NSF - SRC TeleSeminar

CMP Market in the Eyes of a Chemical Supplier

(Focus on Slurry Market and Cu/low-k Application)

03-07 2002

EKC Technology, Inc.
A ChemFirst Company

Solutions for Wafer Cleaning, Surface Preparation and CMP Processes

EKC Technology, Inc

EKC Technology, Inc., a wholly owned subsidiary of ChemFirst Inc., is a worldwide supplier of high purity, patented proprietary chemicals for wafer cleaning, surface preparations, CMP and photoresist/post-etch residue removal for the semiconductor industry. ChemFirst is a global supplier of electronic chemicals and materials to the semiconductor industry and specialty intermediates for polyurethanes and other applications and is listed on the New York stock exchange under the trading symbol CEM. EKC Technology, Inc. serves the semiconductor industry from facilities in Hayward and Danville, CA, East Kilbride, Scotland (EKC Technology, Ltd.) and near Tokyo, Japan (EKC Technology, K.K.).

Please visit www.ekctech.com for more information.

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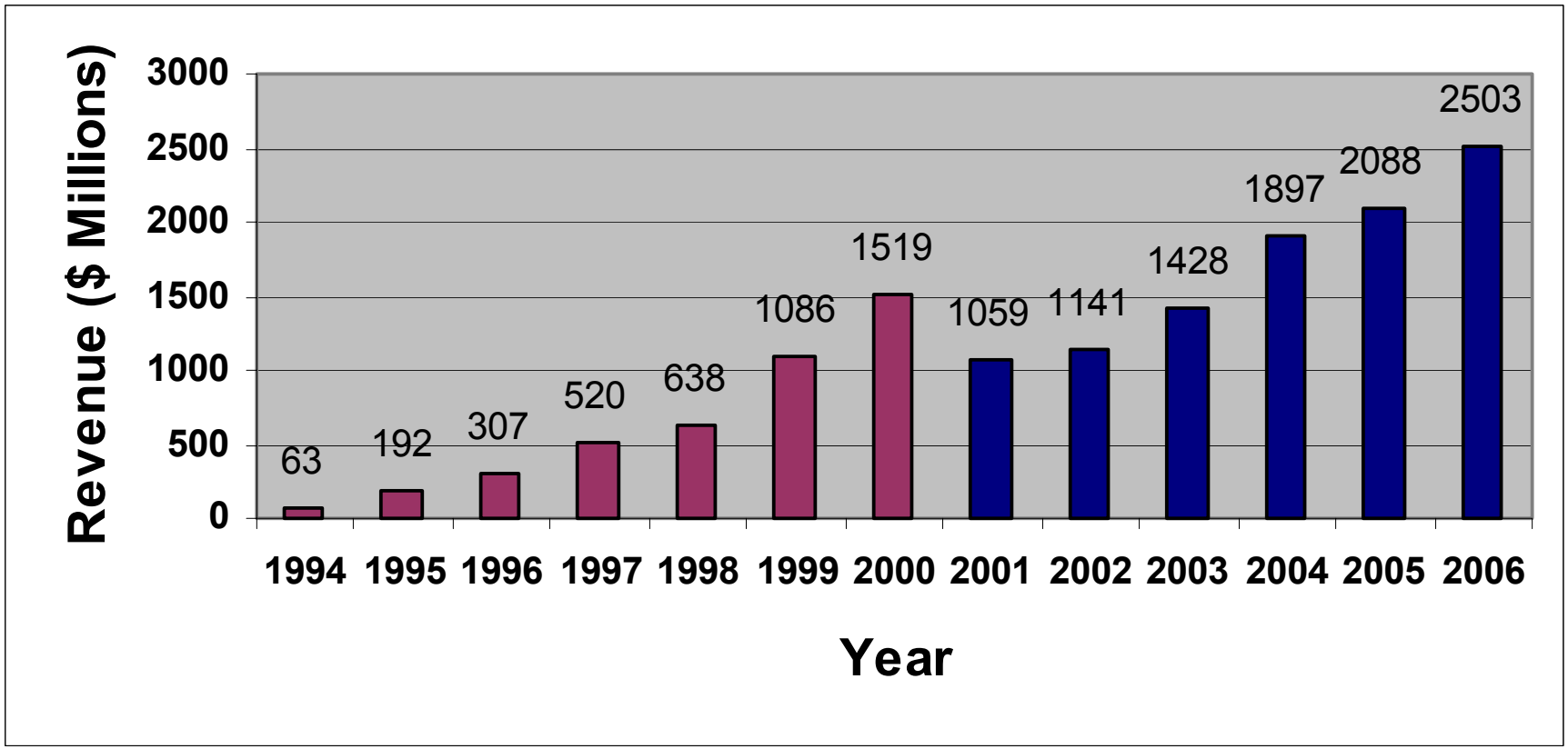
Actual And Projected CMP Industry Revenues



