ERC History

Founded in 1996 by NSF & SRC; now co-sponsored by Sematech and SRC

Founding Universities

- U Arizona
- MIT
- Stanford
- U California – Berkeley

Other University members

- Arizona State U (1998 -)
- Cornell (1998 -)
- U Maryland (1999-2003)
- Purdue (2003 - 2008)
- Tufts (2005 -)
- Columbia (2006 -)
- U Massachusetts (2006 -)
- U Washington (2008-)
- U North Carolina (2009 -)
- U Wisconsin (2009-)
- U Texas - Dallas (2009 -)

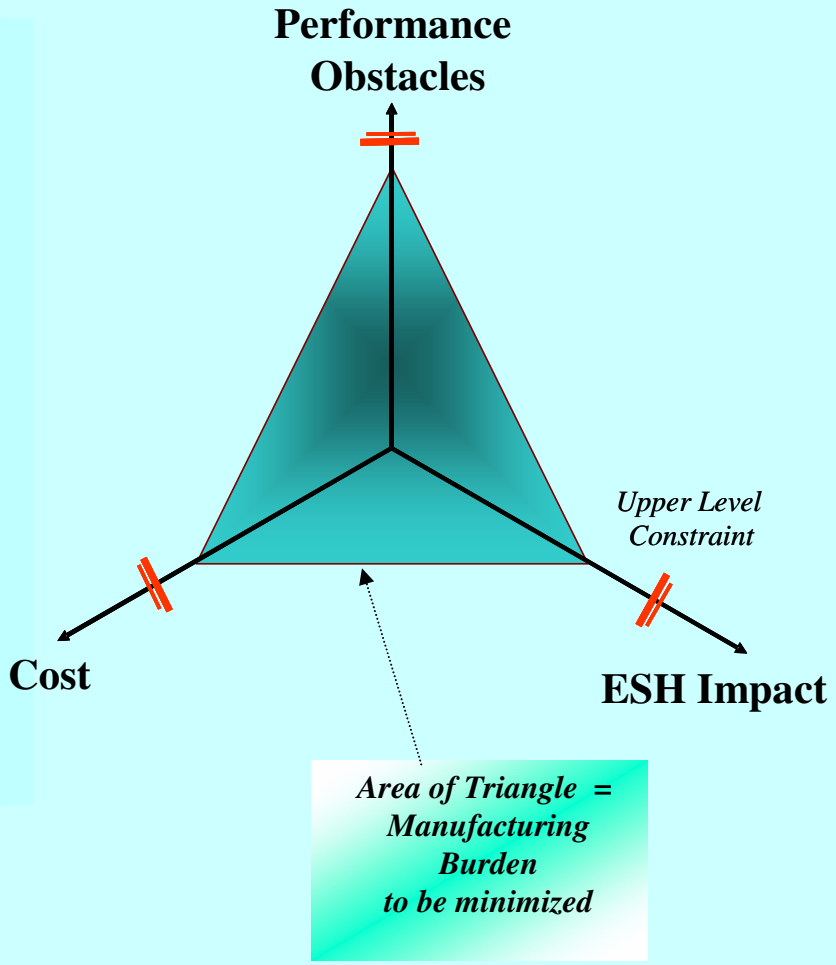
Selected Statistics

The Only Center Dedicated to Research on Sustainability Aspects of Electronics and Photonics Manufacturing

12 Universities
13 Academic disciplines
25 Faculty members

Students Cumulative:
236 PhD and MS
198 Undergraduates

Employment of graduates:
> 80% joining SC industry & suppliers; mostly by ERC members

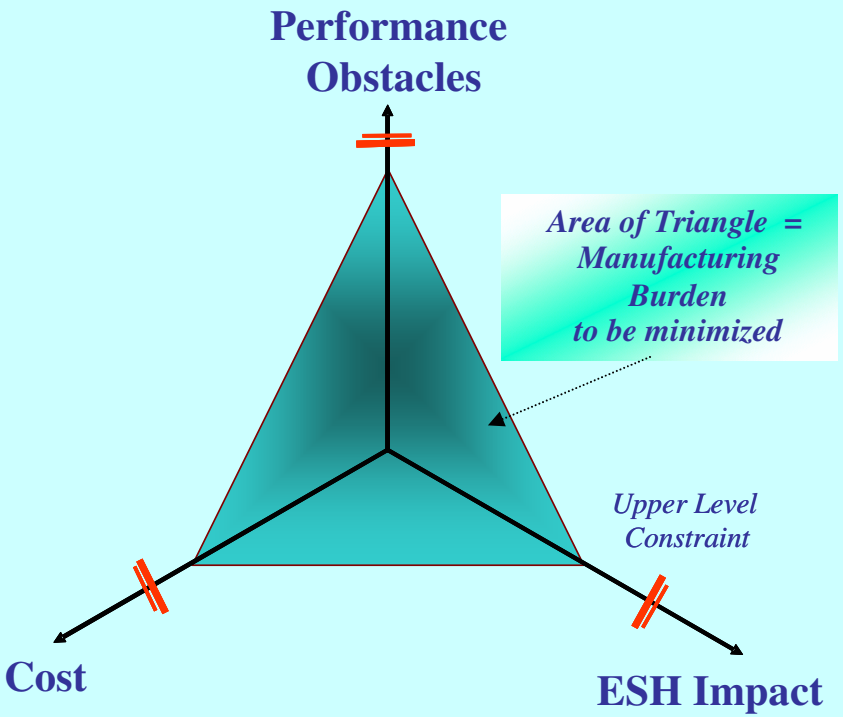


Selected Statistics

- **Funding Leverage:**
  - **Currently $2M/year core funding from SRC/SEMATECH**
  - **Average $3M/year from other sources for the past 12 years**
- **Research: 74 research projects in 12 years**
- **Recognitions: 42 national/international awards and fellow positions for students; 21 national and international awards for faculty**
- **Simon Karecki Fellowship and Award**
- **$1 M Fujimi Endowment and Professorship in Planarization**
- **Technology Transfer:**
  - **28 joint ventures with member companies**
  - **6 spin-off companies**

