

Programmable Metallization Cell: From Academic Research to (a) Market Place(s)!

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What is Axon?

- **Axon Technologies Corporation develops, protects, and commercializes *nanoionic* technology platforms**
- **Axon supports academic research in nanoionic systems and engages in joint development activities with high-technology companies**
- **Axon has a strong international patent portfolio in an area that is becoming vital to solid state memory**
- **Axon provides critical intellectual property to high-tech industry via licenses for patents and know-how**

What is nanoionics?

PROGRESS ARTICLE

Nanoionics: ion transport and electrochemical storage in confined systems

The past two decades have shown that the exploration of properties on the nanoscale can lead to substantially new insights regarding fundamental issues, but also to novel technological perspectives.

J. MAIER

NATURE **MATERIALS** | VOL 4 | NOVEMBER 2005 | www.nature.com/naturematerials

...the crystallizing field of 'nanoionics' bears the conceptual and technological potential that justifies comparison with the well-acknowledged area of nanoelectronics.

IBM: Materials Will Spur Next Wave of Chip Innovation

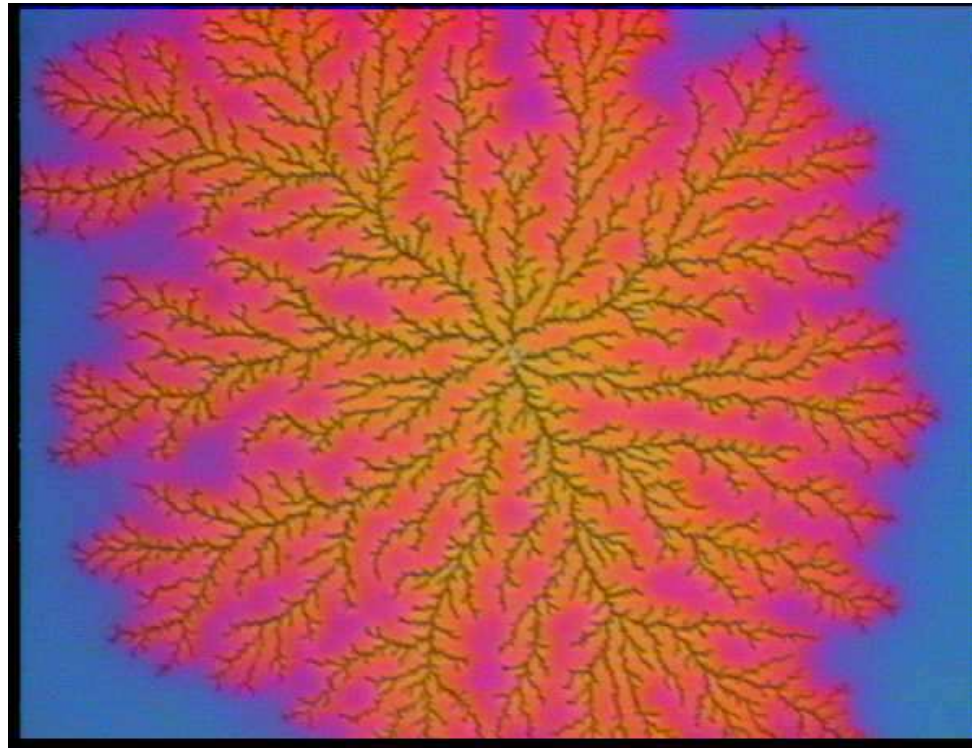
Online staff -- *Electronic News*, 11/4/2005
Innovation in materials has replaced scaling as the main source of performance and feature improvements in leading edge CMOS chips.

Axon's history

- In the mid 90s, a technology platform called “Programmable Metallization Cell (PMC)” was created at ASU
- Axon Technologies Corporation was founded in 1996 as a spin-out from ASU to develop, protect and commercialize PMC
- Originally funded via a private placement (angel investors)
- Stayed solvent via license and JDA revenues
 - Licensed Micron Technology in 2001
 - Licensed Infineon Technologies (now Qimonda) in 2004
 - Licenced “stealth” VC-funded start-up in 2007
 - Various development relationships completed or in place