Source: Laredo Technology

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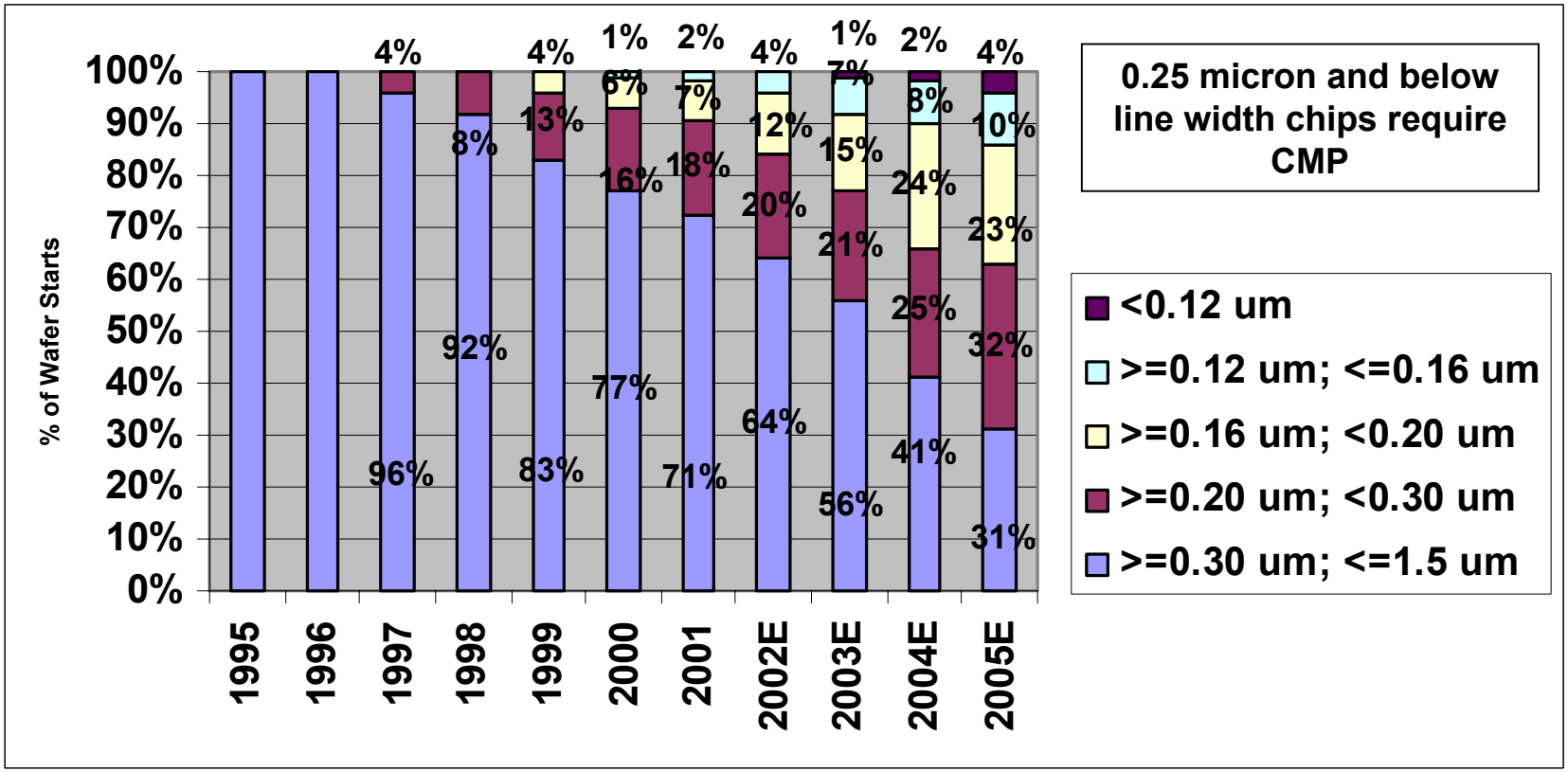
Migration to smaller technology nodes drives CMP



