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# ***Equipment & Materials Integration Challenges***

**American Vacuum Society CMP User Group  
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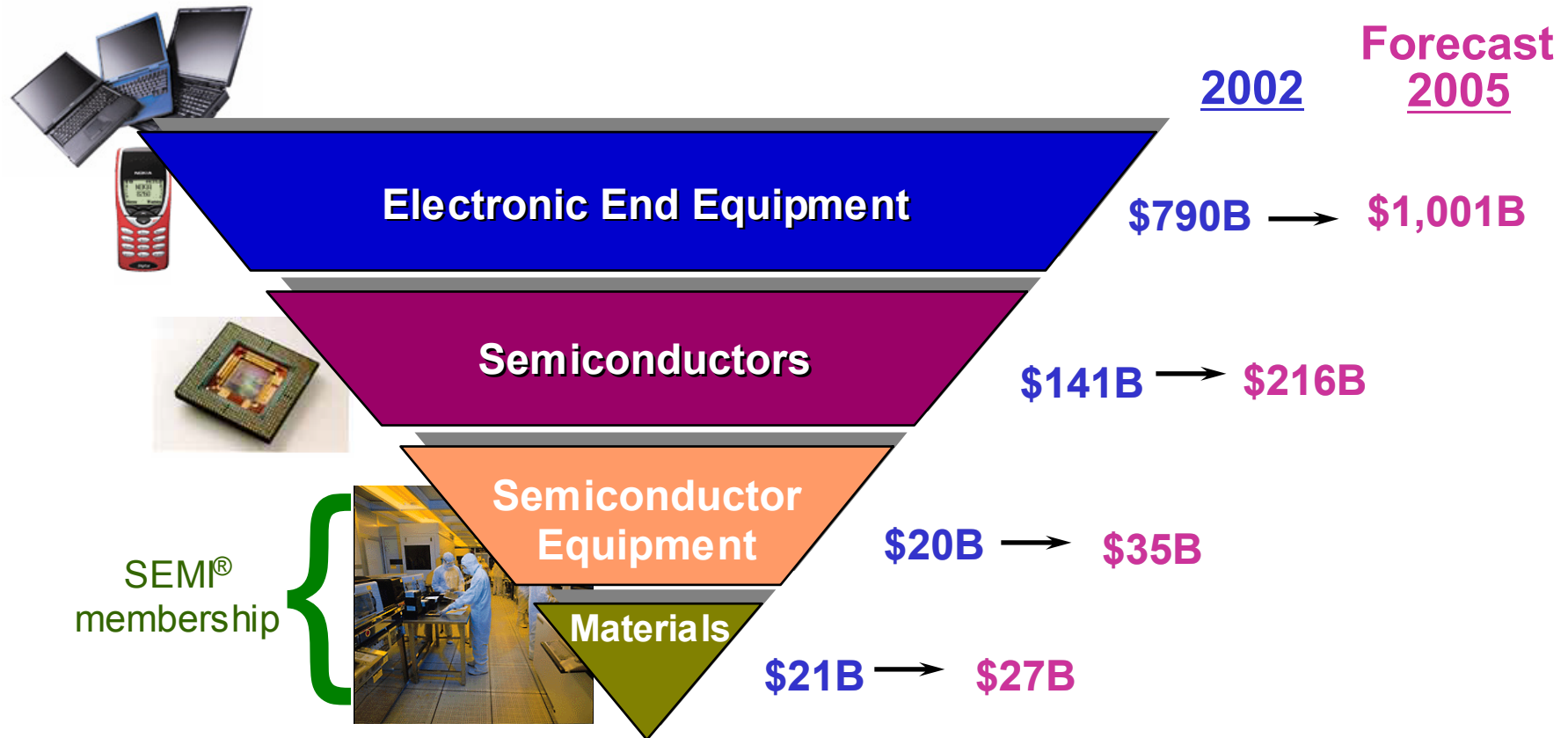


# *Outline*

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- Materials & Equipment Markets**
- Emerging Technologies**
- Interconnect Integration Challenges**
- Summary**

