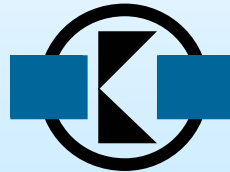


# **COPPER AND LOW-k: CONSUMABLES OUTLOOK**

**Silicon Valley CMP Users Group**

**June 5, 2002**



***For confident decisions in a complex world™***

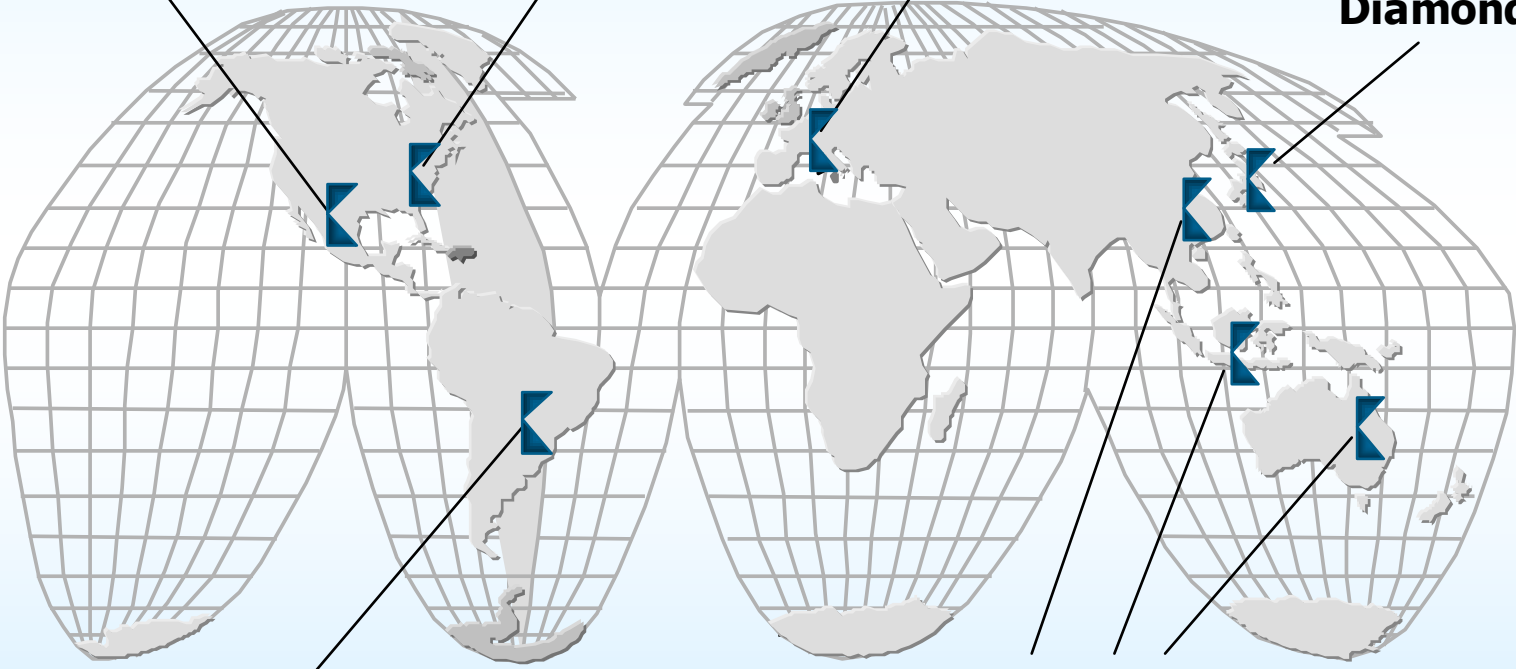
# GLOBAL NETWORK

**Kline Group  
Latin America**

**Kline & Company, Inc.**

**Kline Europe, S.A.**

**Kline Japan, Ltd./  
Diamond**



**Kline Group  
Brazil**

**Kline Group  
Asia/Pacific**



# SEMICONDUCTOR EXPERIENCE (Selected)

▶ Acids, Etchants and Cleaners

▶ Dielectrics

▶ CMP Consumables

▶ MOCVD Precursors

▶ Dual Damascene Processing

▶ Integration schemes

▶ Gate-stack materials

▶ Cost of ownership

▶ Removers

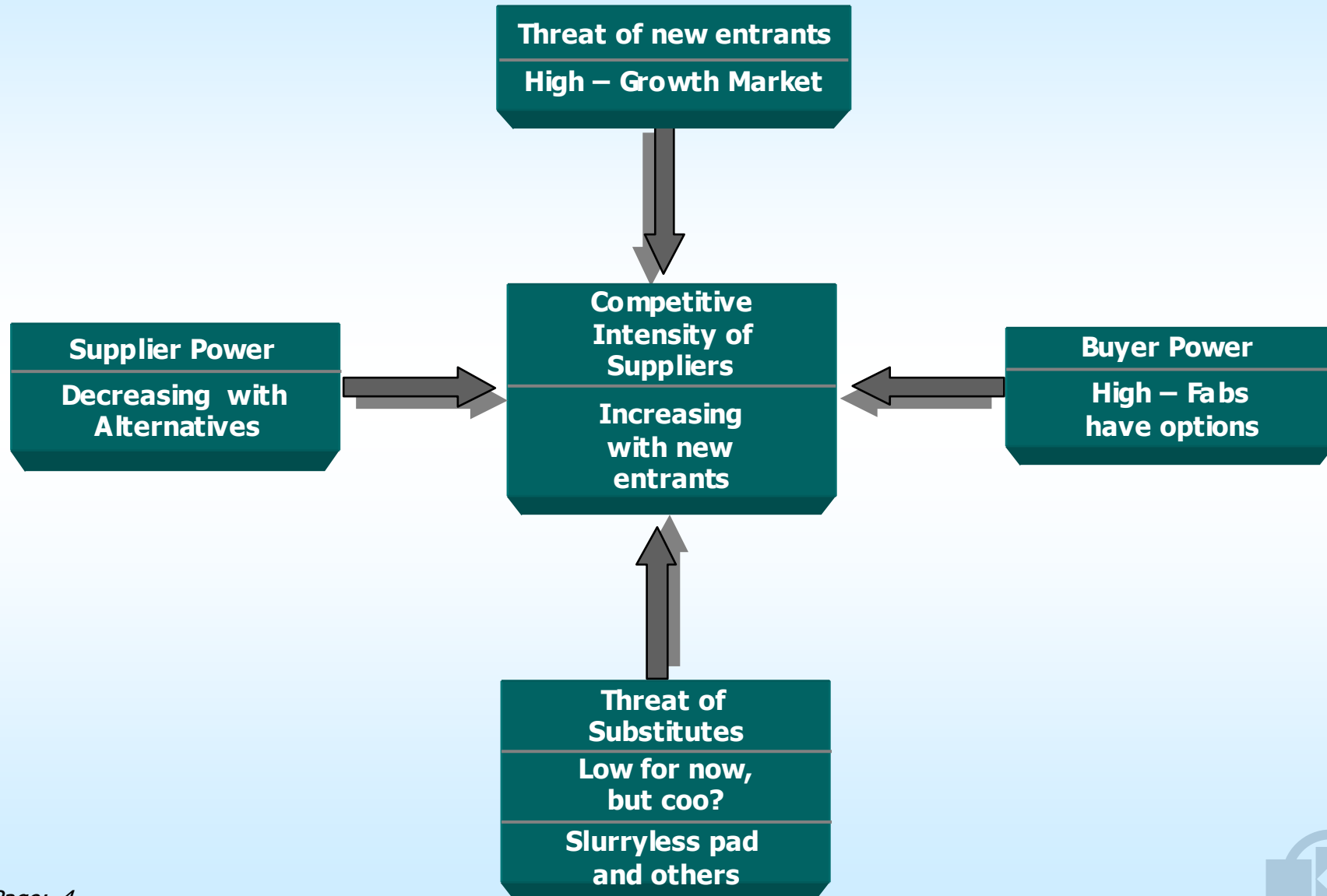
▶ Metals



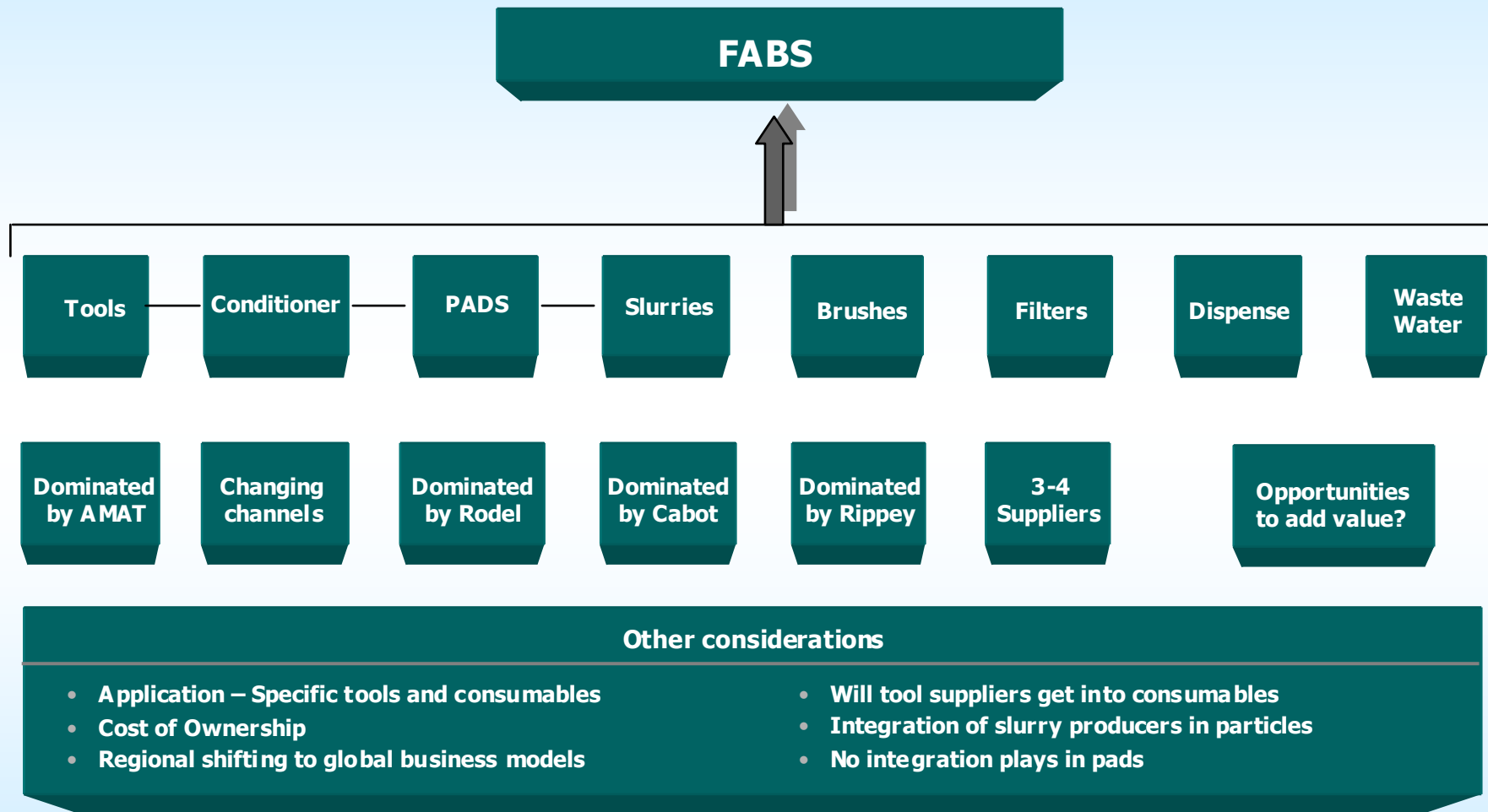