It is estimated that less than 30% of the wafer starts in 2001 required CMP

Source: VLSI Research

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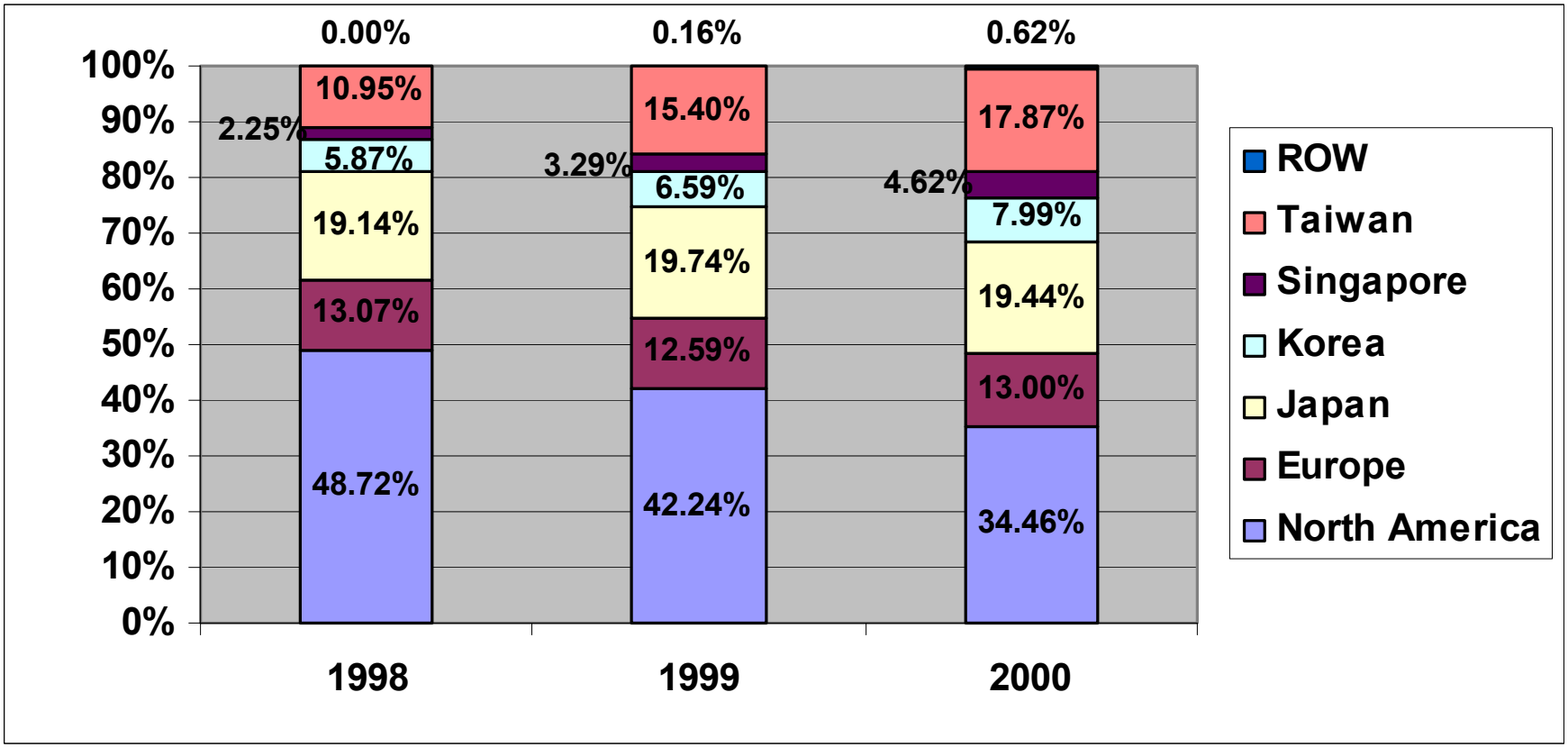
Total Installed Spindle Based by Region



Taiwan has highest growth.

