The Opportunities and Challenges of Bringing New Metrology Equipment to Market

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Sunnyvale, CA 94086
Consumer applications drive the $175B semiconductor market

**Low Cost is Critical!!**

The Digital Consumer Revolution
Higher speed and lower power fuels the $30B equipment market

- Smaller geometries
- Thinner films
- New materials
Metrology and inspection represent a significant share of semiconductor equipment

- Critical Dimensions & Overlay Error
- Film Stack Thickness & Composition
- Material, Interfacial & Electrical Properties
- Implant Dose & Profile
- Sensor Based Parameters
- Contaminant and Residue Properties
- Defect & Particle Detection
- Data Mining & Yield Correlation
- Defect Review & Classification
- Morphological & Compositional Analysis
- Sensor Based Parameters
- Data Mining & Yield Correlation

Source: VLSI Research 8/04
Metrology and inspection represent a significant share of semiconductor equipment (cont.)

Source: VLSI Research 8/04
Market share of top two suppliers by industry segment

Assembly/Packaging
Components
Photomasks
Cleaning
Factory Automation
Process Control
Mask Writing Equip.
Strip
Etch
CVD
Test
Implant
Oxidation/diffusion
PVD
Epi
Steppers
ECP
RTP
DUV Lasers
CMP
Track
CMP Clean

% market share

Source: UBS Securities 1/05

“Process Control” segment provides head room for new companies
New metrology and inspection companies continue to emerge

- Next generation process and device technology provide new opportunities
  - Smaller geometries
  - New materials
  - Integration challenges
- Semiconductor chip manufacturers actively encourage fresh approaches and are willing to work with new suppliers to refine their product offerings and business practices

The barrier to entry is high, but not insurmountable!
## Venture backed metrology companies (since 2000)

<table>
<thead>
<tr>
<th>Company</th>
<th>Application area</th>
<th>Founded</th>
<th>Funded</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imago Scientific Instruments</strong></td>
<td>Three-dimensional atomic scale imaging</td>
<td>1999</td>
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<td><strong>Metara, Inc.</strong></td>
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*Source: Dow/Jones Venture Source*
Sources of investment

- Equipment Company: 2
- Chip Company: 2
- Corporate Venture Fund: 3
- University: 3
- Distributor: 4
- Investment Group: 7
- Traditional VC: 19, 2, 2

Expectations:
- Founder expertise
- Strong IP portfolio
- Disruptive technology
- Barrier to competition
- Scalable solution

Sources:
- CalTech
- MIT
- Stanford

"The Opportunities and Challenges of Bringing New Metrology Equipment to Market" by D. S. Perloff
2005 International Conference on Characterization and Metrology for ULSI Technology
Investors need to be educated about the metrology equipment market

- Concentrated customer base
- Lengthy product development cycle
- Perceived dominant competition
- Difficulty establishing enterprise value in relation to other industries
- Uncertainty about timing and method of achieving liquidity

"Whaddya mean, it’s only a model? How much bigger d’you wanna build it?"

"Investors have many other options!"
Emerging metrology companies need substantial funding

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<th>Metrology Company</th>
<th>Total Funding</th>
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<tr>
<td>A</td>
<td>$7.8M</td>
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<tr>
<td>B</td>
<td>$8.0M</td>
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<td>C</td>
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<td>D</td>
<td>$13.5M</td>
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<td>E</td>
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<td>G</td>
<td>$39.2M</td>
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<td>H</td>
<td>$47.5M</td>
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Cumulative funding: $160M

$10M $20M $30M $40M $50M

Total Funding
Challenges facing emerging metrology companies

- Transitioning from a laboratory or research mindset to in-line manufacturing
- Blending an experienced management team with core technologists
- Identifying clear needs in the market to drive initial equipment demand and long term growth
- Winning business at leading edge semiconductor manufacturers
- Supporting customers both pre- and post-sales with applications expertise and rapid response to changing requirements
Serving a global market

Someday son, all this will be outsourced.
Serving a global market (cont.)