# Current consumables market



# CMP: CURRENT STATE OF INDUSTRY



# CMP: CURRENT STATE OF INDUSTRY



## Current state of consumables market . . .

### Market-share leaders:

- Cabot down 8-9% from a year ago, and down 18% from the record performance seen in late 2000, BUT...
  - Current quarter-to-quarter sales have flattened
  - Latest quarterly volume up 2.6%, though prices down 1.8%
- Rohm and Haas (Rodel parent) reported Electronics business down 26% as of 1Q02, BUT...
  - Still profitable
  - Includes the photoresist business
  - Slight increases in business noted in 1Q02

### The sky isn't falling:

- Volatility in consumables less than half that of equipment
- Technological fundamentals still spell strong growth
- But competition is heavier, especially in oxide slurries



## **Competing market trends . . .**

### **Price competition in oxide slurries:**

- Oxides becoming commodity-like
- More competitors, especially from Asia
- Price erosion

### **Focus on technology, not pricing, elsewhere:**

- Tough integration challenges remain
- Copper CMP
- Fabs relying on established leaders

### **Bottom line: Price is crowding out technology effect:**

- 250- and 180-nm nodes still very popular
- Bracing for tungsten-slurry price competition



## **North American market share declining . . .**

- Cabot saw 62% of sales outside U.S. in 2001
- In 2002, the percentage is up to 65%
- Most of the share re-allocation is going to Asia



## **Pad sector active with new development . . .**

### **Several new entrants:**

- PPG Industries
- Madison Filter
- Psiloquest
- Others expected

### **Continuing developments by leaders:**

- Rodel photo-patterned thermoplastics pads
- Thomas West "Right Pad"
- Both developments point to more options in hardness v.s. softness in pads