Source: Laredo Technology

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Key Players - Planarization Tools

- One clear leader, Applied Materials with:
  - ~70% market share in Oxide
  - ~75% market share in Copper
  - ~30% market share in Tungsten
- Applied Materials with Ebara, SpeedFam-IPEC and Lam Research have together over 95% of tool shipments
- More than 10 other suppliers are developing a tool solution
- Drive towards, multi-platen and integrated tools

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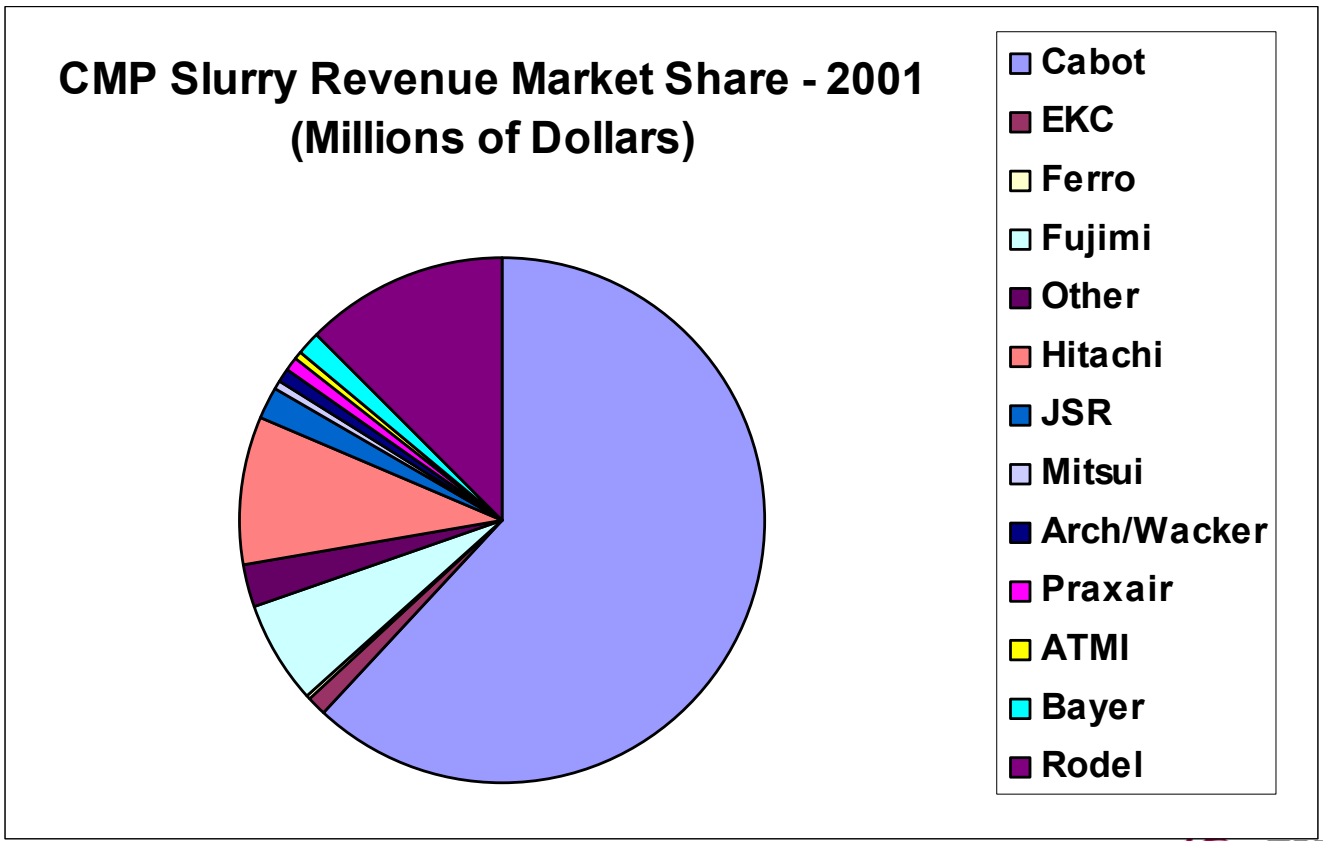
Key Players - Pads

- One clear leader, Rodel is dominating the market
- Others are Thomas West, Freudenburg, Fujimi, Cabot, Madison, Universal Photonics. JSR recently announced they will also be promoting a novel technology in their pad.
- 3M offers a competing technology with its fixed abrasive pad.

CMP Slurry Supplier Landscape

Many try to enter the market.
Consolidation will occur.



