The Nano Future: More Moore & More Than Moore

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Micro Nano Technology Conference * Penn State University * May 9, 2012
Profile of U.S. Semiconductor Industry

2010 Sales = $144 Billion

2010 World Market Share = 48% of $298 Billion Market

U.S. Jobs = 182,200

Average Income = $99,622

Percent of Sales Outside U.S. Market = 82%

R&D Investment = $20 Billion, 17% of Sales

Capital Equipment = $13 Billion, 11% of Sales

2005-Present: Semiconductors are #1 Export in the United States

Source: SIA, U.S. DoL
Note: Sales/Market share/% of Sales Outside U.S. updated for 2010 year end. US Jobs/Avg Income reflect latest available data from DoL
Semiconductors are in many different products

Cell Phone Shipments
+11-13% (units)
Smartphones increasing as percent of total

PC Shipments +15%
(Units)
Enterprise purchasing increasing – with higher ASPS

Consumer Electronics +3.0% (Units)

LCD TV +19-20% (Units)
Digital Set Top Box +10-11% (units)

Wired Communications 6%
Industrial/Military 8%
Automotive 7%
Consumer 21%

Semiconductor content = ~$350/car and rising

Sources: SIA November 2010 Forecast/Credit Suisse/JP Morgan/iSuppli
Note: Military is <1% and is included in Industrial.
Moore’s Law: # transistors/chip doubles every 24 months
Nanotechnology + Electronics = Today’s “Semiconductor” Industry
Increasing Complexity in CMOS Chips

What are the possible environmental effects?
Are some elements in limited supply?

Source: Intel
Industry is hiring at all levels
Industry is hiring at all levels
<table>
<thead>
<tr>
<th>Position</th>
<th>Apply for Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Analysis Technician</td>
<td>Apply</td>
</tr>
<tr>
<td>EHS &amp; Security Technicians</td>
<td>Apply</td>
</tr>
<tr>
<td>Fab Systems Setup Technician</td>
<td>Apply</td>
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<tr>
<td>Facilities Dept</td>
<td>Apply</td>
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<tr>
<td>Factory Automation Technician</td>
<td>Apply</td>
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<tr>
<td>Factory Information Control Technician</td>
<td>Apply</td>
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<tr>
<td>Integration Engineering Technician</td>
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<tr>
<td>Maintenance Technician</td>
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<tr>
<td>Process Integration Technician</td>
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<tr>
<td>Process Technician</td>
<td>Apply</td>
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<tr>
<td>Wafer Fab Operator</td>
<td>Apply</td>
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<tr>
<td>Warehousing Log &amp; Mat</td>
<td>Apply</td>
</tr>
<tr>
<td>Process Integration &amp; Yield Enhancement</td>
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Transistor/chip ↑ = Price/transistor ↓

Microprocessor that cost $1500 when it was released in 1986 today costs 50 cents.
Nano jobs in research have grown

- National Nanotechnology Initiative has invested $18B since 2000 (mostly academic and government research)
- Multi-disciplinary, including medicine, materials, applications, manufacturing, health effects, etc.
- See www.nano.gov for more information
STEM Education Pipeline

Jobs in Industry, Govt and Academia

- 2-year Technical Degree
- Undergraduate Degree
- Masters Degree
- PhD Degree
- Post-docs

K-12
STEM Completion Rates Increased by Undergraduate Research Opportunities

<table>
<thead>
<tr>
<th>Research Opportunities</th>
<th>Non-Completion Rate</th>
<th>Non-STEM Degree Completion Rate</th>
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</tr>
</thead>
<tbody>
<tr>
<td>No research opportunities</td>
<td>100%</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>Some research opportunities</td>
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Source: UCLA HERI
Low-cost, DIY Atomic Force Microscope

- Resolution: 30 nm (horiz.); 6 nm (vert.)
- Scan area: 6.2 X 6.2 nm
- Cost: less than $1000
- Developed by Prof. A. Avila (Univ. of the Andes)
AFM Concept Kit

- Suitable for young students
- Very low cost
SRC Student Programs

• Students work on projects that are relevant to industry

• Promotes close relationships between students and industry experts
  – Industry liaisons mentor students
  – Fellowships & Scholarships
  – Internships & co-ops

• Student resumes available online to SRC member companies

• Networking & recruiting opportunities
- Over 1200 currently funded graduate students; ~9000 total graduates
- Citizenship/status: 36% US/green card; 62% student visa (44% non-export controlled, 18% export controlled); 2% unspecified
SRC Undergraduate Research Opportunities

Provides hands on research experience and supports progression toward advanced degrees

PROGRAM HIGHLIGHTS

• 300+ students/year
• 14 University partners
• 158 Faculty advisors
• 42% Female; 55% Male
• 86% retention in program (95% in STEM)
• 60% progress to graduate school
• All are U.S. citizens
Summary

• Nano-related job opportunities exist in every sector and virtually every tech-based industry.
• Nano is at the bleeding edge of research, but also is making technology affordable.
• Advances in nanomaterials and nano-manufacturing will create new products, new businesses, new industries, and new jobs.
• Well prepared students are essential to realizing the benefits of nanotechnology advances.