### **Still a Rodel stronghold, BUT:**

- Pad market appears to be the most active in terms of competitive development

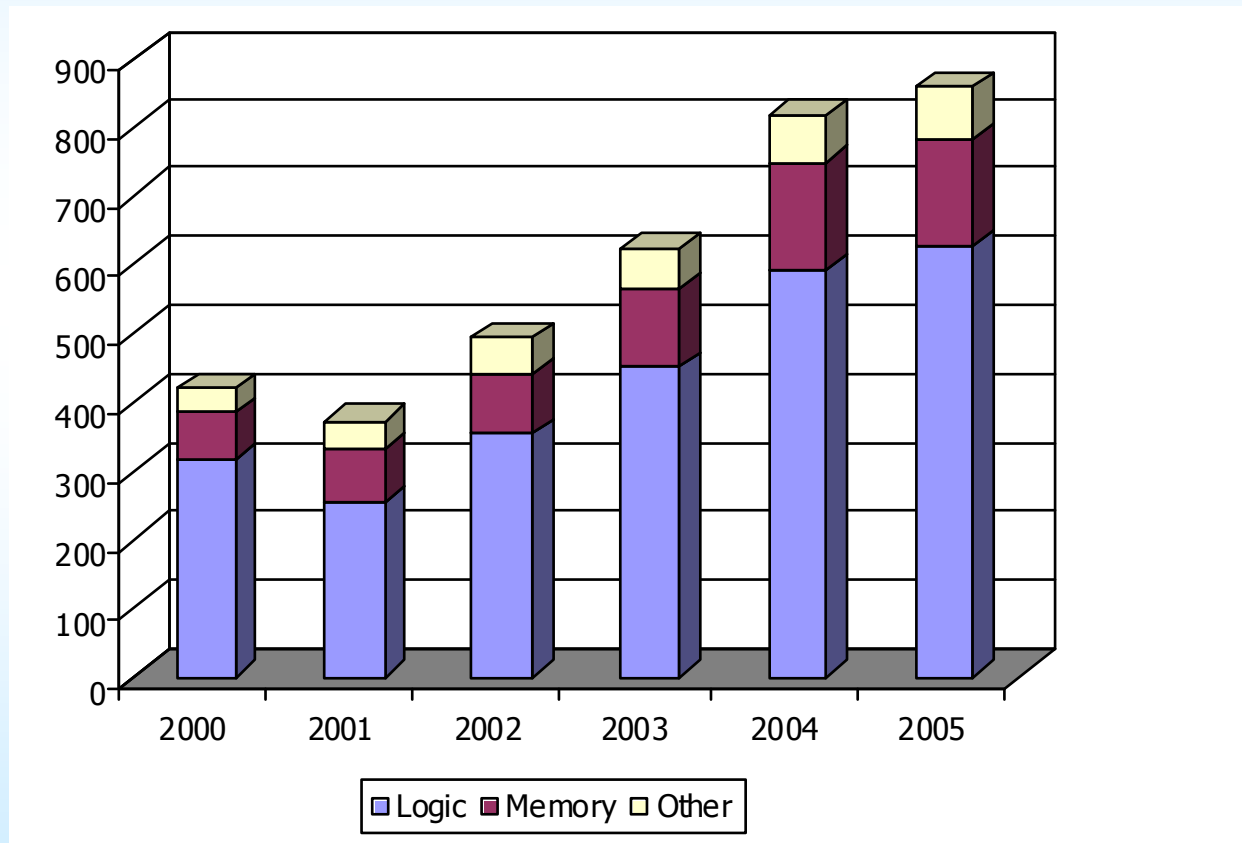


# Consumables outlook

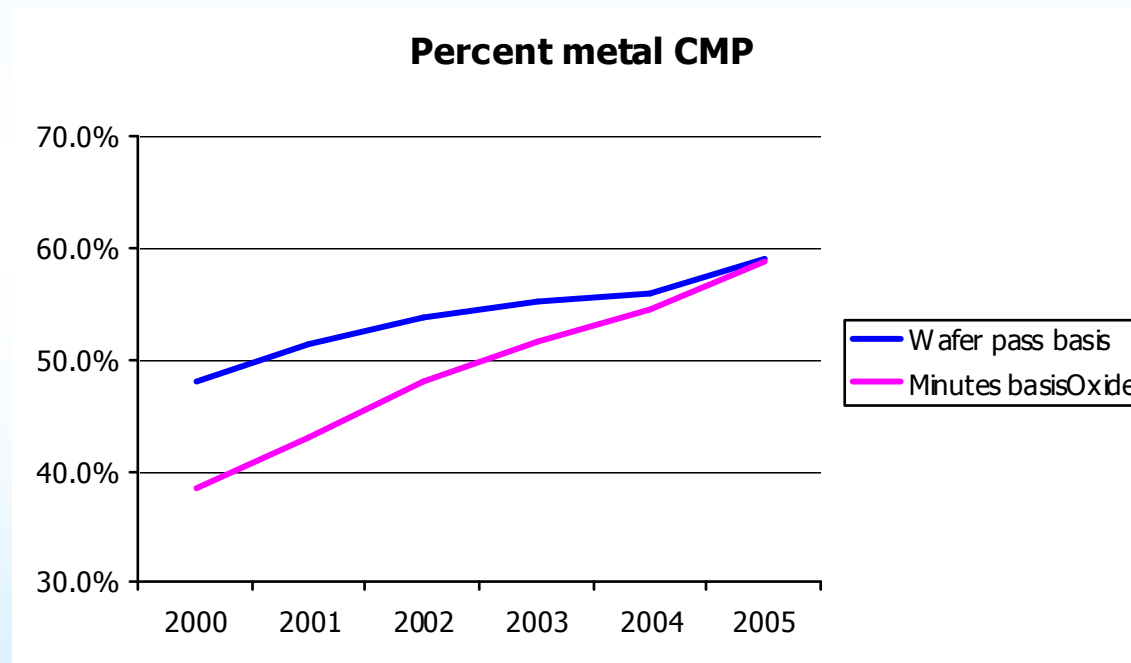