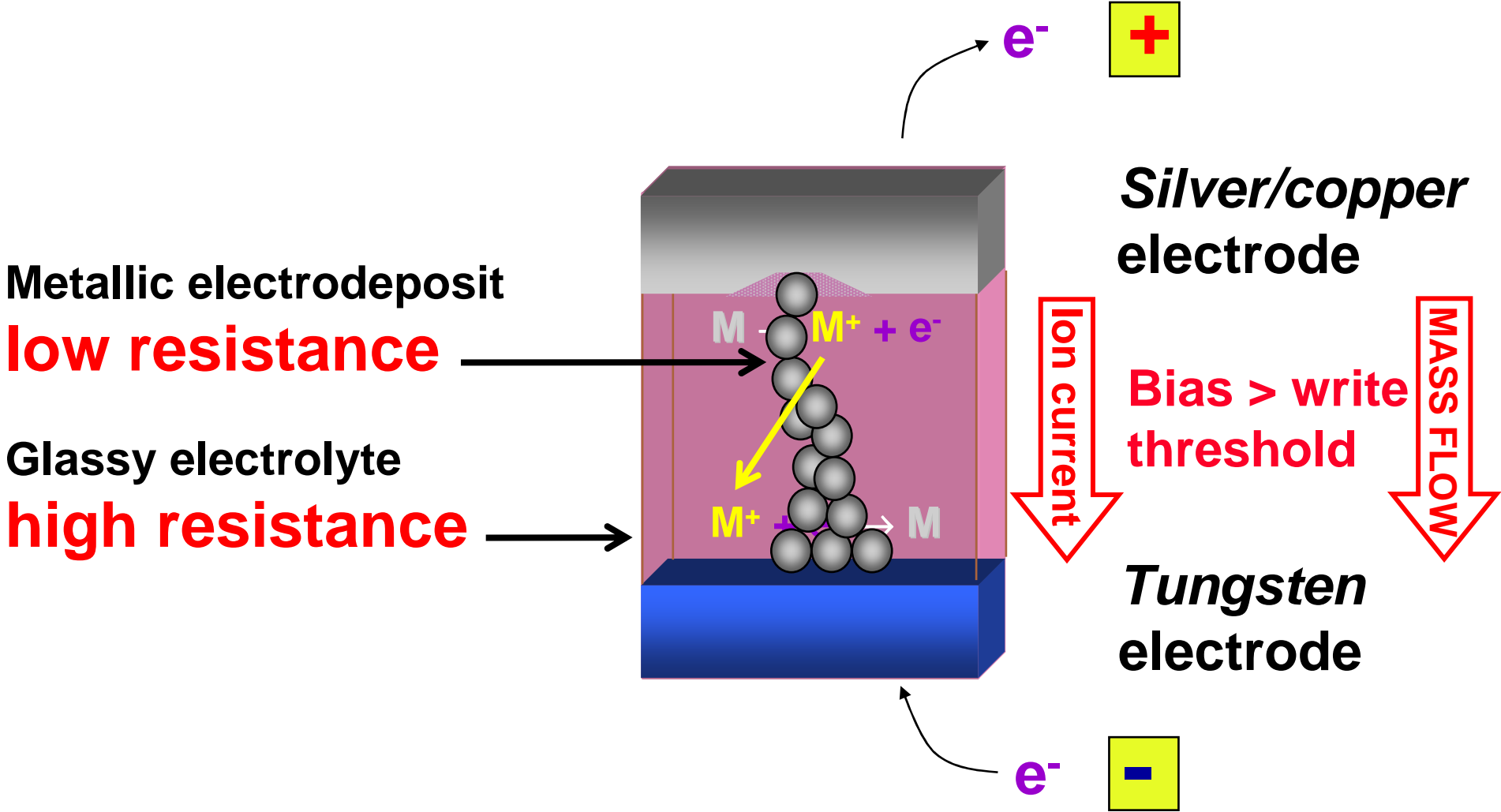
What is PMC?

- **PMC could very well be some kind of alien technology...**



- **Nanoscale quantities of metal are transported in solid electrolytes to alter the macroscopic characteristics of a system...**

Memory device example



Reverse bias dissolves electrodeposit

Infineon, Axon to partner on nonvolatile memories

By [Mark LaPedus](#)
[Silicon Strategies](#)

October 27, 2003 (4:18 a.m. ET)



ONLINE
EETIMES

Articles

Altis, Infineon test conductive-bridging RAM at 90-nm

[Peter Clarke](#)

(06/12/2006 8:30 AM EDT)

URL: <http://www.eetimes.com/showArticle.jhtml?articleID=189400056>

LONDON — Altis Semiconductor SA, a French joint-venture between Infineon Technologies AG and IBM Corp., has contributed to a paper on conductive-bridging RAM (CBRAM) mainly authored by parent Infineon. The paper is due to be presented at the VLSI Circuits Symposium in Honolulu, Hawaii on Friday (June 16).

The paper covers a 2-Mbit test chip with read-write control circuitry implemented in a 90-nanometer manufacturing process. The memory works by having an alterable resistance condition in a thin solid state electrolyte layer sandwiched between an oxidizable anode and an inert cathode

Infineon (Munich, Germany) has been investigating CBRAM for a three or four years and Infineon acknowledged it had licensed a technology called Programmable Metallization Cell (PMCm) from Axon Technologies Corp. (Scottsdale, Ariz.) in [September 2004](#). Infineon was also reported to have a CBRAM test chip at that time.