Source: Laredo Technology

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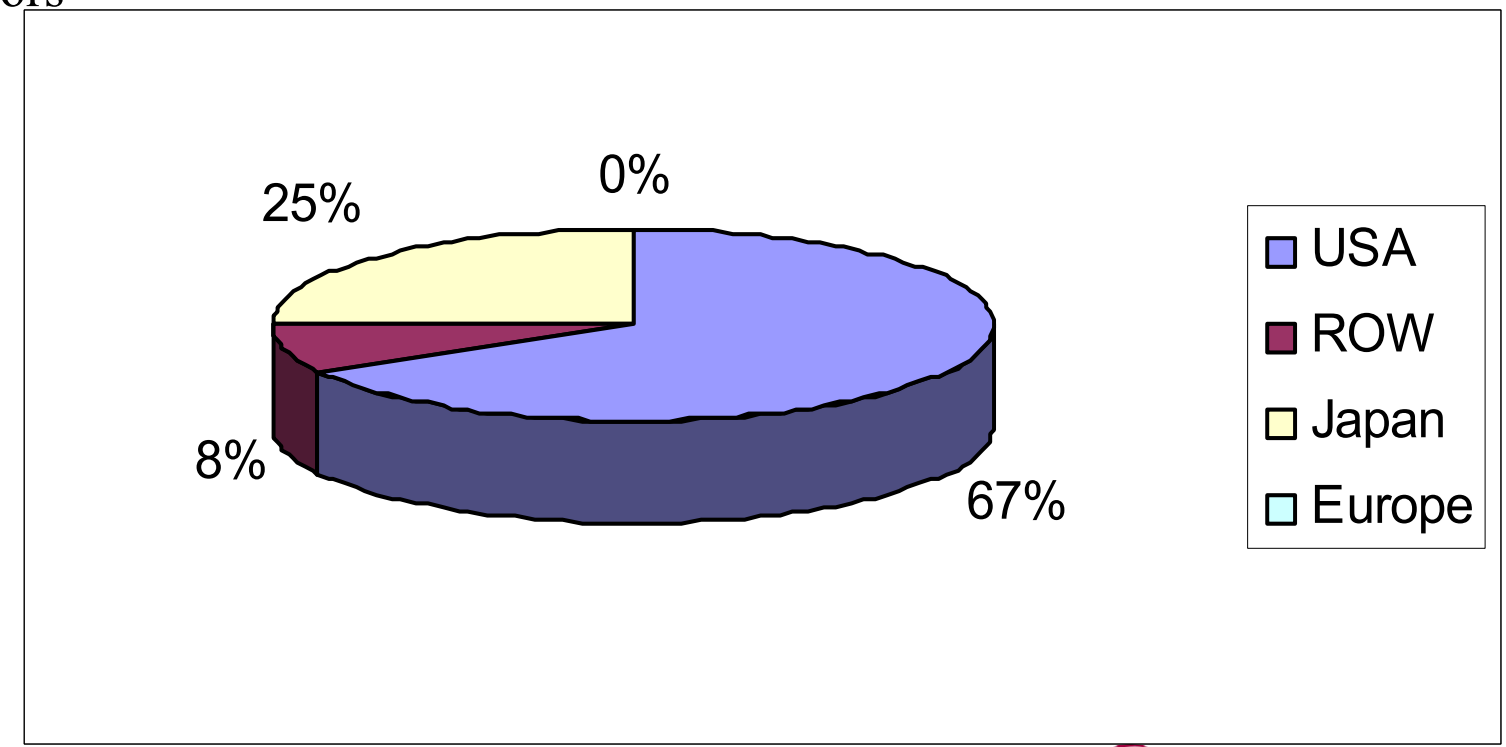
Slurry Suppliers

- Large number of suppliers offer solutions and try to increase their market share mainly through Copper and STI CMP market penetration… Despite high barriers to success.
- Clear leader with over 60% market share worldwide.
- Due to the number of competitors trying to enter the market, consolidation and/or niche focused market are likely to emerge

Cu CMP Suppliers

- Approx. 12 slurry suppliers worldwide are seriously marketing a variety of products for Copper technology.
- Homebrews or Hybrid homebrews have been developed by customers and tool vendors