Production is moving “off shore”

The emerging company must be capable of selling, servicing and supporting its products throughout the world
# Case Studies

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Case Study I: *Imago Scientific Instruments*

- Materials Science Center
- Atom probe microscope for research and scientific applications
- Publications and IP
- Founder

- $$
- Guidance
- Relationships
- Executive Team Recruiting

- 3D Atom Probe for micro structural characterization

*Source: Tim Stultz*
Case Study II: OnWafer Technologies

UC Berkeley
Computer-Aided Manufacturing
Berkeley Microfabrication Laboratory

- Basic pre-IP concept
- Original Experimental Work
- Refereed Publications
- Founders

- $\$ $
- Guidance
- Relationships
- Executive Team Recruiting

- World-wide proliferation of Wireless, Zero-Footprint Metrology

Source: Rod Browning
Case Study III: ReVera Inc.

Physical Electronics

- Products
- IP
- Employees

- $$
- Guidance
- Relationships

- In-line compositional metrology for hyper thin films

Source: Dave Ring
The Four Business Stages

- Stage 1: *Business Formation*
- Stage 2: *Proof-of-Concept*
- Stage 3: *Market Acceptance*
- Stage 4: *Stable Operation*

That's fantastic! I can't keep up with all this modern technology.
Stage 1: Business Formation

- Seed capital in the range of $500K to $1M is used to assemble the start up team
- Experienced legal and accounting resources are engaged
- Common stock is distributed among the founders
- Market need and product direction are defined
Stage 2: Proof-of-Concept

- Investment capital in the range of $4M - $5M is obtained from outside investors to reach “demo-readiness”
- Preferred stock is issued that establishes relative ownership among the parties
- The company’s valuation is determined (# of shares x $ per share)
- Founders may move to key technology roles, while an experienced CEO is brought on board to manage the company
Stage 3: *Market Acceptance*

- An additional round of $8M - $10M may be needed to achieve broad market acceptance

- Key challenges facing the company are
  - Fully meeting design objectives and specifications for the first generation product
  - Developing a suite of applications that broaden tool use or open new market opportunities
  - Introducing follow-on products that maintain a competitive edge in the marketplace
  - Providing 7 x 24 x 365 worldwide customer support assuring full system utilization and up-time

If you buy a goldfish I’ll throw in the aardvark.
Stage 4: Stable Operation

- In this stage, the company has gained market acceptance for its products, but the need for capital may persist.
- Non-equity sources of financing can help deal with the challenges of inventory and accounts receivable.
- Investors may grow impatient to see a return on capital, and typically prefer an Initial Public Offering (IPO) as a vehicle to “liquidity” for founders and investors.

Acquisition by an established equipment supplier is the most likely outcome for metrology and inspection start ups.
## Significant merger, acquisition and IPO events since 1995

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<td>Amray</td>
<td>Phase Metrics</td>
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<td>$67M</td>
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</table>

**VC Funded Metrology Startups**
- Sensys
- B.Cross
- Metara
- Candela
- IMAGO
- Oraxion
- Qcept Technologies
- ON Wafer Systems
- Piotal
- Revera

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Concluding remarks

- The total available market for metrology and inspection equipment in 2004 was approx. $5B, with anticipated growth to $9B by 2009, making this an attractive market for venture investment.

- The metrology and inspection market is quite fluid, with 4 IPOs and 19 significant mergers and acquisitions since 1996, while during the same time period 12 start up metrology and inspection companies were receiving first-time venture funding.

- It will take on the order of $20M, involving multiple rounds of investment, to bring a metrology or inspection company from start-up to stable operation.

- Venture capital companies tend to invest in only one metrology or inspection company at any time, making raising capital an ongoing, time consuming effort.
Acknowledgements

- Dave Ring, CEO, Revera Inc.
- Rod Browning, CEO, OnWafer Technologies
- Tim Stultz, CEO, Imago Scientific Systems