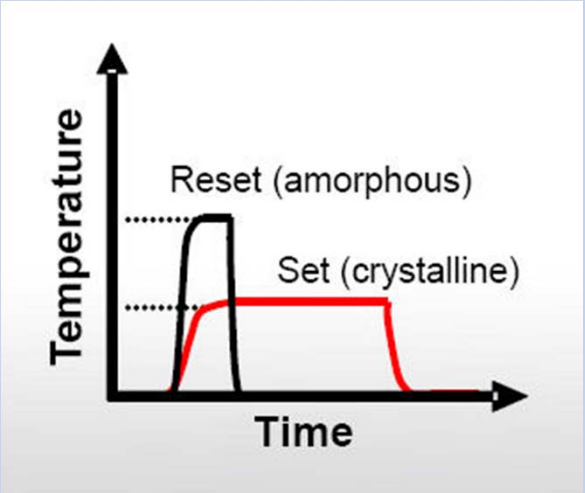
- May replace flash and RAM
- Uses small “heaters” to change the state of alloy
  - Different temperatures causes different states



Write and Read

- Bit alterable
- Uses Joule heating(resistive heating)
  - Uses a intense voltage pulse to control heat
- Write time is limited by crystalline formation
- Read is simply measuring the resistance between two nodes
- Can be read like RAM
- Read and Write speeds improve with scaling





Benefits

- Non-volatile memory
- Scalability (2 bits per cell)
- Better reliability
- Endurance (1 million write cycles)
- More resistance to radiation
- Less Power Consumption

Barriers

- Needs a high current density
  - Write temperature is 600°C for GST
- Constant changes in state causes cell degradation
- Data retention based on room temperature
- More than twice as expensive as flash
- Heat leakage

Future

- Carbon nanotubes instead of wires
  - Reduces power consumption 100x
- Outerspace applications
- Replace Flash and RAM memory in phones and computers
  - Most phones and computers use SRAM for fast read and write capabilities combined with Flash for non-volatile memory.

Questions?

Resources

- http://en.wikipedia.org/wiki/Phase-change_memory
- http://agigatech.com/blog/pcm-phase-change-memory-basics-and-technology-advances/
- http://www.numonyx.com/Documents/WhitePapers/PCM_Basics_WP.pdf
- http://www.enterprisestorageforum.com/technology/features/article.php/3862741/Phase-Change-Memory-The-Next-Big-Thing-in-Data-Storage.htm
- http://www.technologyreview.com/Infotech/20148/?a=f
- http://www.youtube.com/watch?v=EPsi1mBji2E&feature=related