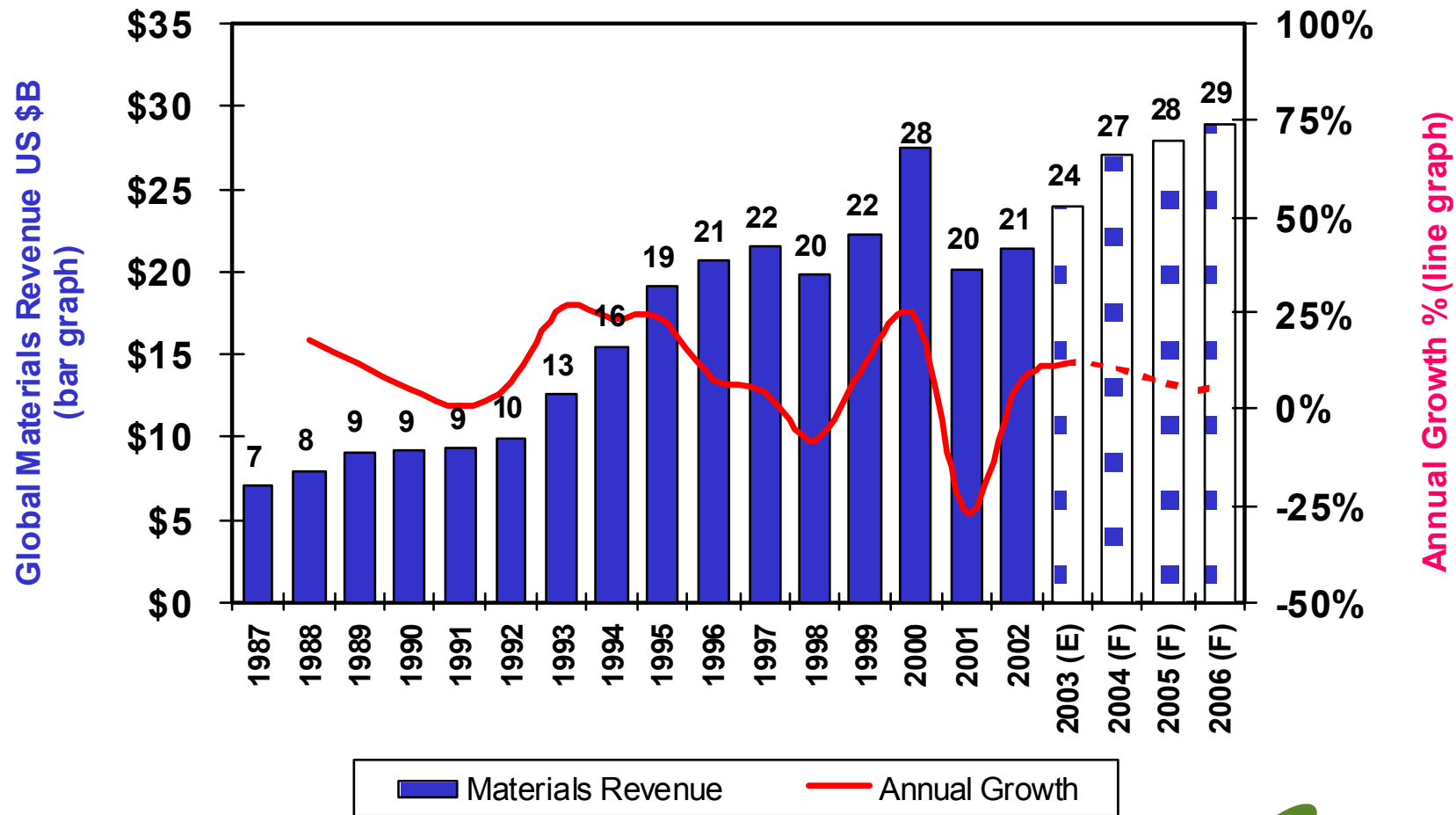
# The Electronics Ecosystem



Source: SEMI, SIA/WSTS October 2003, Henderson Ventures November 2003



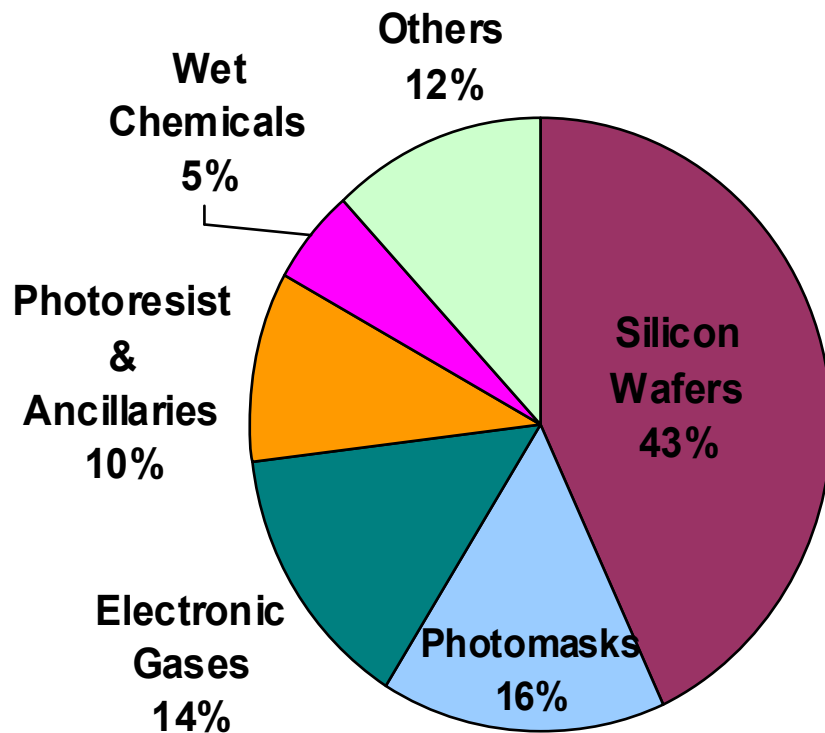
# Electronic Materials Cycles



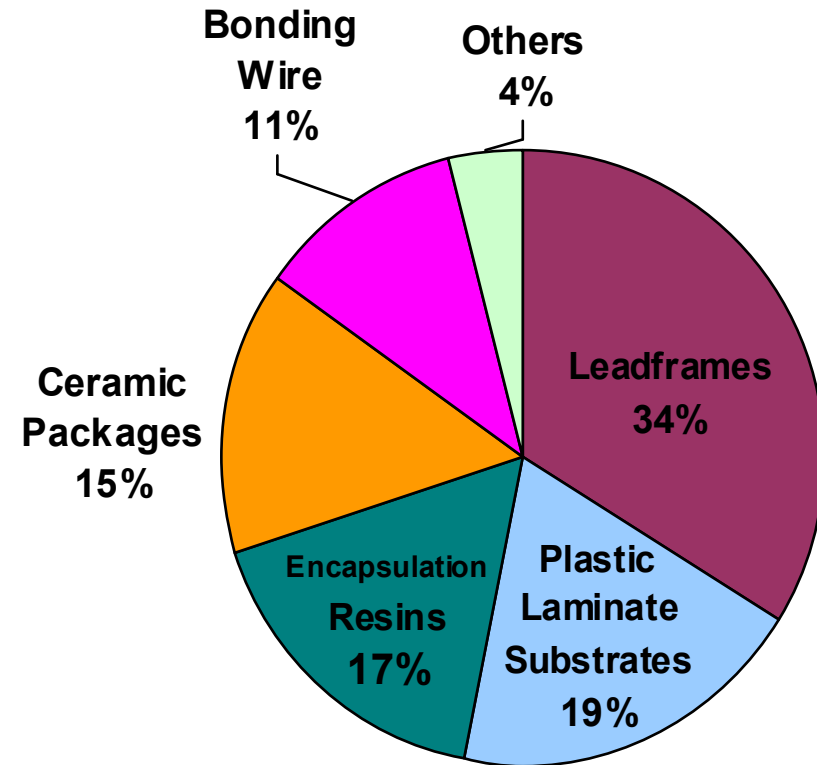
Source: Rose Associates historical reports, SEMI