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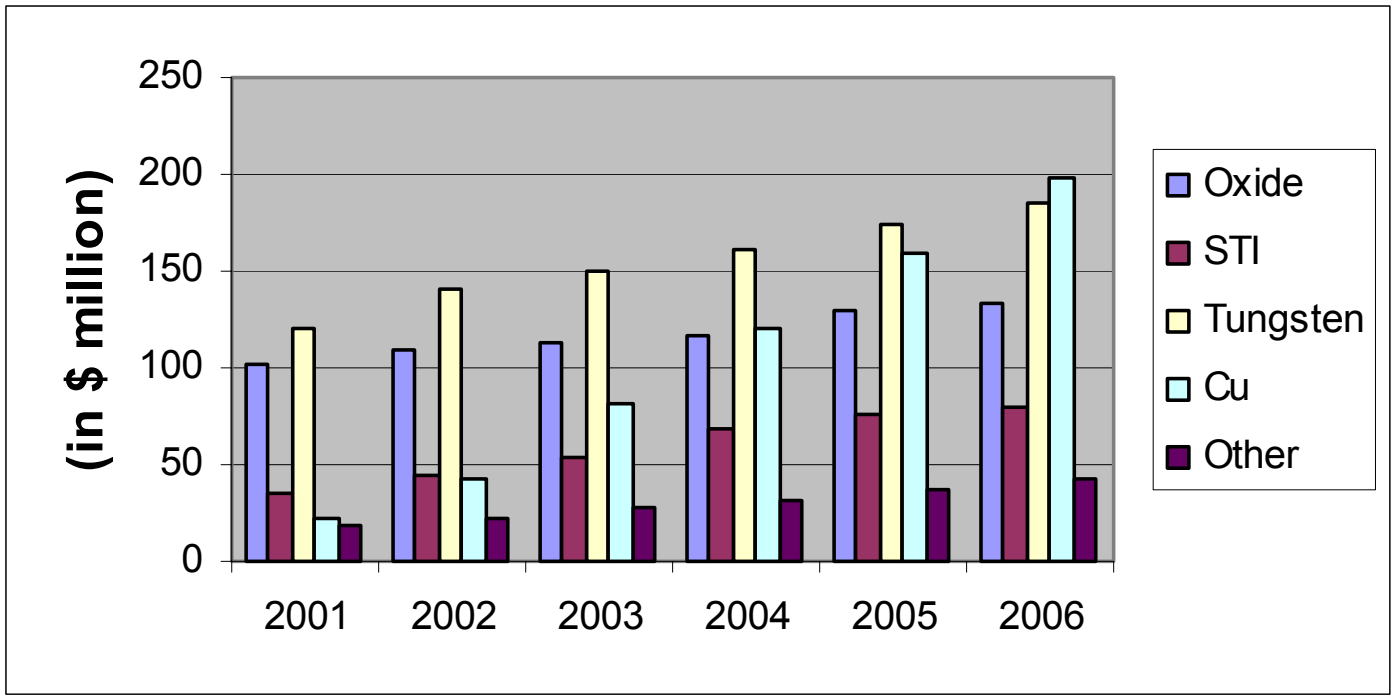
CMP Slurry Market by Application



Other includes Polysilicon and Noble Metals

Year	2001	2002	2003	2004	2005	2006
Total (in $ million)	300	360	425	498	575	640

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Market for PCMP Cleaning Chemicals

- Tungsten and Oxide (silica based) applications use standard chemical solutions (Dilute HF, Dilute NH_4OH)
- Copper Post CMP solutions and solutions to remove ceria particles will require custom formulation.
- Numerous proposed solutions in the market place from slurry suppliers, tool suppliers and other chemical companies.
- Technical challenges include compatibility, corrosion control and improved particle removal