# GLOBAL GROWTH IN CMP OPERATIONS BY DEVICE CATEGORY, 2000 - 2005

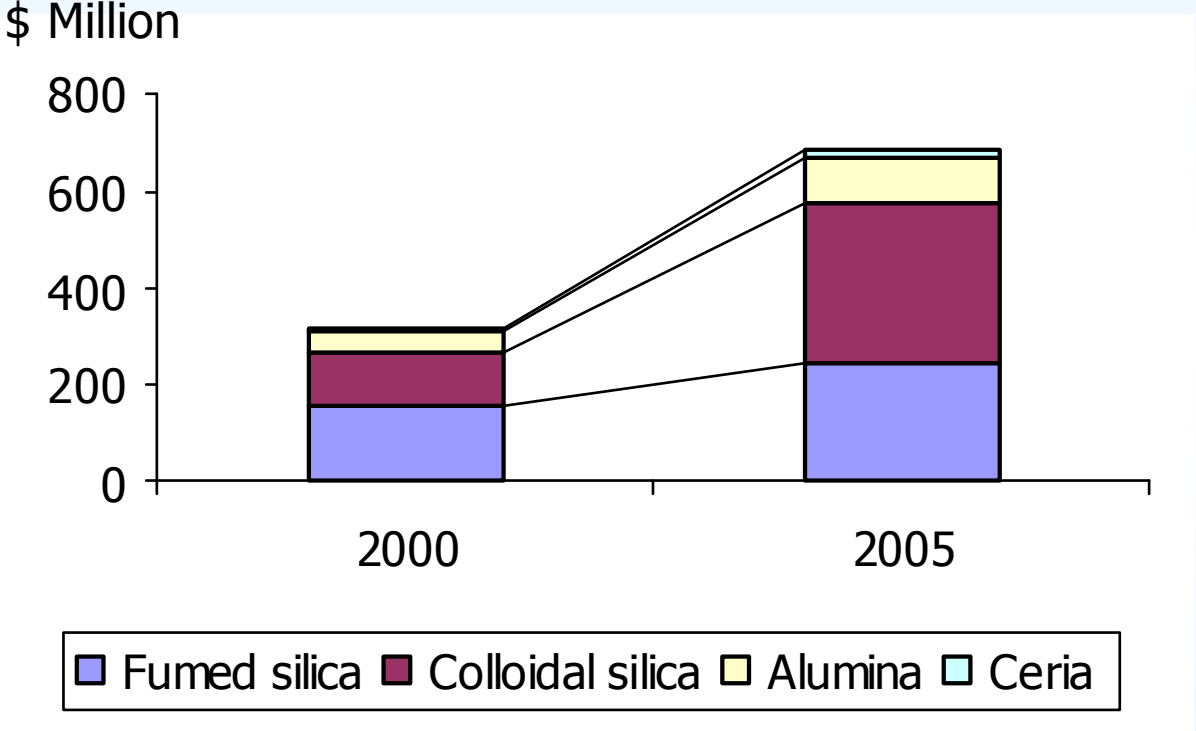
Million minutes undergoing CMP



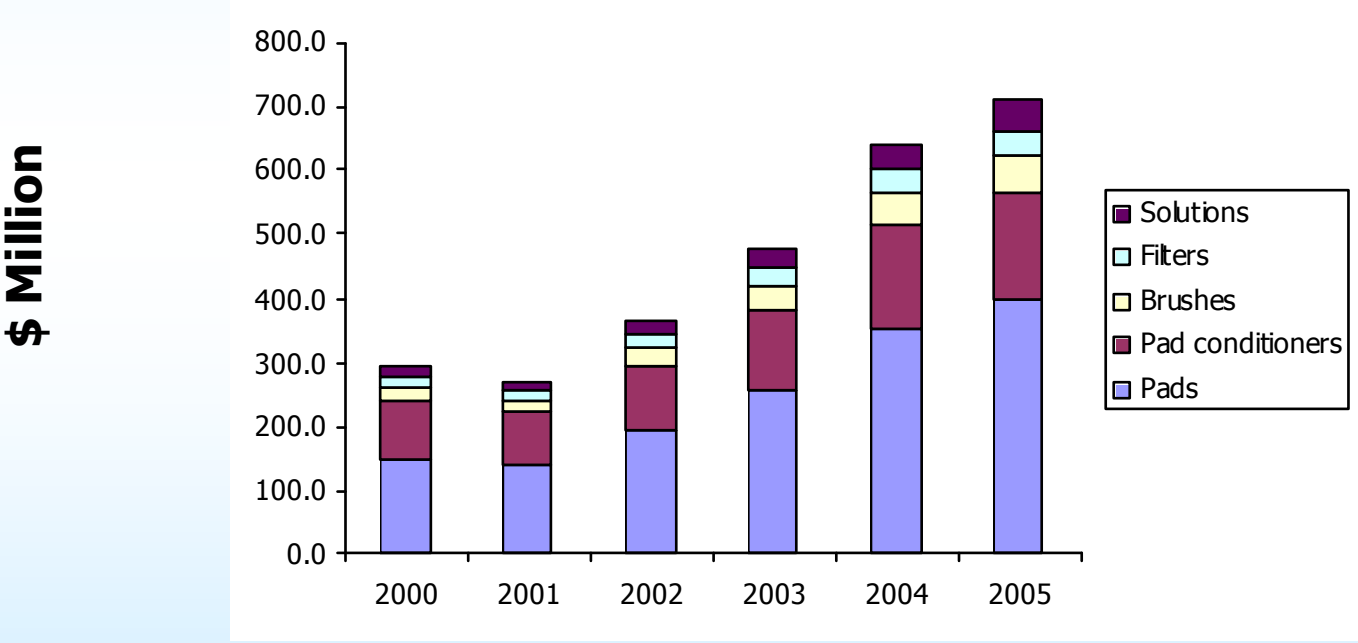
**As CMP matures the number and types of planarizations will shift from oxide to metal . . .**