# 2002 Global Materials Markets



2002 Global Wafer Fab Materials \$12.98B

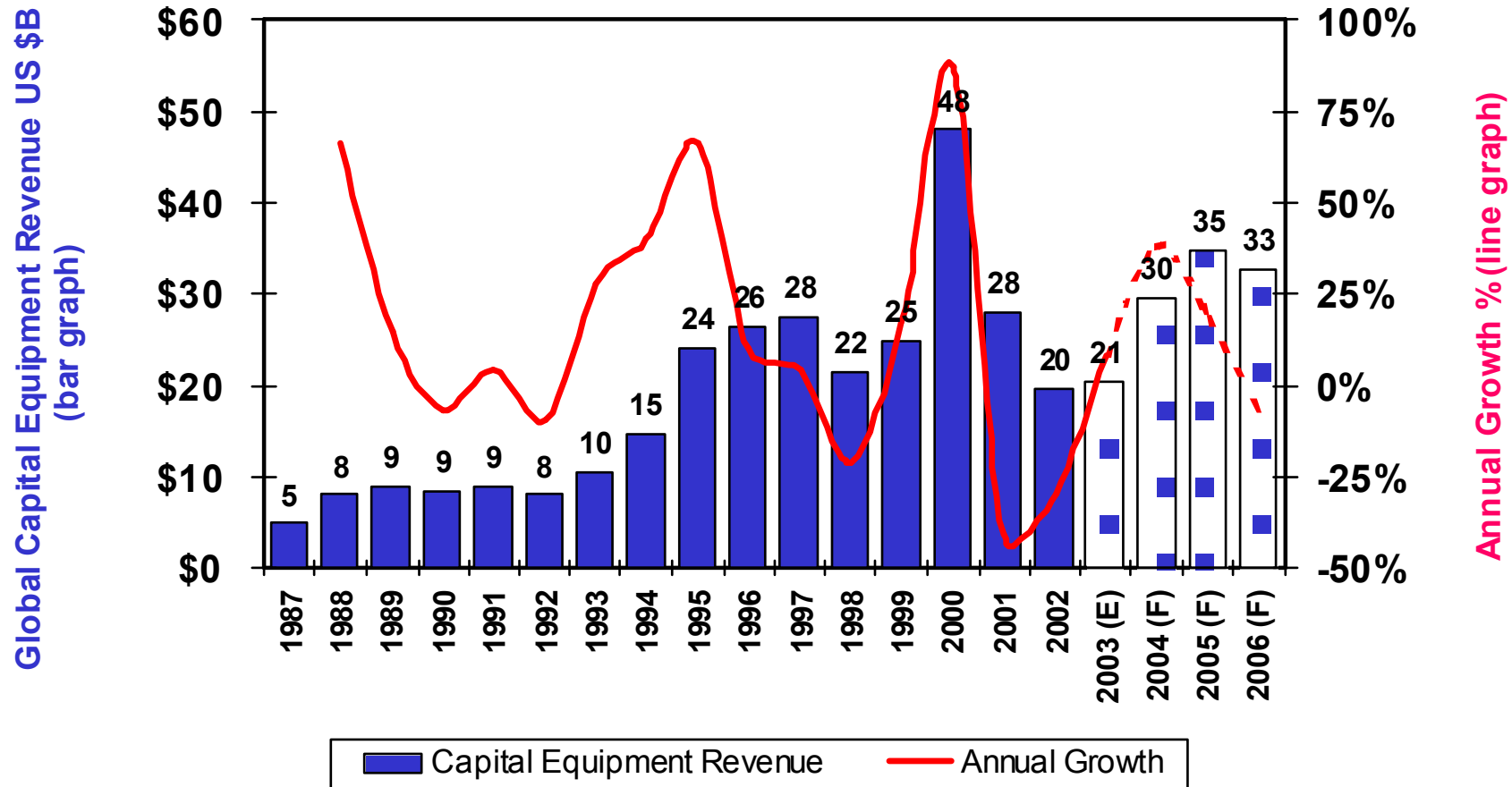


2002 Global Package Materials \$8.41B

Source: SEMI March 2003



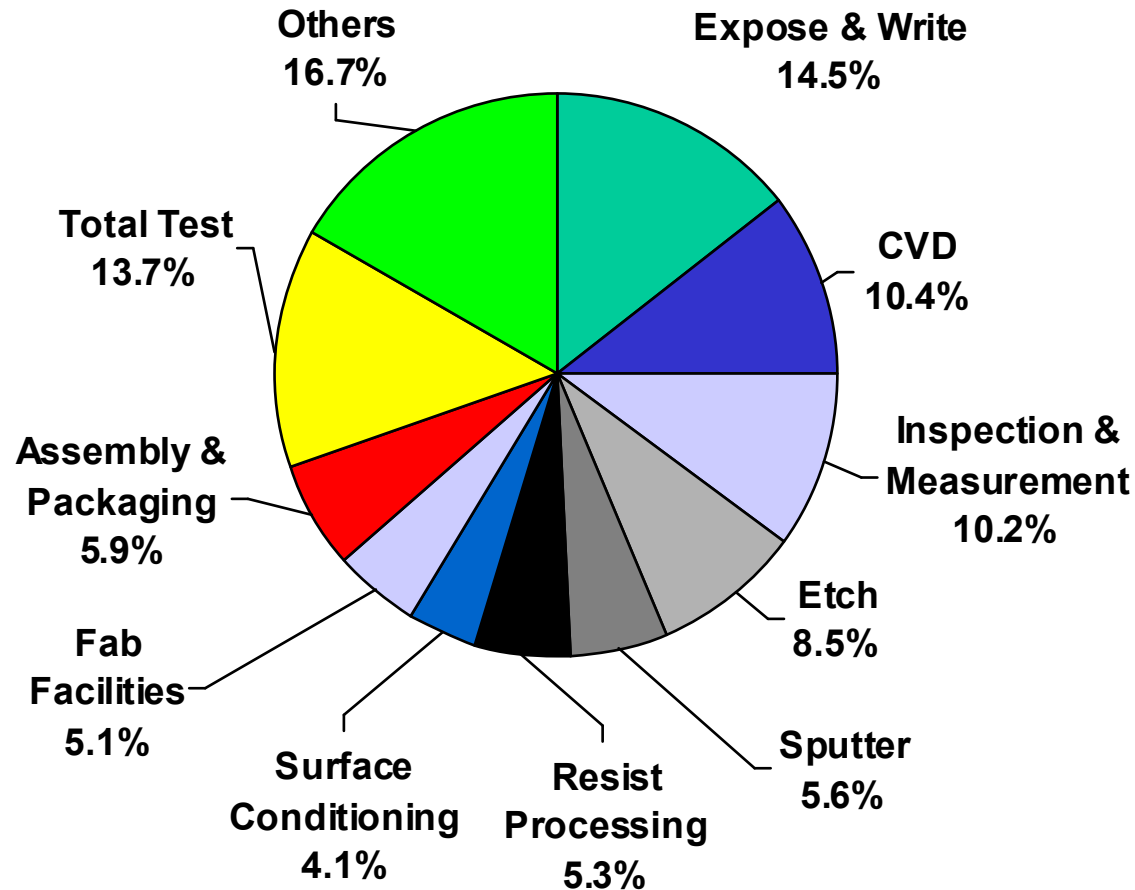
# Capital Equipment Cycles



Source: SEMI and SEMI/SEAJ year end historical reports



# 2002 Global Equipment Markets



**Worldwide 2002 Billings = \$19.75B**

Source: SEMI/SEAJ March 2003



# Emerging Technologies Summary

Selected Emerging Technologies Summary	
<b>Substrates</b>	<b>Silicon on insulator (SOI) &amp; derivatives, strained silicon, strained SOI, 300 mm</b>
<b>Lithography</b>	<b>Lower cost photomasks, 2<sup>nd</sup> generation 193 nm resists and ancillaries, immersion lithography , 157 nm resists and ancillaries, NGL resists and ancillaries</b>
<b>Interconnects</b>	<b>Advanced copper electro plating solutions, hybrid low k materials, high k materials, spin on versus CVD, dielectric cleaning solutions, low k compatible CMP slurries</b>
<b>Package Materials</b>	<b>Green molding compounds, dielectric materials, overcoat materials, back coat materials, solder stems and balls</b>

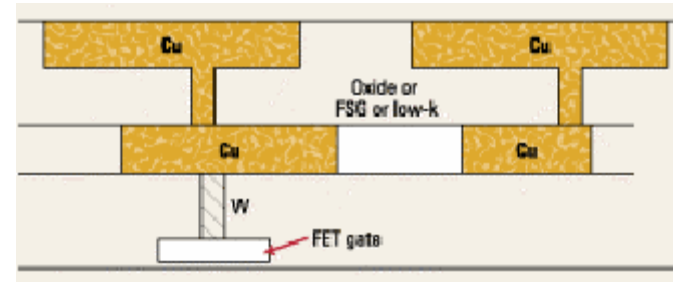


**Multiple “winning” solutions for given technology node creates challenge and opportunity**

# Interconnect Integration Challenges

## ❑ Copper Interconnects

- “Single batch” ECP tools for 65 nm
- Electroplating chemistries becoming more complex