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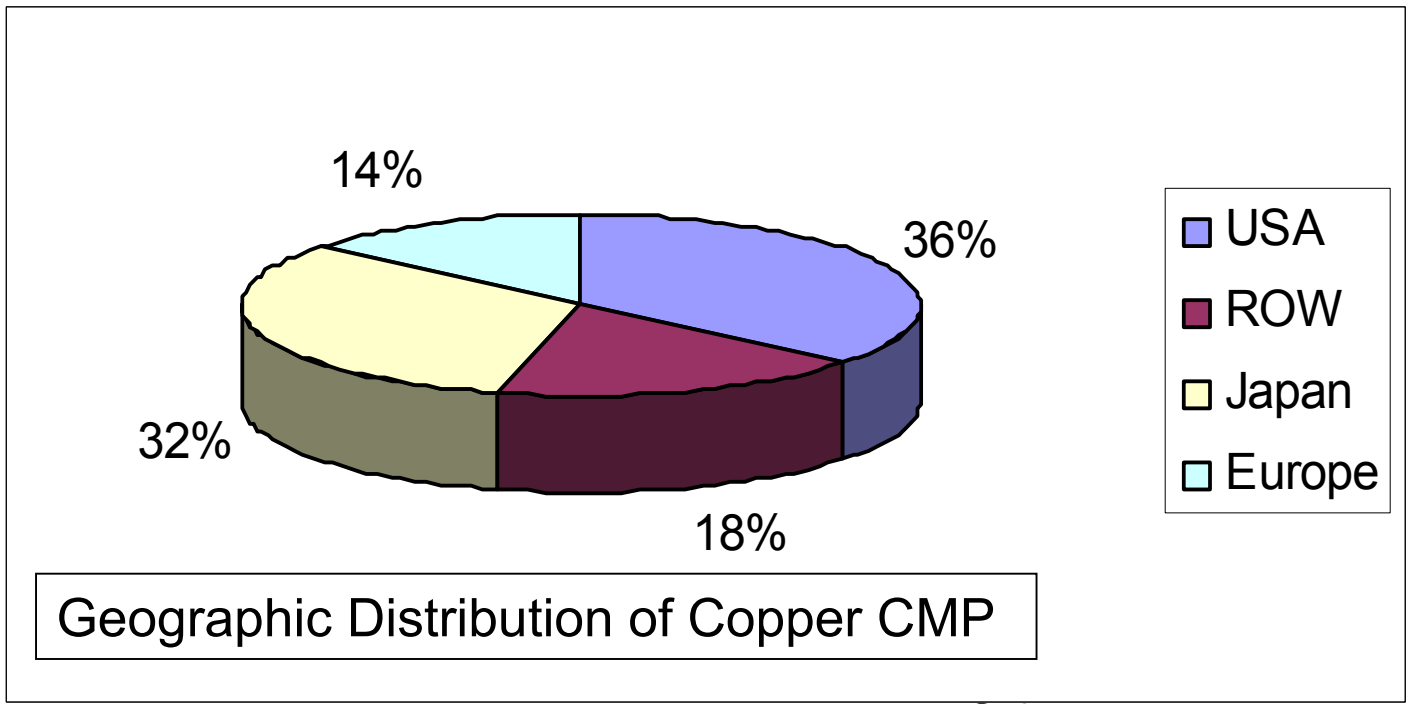
Market Segmentation / Application Drivers

- The metal market will have the fastest growth, mainly driven by copper
  - Tungsten will be driven by late CMP adopters looking for lower defectivity and cost and the DRAM market. Time is available to qualify replacement technology in this downturn. The window of opportunity will close as the semiconductor industry recovers
  - Copper market is very fragmented and will be driven by technology for several more years
  - Adoption of low-k materials could have significant impact on consumable choices
- The dielectric market will continue to grow with a drive for a lower cost slurry. STI is diverging with products specifically designed for this application
- Niches in Post CMP cleaning are emerging (Cu, ceria). Volumes could be important but revenues limited due to a required low cost. Many players (such as process chemical companies) are already involved in these niches.

Specific Note on Copper CMP

- **More than 25 semiconductor manufacturers worldwide are pursuing the use of Copper technology**

- **Next entrants will in majority target the 0.13 µm technology. Most delayed the transfer to mfg. during the downturn and will jump into 0.13 µm.**



