Equipment & Materials
Integration Challenges

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Outline

- 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

- Silicon Wafers: 43%
- Photomasks: 16%
- Wet Chemicals: 5%
- Photoresist & Ancillaries: 10%
- Electronic Gases: 14%
- Others: 12%

- Leadframes: 34%
- Plastic Laminate Substrates: 19%
- Encapsulation Resins: 17%
- Bonding Wire: 11%
- Others: 4%

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

<table>
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<th>Selected Emerging Technologies Summary</th>
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<td><strong>Substrates</strong></td>
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<td><strong>Lithography</strong></td>
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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

- 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
CMP Consumables

2003 WW CMP Slurry
Market Estimate ~$350M

2003 WW CMP Pad
Market Estimate ~$250M

Source: Techcet Group May 2003
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

- **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

- 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