## ❑ Dielectrics

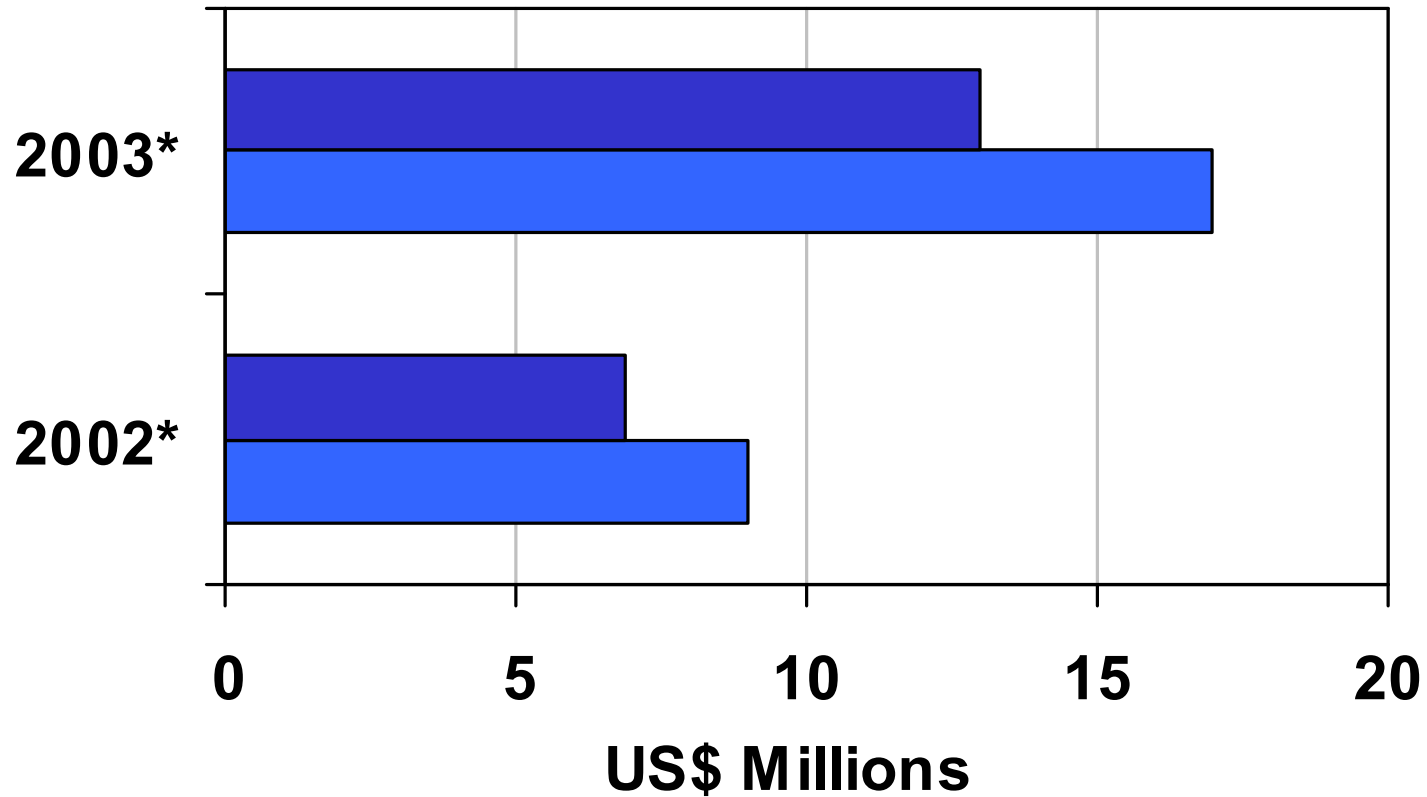
- Hybrid low k approach for inter metal dielectric
- Spin on versus chemical vapor deposition
- Hafnium based high k materials for gate insulator
- Metal gates

## ❑ Chemical Mechanical Planarization

- Low k compatible slurries
- Nanotechnology for slurries
- Post CMP Cleaning solutions

Source: Semiconductor International (image)