Source: Novellus

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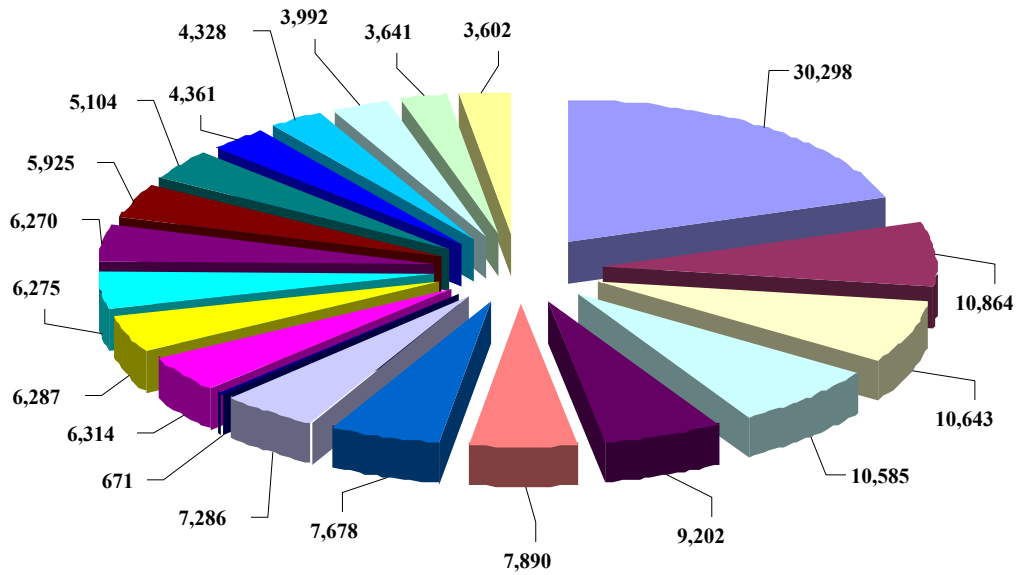
Specific Note on Copper CMP

Total WW Semiconductor Shipments for Top 20 Companies in 2000



(Millions of U.S. Dollars)

ALL INVOLVED WITH COPPER IN PRODUCTION OR AT DEVELOPMENT STAGE

- **1 - Intel**
- **2 -Toshiba**
- **3 - NEC**
- 4 - Samsung
- **5 - Texas Instruments**
- **6 - Motorola**
- **7 - STMicroelectronics**
- 8 - Hitachi
- **9 - Infineon Technologies**
- 10 - Micron Technology
- 11 - Hyundai
- 12 - Philips Semiconductor
- 13 - Mitsubishi
- 14 - Fujitsu
- 15 - Lucent Technologies
- **16 - Advanced Mico Devices**
- **17 - IBM Microelectronics**
- **18 - Matsushita**
- **19 - Sony**
- 20 - Sharp

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Cu - Low-k Integration Overview

Over 10 companies currently propose a low-k solution for the 0.13 um technology. They are mainly located in the US.

I- >0.13 µm:

Low-k material not needed

II- At 0.13 µm:

Some will still be using **Silicon dioxide / fluorinated silicon glass (FSG)** due to low-k integration issues.

Dow Chemicals SiLk™ resin (k-effective around 3). Key advantage: no via poisoning). Positioning a porous material to extend k value below 2.

CVD – Trimethylsilane or carbon doped oxides (Applied Materials, Novellus, ASMI, Trikon, Mattson / Black Diamond, Coral, Aurora, Flowfill).

III- At 0.1 µm down to 0.07 µm (ITRS: start 2005 but!!….)

Low-k ILD material needs k less than 2.1

a- Heading toward spin on solution (Dow, JSR, Corning,…)

b- Porous SiLK™

NOTES: Other Low-k providers: Dow Corning (Fox HSQ and XLK), Air Products (MesoELK), Honeywell (Nanoglass, GX-3, HOSP).

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Cu CMP Technical Challenges

New Requirements as technology progresses to 0.1 µm

Cu	Barrier	Both
Improved Planarity	Flexibility	Gentle Process (requirements=f(low-k))
Less abrasive	Less abrasive	Lower defects
more chemical in nature	Accommodate different	No Corrosion
Softer passivation film	dielectrics (Ox, low-k, high-k)	Easy mix at POU
including organics	Improved Planarity	Compatibility slurry to slurry
	Lower Cu loss	Compatibility with devices
	Lower dielectric loss	Extendibility would be a plus

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Potential Disruptive Technologies

- Fixed abrasive pads for STI and Cu CMP.
- Non-abrasive solutions for Cu CMP. Far from implementation. Improve dishing, lower cost. Believed to be possible only on first step.
- Self planarizing electrodeposition for Cu CMP (NuTool). Involves limited CMP during the last step.
- Spin-etch planarization (SEZ). Wet-removal process using no physical contact with the wafer surface.
- Stress Free Polishing - SFP (ACM Research). Copper is removed by reversing the electroplating process.
- BOC point of use mixing of different components opens doors to new formulation. Few believe in it.

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Thank You

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