However, Infineon recently moved to separate its memory interests into a separate company Qimonda AG, which it intends to float on the stock exchange in August.

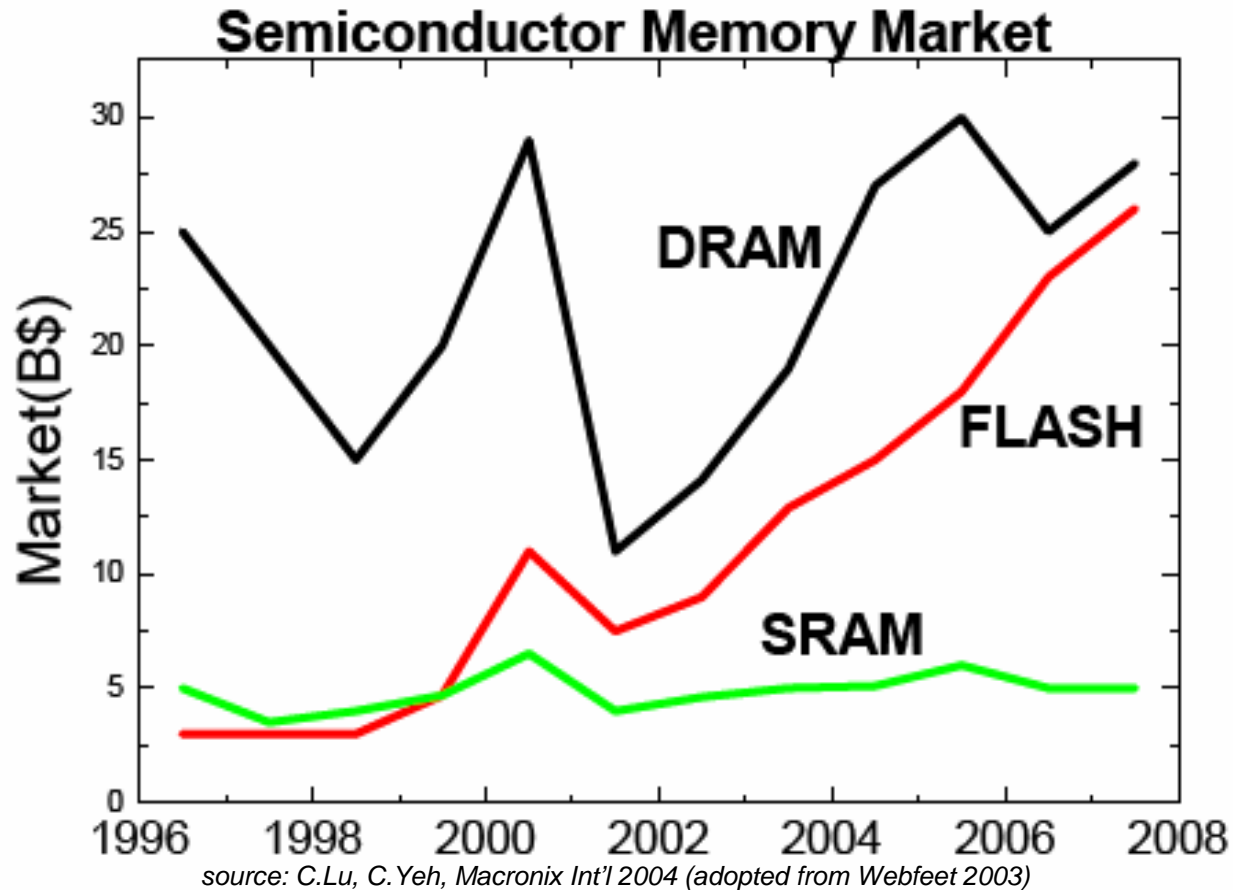
PMCm was developed by Axon in conjunction with Arizona State University. The technology uses a silver-based chalcogenide metal compound for the non-volatile memory cell built on top of conventional CMOS chip sensors and circuitry.

of conventional CMOS chip sensors and circuitry.