# Electroplating Chemicals

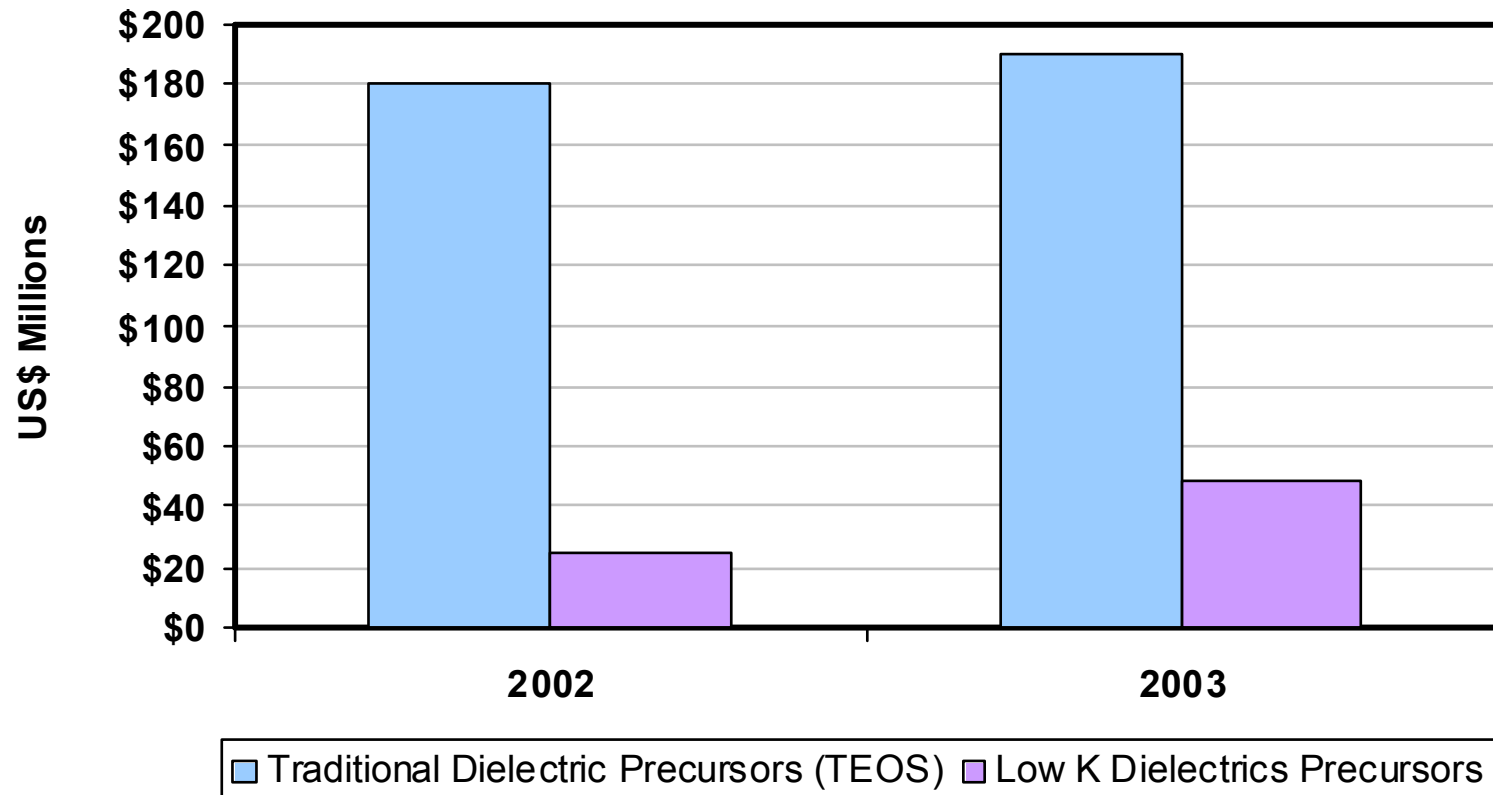


\* High and low estimates due to significant volume of custom chemicals at some large customers