**Fumed silica dispersions will continue to grow rapidly but will lose share to other types of CMP slurries over the next five years . . .**



**Other major consumables in CMP are pads, brushes and filters. Together they account for approximately one-half of the total consumables market . . .**



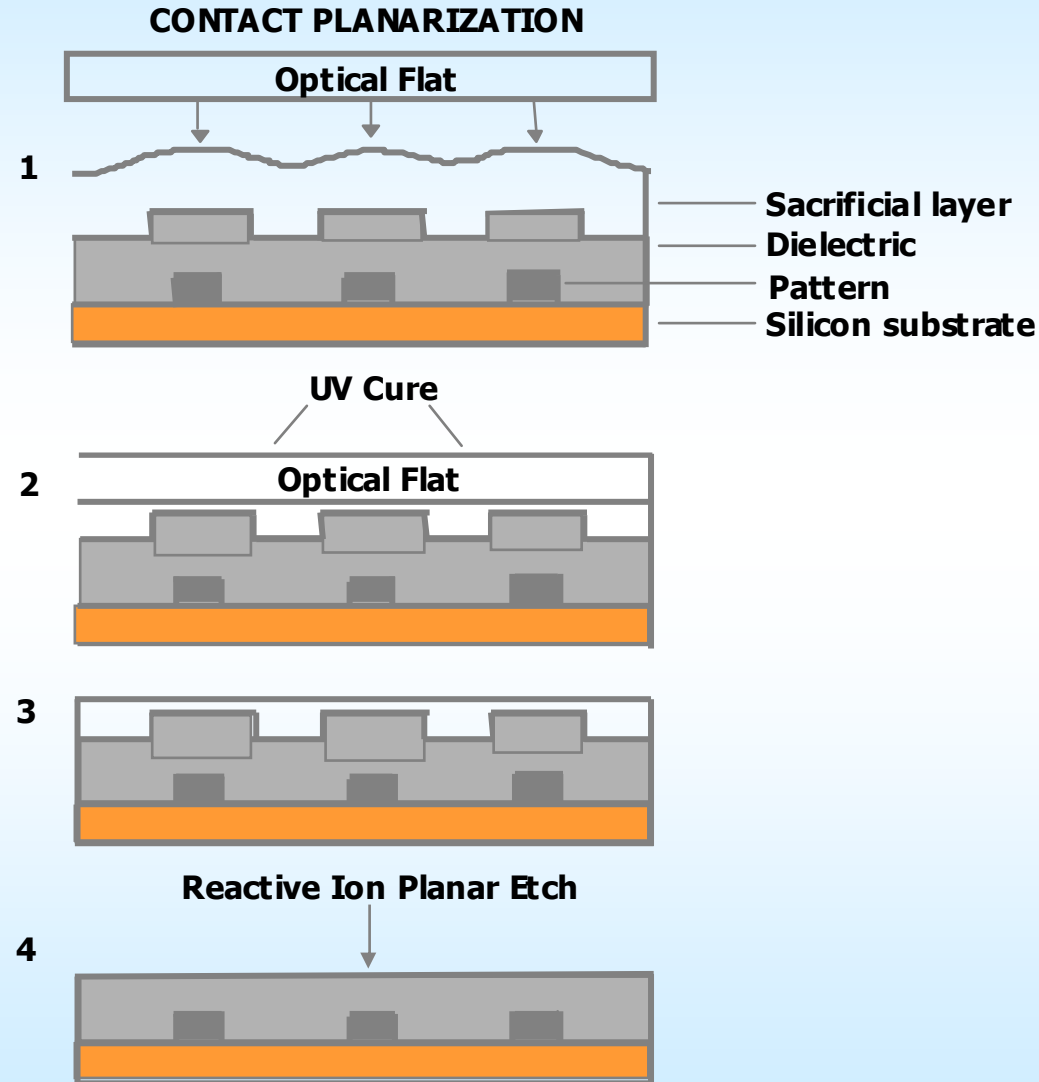
**CMP has been a process standard since the 250-nm design rule was passed, over five years ago, but its continued use “as we know it” is by no means certain**

**Alternatives include:**

- CMP without abrasive slurry
  - Abrasive-free polishing solutions
  - Electropolishing
- Fixed-abrasive pads
- Non-CMP planarization
  - Contact planarization
  - Planar etch
  - Press & Peel dielectrics