[IBM seeks to raise doubts about](#)



Prospects

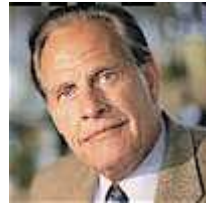


**PMC plays in both
DRAM and Flash space**

The Present

- **Excellent research/tech transfer partnership between Axon and ASU**
 - Administered by AzTE
 - Co-owned IP, licensing, and assignment of IP
 - Royalties, research funding to ASU (>\$2M total)
- **24 broad-ranging US patents issued**
 - Several dozen cases issued/in process Worldwide
 - All research/legal costs met by Axon
- **Drive to build broader patent portfolio, engage in more development relationships, and issue more licenses!**
 - Materials, processes and devices
 - Use of PMC in a variety of applications

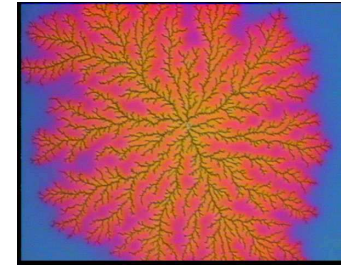
In the words of the prophet, Ron Popeil



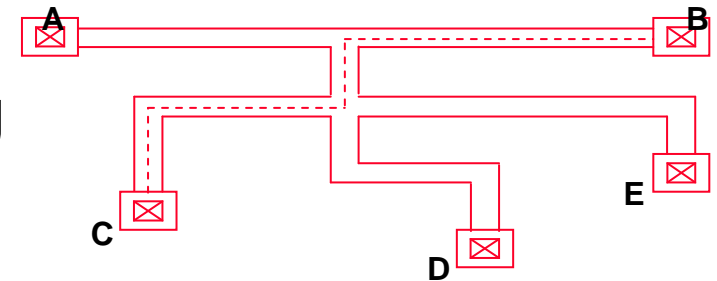
But wait, there's more...

Other opportunities

- The ability to move nanoscale quantities of mass leads to a variety of potential applications.
- We have applied this principle to



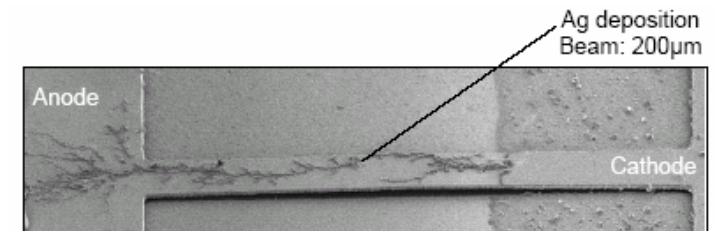
- Reconfigurable and self-healing interconnect, RF switches



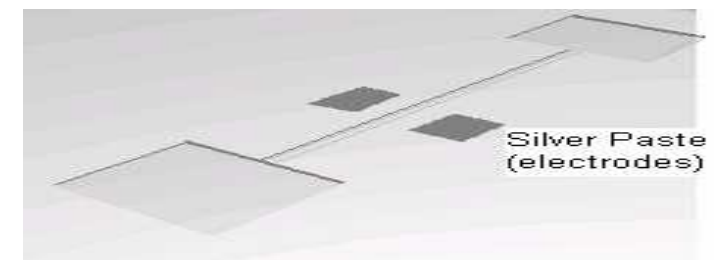
- Optical switches



- Microelectromechanical system (MEMS) resonators



- Valves for microfluidics



Challenges

- **The competition is always much bigger**
- **The best technologies are not necessarily the ones that win**
- **Sales cycles are measured in geological timescales**
- **Management of cash flow is hellishly difficult**
- **Powerpoint is nice but you can't test drive a presentation...**

More challenges

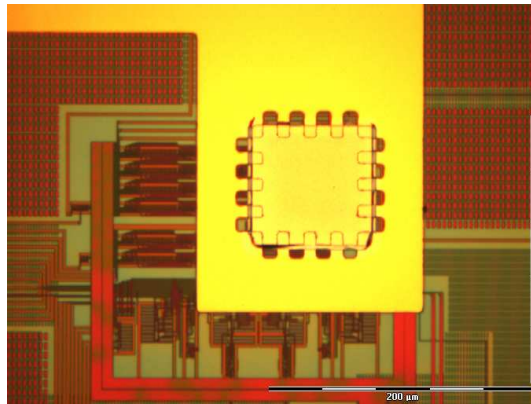
- **If it's worth doing, it's worth stealing**
- **The Japanese patent system is nasty**
- **Relationships with large companies are like dancing with a bad tempered drunken elephant**
- **Many companies make decisions using financial criteria only**
 - This is much worse than it sounds...

Solutions

- **Turn the competition into prospects**
- **Get companies to adopt and champion your technology**
- **Keep costs/overhead as low as possible**
- **Develop a prototype, no matter how simple**
- **“Send lawyers, guns, and money”**
- **And above all, don't give up...**

Benefits

- **Well, we're still alive so we must have done something right...**
- **Technology is now in the industry roadmap and in the roadmaps of key companies**
- **Many universities and government labs have joined the chase**
- **Products are in development**
- **Slowly (but surely) becoming an acquisition target**
- **TWD is within reach...**



Thank you!