Source: Techcet Group March 2003



# Dielectric Materials

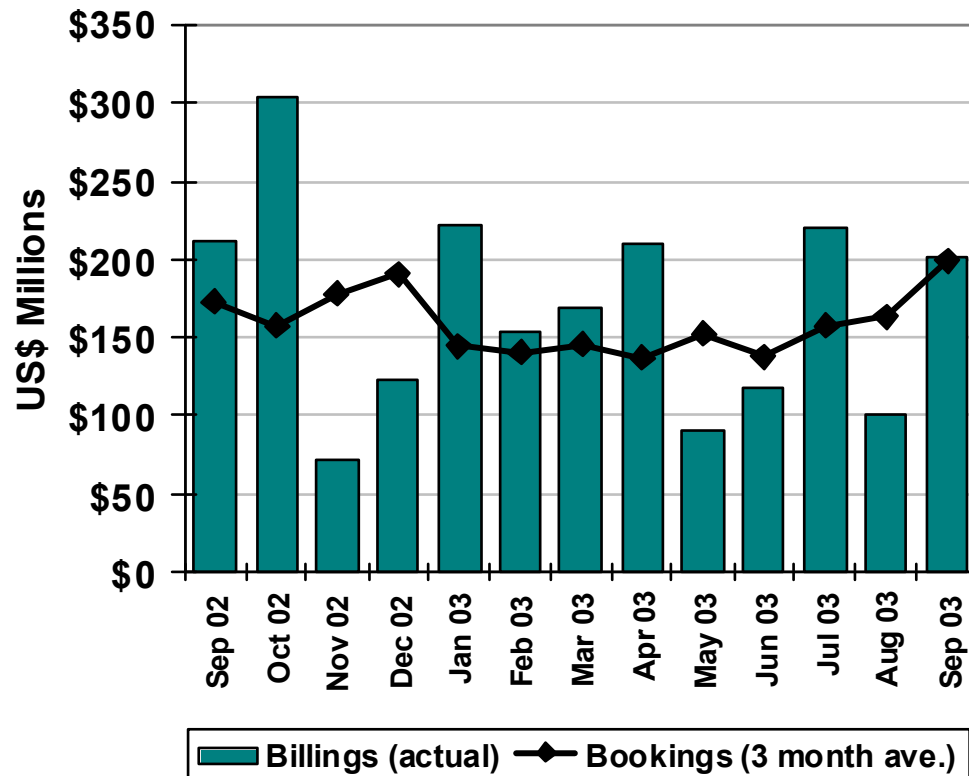


Source: Techcet Group May 2003, Kline & Company 2002



# Chemical Vapor Deposition Trends

## Worldwide CVD Equipment



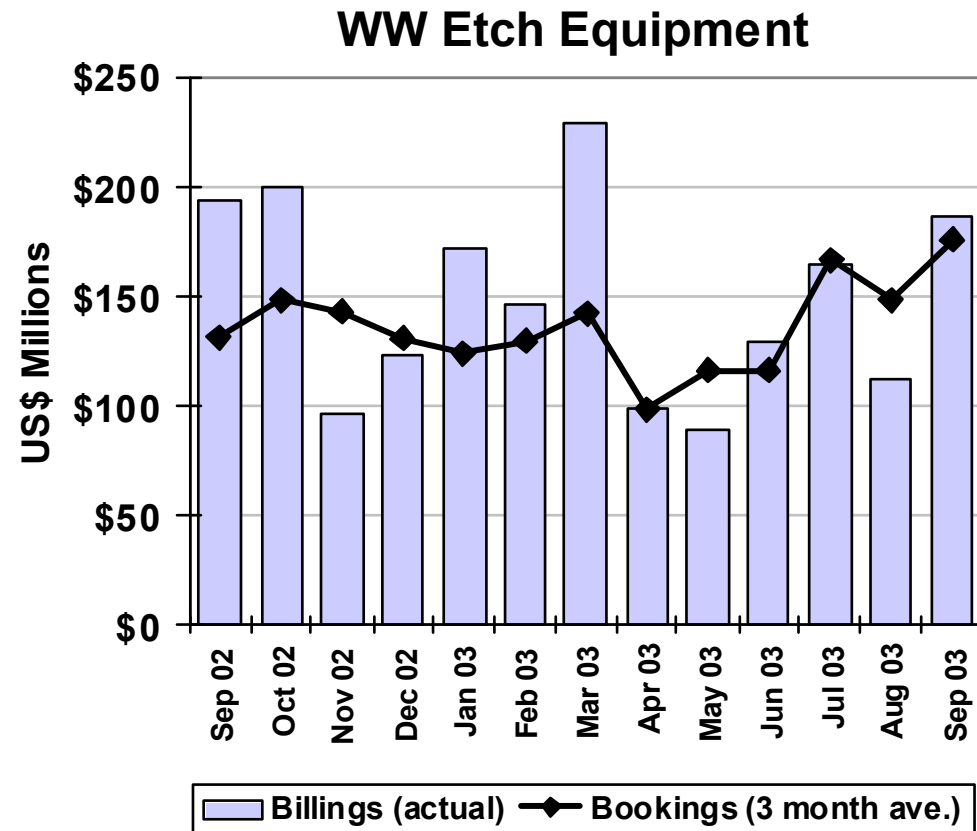
- ❑ September bookings grew 22% over August
- ❑ Low & high k films, dielectric anti-reflective coatings (DARC) and 300 mm offer growth opportunities
- ❑ Atomic layer deposition required for certain applications at 90 nm node
- ❑ Reduced pressure epitaxial reactors for heterostructures

Source: SEMI/SEAJ November 2003



# Etch Equipment Trends

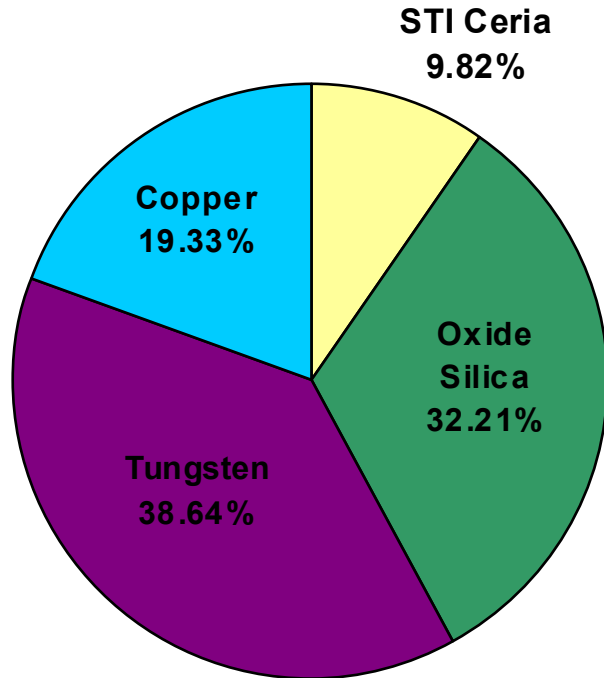
- ❑ September bookings grew 19% over August bookings
- ❑ Japan is largest market, closely followed by U.S. and Korea, respectively, through September 2003
- ❑ Dielectric etch tools represent largest market segment, followed by polysilicon and metal etch
- ❑ Technology and productivity improvements driving growth in dielectric etch tools