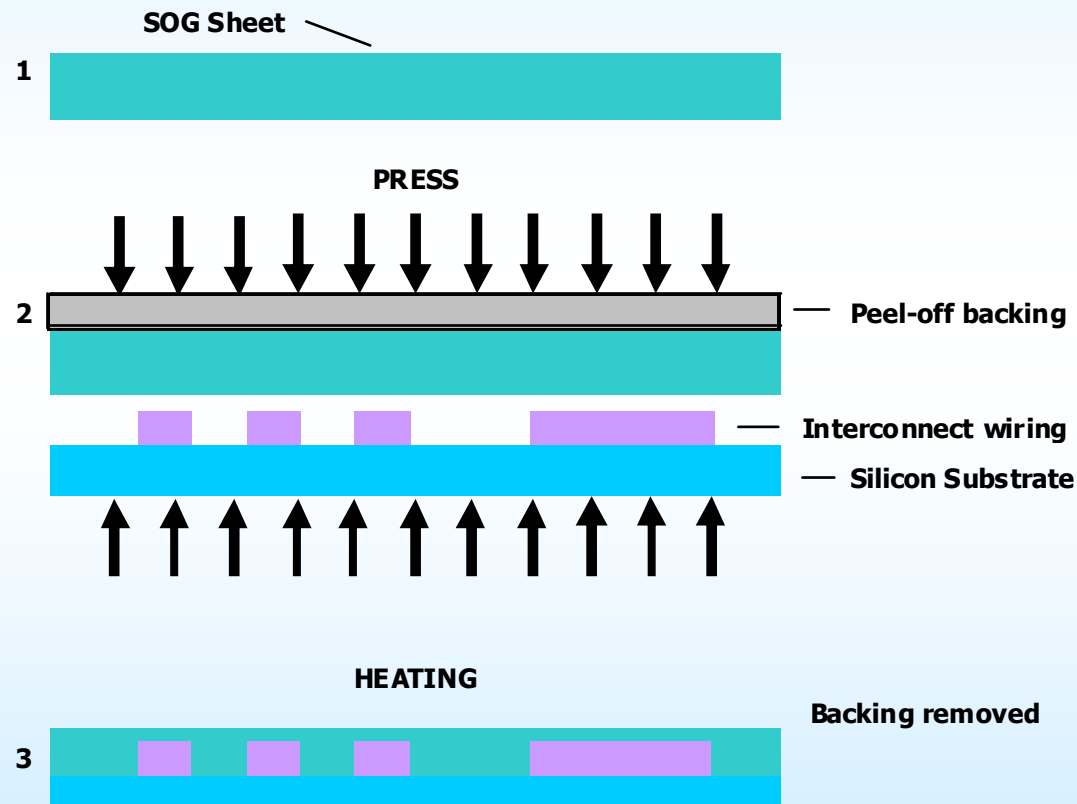
**Contact planarization, involves the use of a lens blank to flatten a sacrificial layer, which is cured with UV and then etched away . . .**



*Source: J.A. Prybala, Lucent Technologies, AVS 2nd Intl Conf., Feb, 2000*



# Press and Peel technology from ASET. Together with DSN, can deposit dielectrics without any need for planarization



## **CMP without abrasive slurry...**

### **Abrasive-free polishing (AFP)**

- Hitachi HS-C, with  $H_2O_2$ , for copper bulk only
- Rodel Reactive Liquid, also for copper bulk
- AMAT claims solutions for copper bulk and finishing

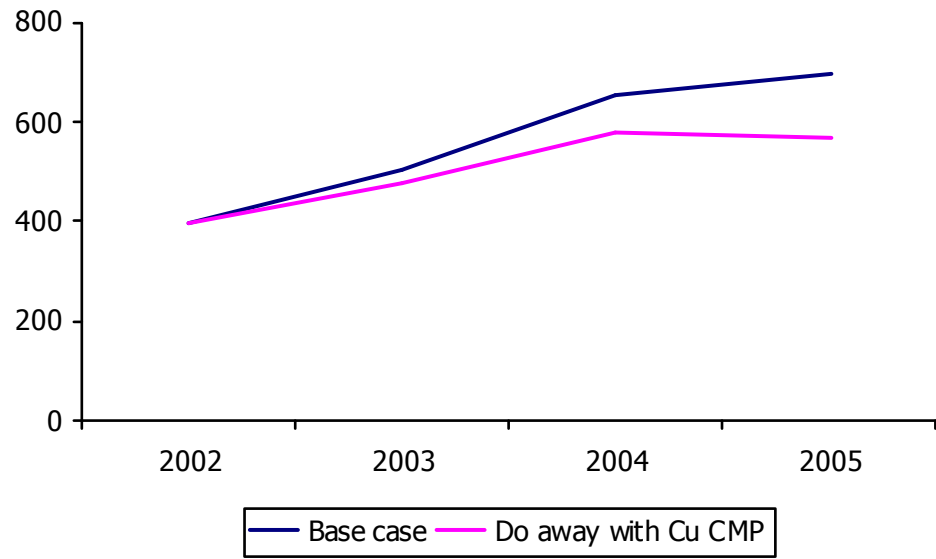
### **Electropolishing**

- NuTool combines electrodeposition with pad polishing, with or without slurry
- ACM Ultra SFP (Stress-Free Polishing)
  - No pads or slurry
  - Aimed at low-k integration



## What if planar deposition wins big?...

- Base case projects token planar deposition in 2003-2005
  - Penetration limited to MPUs, SoCs, DSPs
- If (a BIG IF) just those categories go all to planar deposition, slurry market drops 18%
  - It couldn't happen this fast!!!



## Integration challenges ahead...

- **Not just metal CMP will occur**
  - Expect dishing, hence an oxide buff
  - Expect low-k exposure to slurry
- **Pay attention to platen pressure**
  - Too much might destroy a low-k film
  - Can be used to advantage in “smart” slurries
  - Pressure profile across the head needs control and understanding
- **Implementing low-k while reducing cost-of-ownership**



## **More Integration Challenges to CMP . . .**

### **300-mm wafers could lead to a reduction in the volume of consumables**

- By one estimate, average slurry usage rises from 560 ml/wafer to only 650 ml/wafer -- only a 20% increase for a >200% increase in polishing area

### **Low-k dielectrics require special care**

- Dense versions are now commercial
- Porous versions will go commercial 2006-2008

### **Copper**

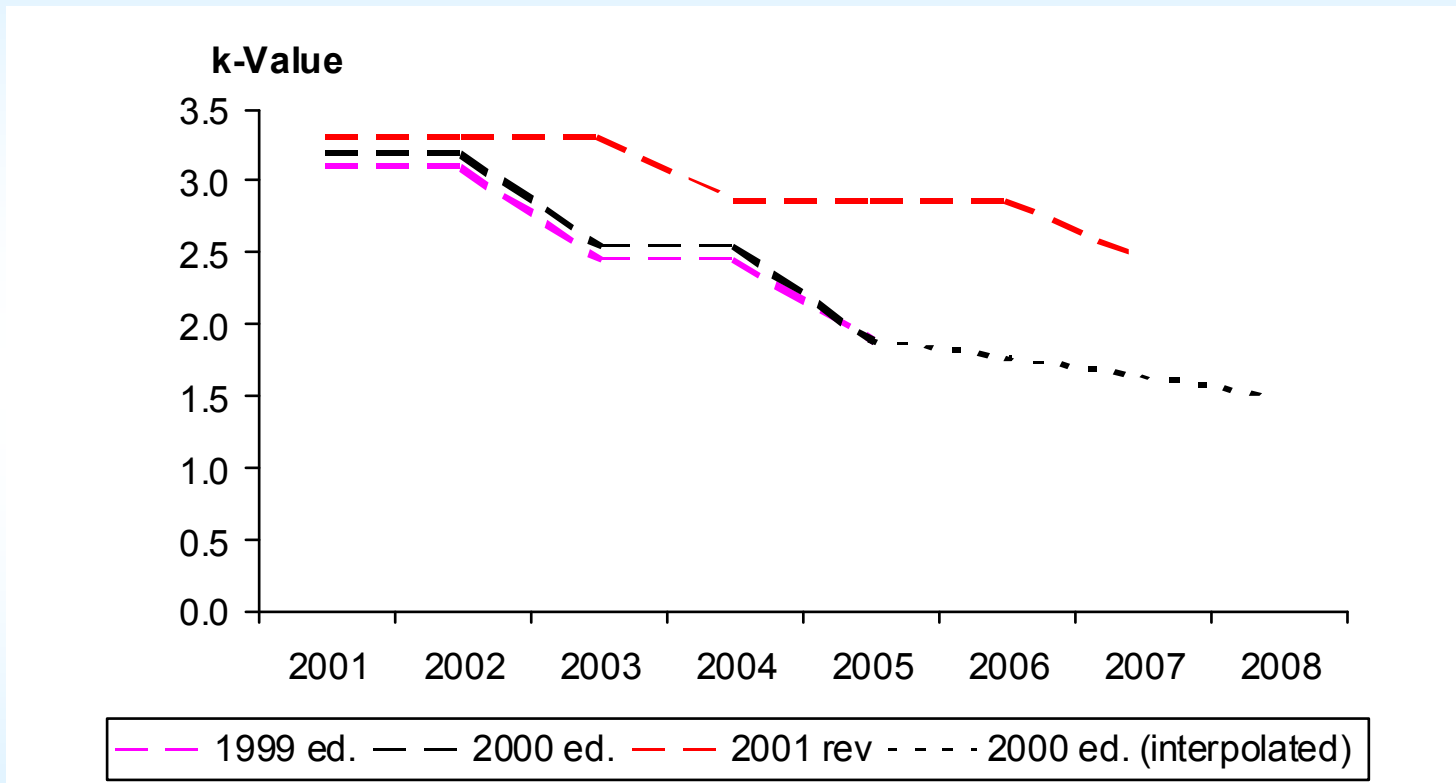
- Numerous grades with custom selectivities



# Low-k dielectrics



## Low-k Roadmap delay...



**CLASSIFICATIONS OF DIELECTRICS AND ANCILLARY MATERIALS**

Function	Material class	Materials	
		CVD	Spin-on
<b>Premetal</b>	<b>Inorganics</b>	BPSG	
<b>Interlayer dielectric (ILD)</b>	<b>Inorganics</b>	SiO <sub>2</sub> , FSG	
	<b>Organics</b>	PTFE, FLAC	Polyphenylene, polyarylene, PTFE, others
	<b>Silico-organics</b>	SiOC	HSQ, SOG, silsesquioxanes, siloxanes, others
<b>Cap/hard mask/etch stop layers</b>	<b>Inorganics</b>	SiN <sub>x</sub> , others	
	<b>Organics</b>		
	<b>Silico-organics</b>	SiC	Proprietary polymers



# CVD v.s. spin-on, continuing debate...