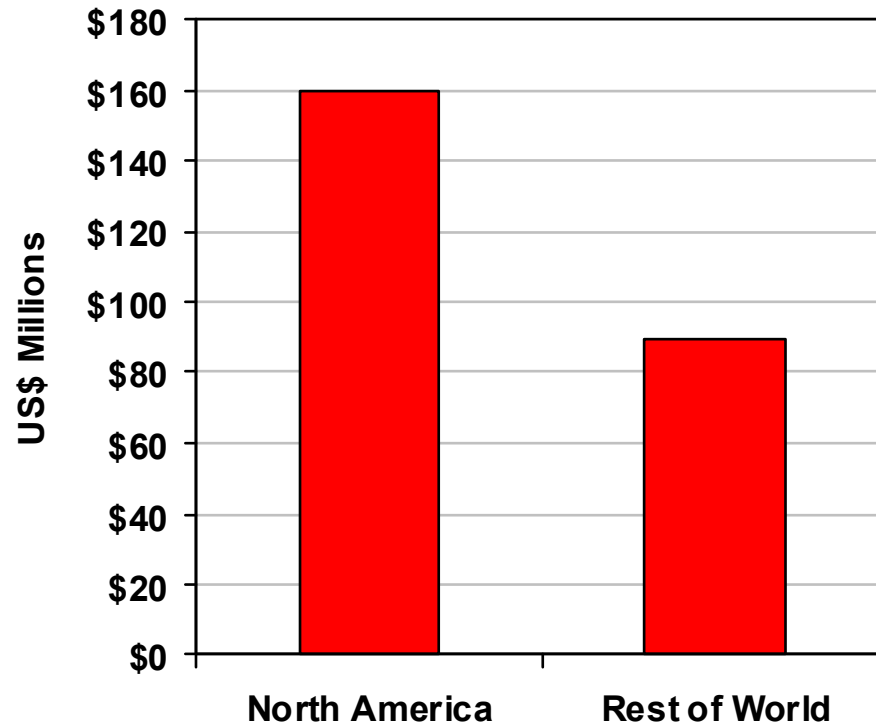
Source: SEMI/SEAJ November 2003



# CMP Consumables



**2003 WW CMP Slurry  
Market Estimate ~\$350M**



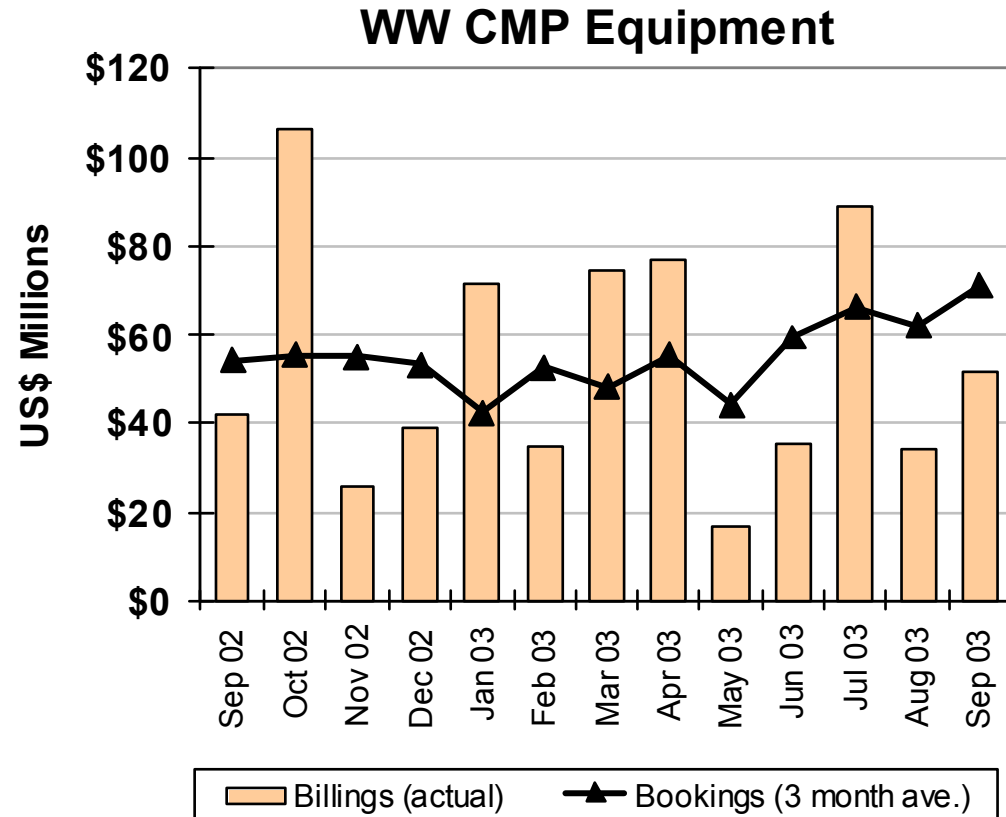
**2003 WW CMP Pad  
Market Estimate ~\$250M**

Source: Techcet Group May 2003



# CMP Equipment Trends

- ❑ September bookings up 15% over August bookings
- ❑ Taiwan demand for CMP tools only 11% of market in 2003, down from 25% in 2002
- ❑ Applied Materials, Ebara and Novellus Systems and Lam Research account for ~90% market



Source: SEMI/SEAJ November 2003



# *Changing Industry Dynamics*

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## **□ Proliferation of Joint Development Agreements**

- Integration mandating closer cooperation
- Equipment suppliers moving into materials arena?
- Consortium for Advanced Semiconductor Materials & Related Technologies

## **□ New Entrants in Emerging Materials Segments**

- CMP slurries and pads
- Dielectrics

## **□ Consolidation of Players**

- Expanding product portfolios
- Powerhouses emerging

# Summary

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## □ Numerous challenges and opportunities in materials and equipment markets

- Adoption of technologies at different nodes leads to slower market penetration for emerging materials and technologies
- Integration requires increased collaboration and increased R&D

## □ Materials markets less cyclical than equipment markets

- Large investments required for infrastructure and R&D
- Variety of supply changes anticipated