ERC Mission:
R/D for Sustainable ESH-Friendly SC Manufacturing

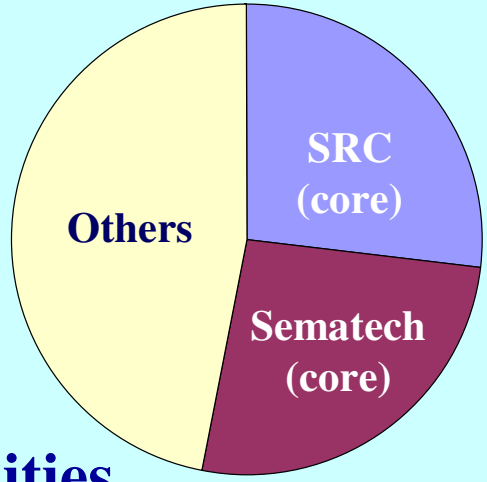
Semiconductor Industry Sustainability Model



Method of Approach

- Focus on manufacturing needs, technology gaps, and potential gains
- Fundamental research followed by tech transfer and move towards commercial application of results
- Creating synergy and partnership with industry in both funding and conduct of research

Partnership in Funding



- SRC (core)
- Sematech/ISMI (core)
- Other industrial members
- Customized projects
- Cost sharing by participating universities
- Grants from Federal and State agencies
- Gifts and donations (Planarization Chair by Fujimi; Simon Karecki and Ella Philipossian endowment, WSP and TRIF Fellowships, etc.)

➢ **Funding Leverage: $1 of Sematech is leveraged with >$3 from elsewhere (cost effective and unique)**

Success in creating research leverage for S/C industry

Partnership in Conducting Research

Industry Members Role and Benefits

- Representation on the Industrial Advisory Board (IAB)
- Project selection and review
- Special IP and licensing privileges and rights
- Access to patents and pre-publication research results
- Some free consulting services to ISMI member companies
- Reduced overhead
- Customized projects
- Access to state-of-the-art research facilities in top universities (specialized labs in 13 academic disciplines)
- Opportunities for assignees from industry

Current ERC Research Projects

- **Two types of projects:**
  - **15 *core projects* (funded by the core SRC/Sematech contract and some membership funds)**
  - **14 *customized projects* (non-core funding)**
- **Core projects are selected through RFP process, proposals, and review/selection by a panel appointed by Sematech and SRC.**
- **Customized projects are added throughout the year. Review and selection procedures are set by the ERC and the sponsors.**

New Core Project in (2009 – 2012 Cycle)

- **Development of Quantitative Structure-Activity Relationship for Prediction of Biological Effects of Nanoparticles Associated with Semiconductor Industries**
  PIs: Yongsheng Chen, Trevor Thornton, Jonathan Posner (Arizona State U)

- **Environmental Safety and Health (ESH) Impacts of Emerging Nanoparticles and Byproducts from Semiconductor Manufacturing**
  PIs: Jim Field, Reyes Sierra, Scott Boitano, Farhang Shadman (U of Arizona); Buddy Ratner (U of Washington)

- **Low-ESH-impact Gate Stack Fabrication by Selective Surface Chemistry**
  PI: Anthony Muscat (U of Arizona)

- **Predicting, Testing, and Neutralizing Nanoparticle Toxicity**
  PIs: Steven Nielsen, Rockford Draper, Paul Pantano, Inga Musselman, Gregg Dierkmann, (U of Texas- Dallas); Ara Philipossian (U of Arizona)

New Core Project in (2009 – 2012 Cycle)

- **Lowering the Environmental Impact of High-k and Metal Gate-Stack Surface Preparation Processes**
  PIs: Yoshio Nishi (Stanford); Srini Raghavan, Farhang Shadman (U of Arizona); Bert Vermeire (Arizona State U)

- **Sugar-Based Photoacid Generators (Sweet PAGs): Environmentally Friendly Materials for Next Generation Photolithography**
  PIs: Christopher Ober (Cornell); Reyes Sierra (U of Arizona)

- **Carbon Dioxide Compatible Additives: Design, Synthesis, and Application of an Environmentally Friendly Development Process to Next Generation Lithography**
  PIs: Christopher Ober (Cornell); Juan de Pablo (U of Wisconsin)

- **Fundamentals of Advanced Planarization: Pad Micro-Texture, Pad Conditioning, Slurry Flow, and Retaining Ring Geometry**
  PIs: Ara Philipossian (U of Arizona); Duane Boning (MIT)

New Core Project in (2009 – 2012 Cycle)

- **High-Dose Implant Resist Stripping (HDIS): Alternatives to ASH/Strip Method**
  PI: Srini Raghavan (U of Arizona)

- **Improvement of ESH Impact of Back-End-of-Line (BEOL) Cleaning Formulations Using Ionic Liquids to Replace Traditional Solvents**
  PI: Srini Raghavan (U of Arizona)

- **Computational Models and High-Throughput Cellular-Based Toxicity Assays for Predictive Nanotoxicology**
  PIs: Alex Tropsha, Russell Mumper (U of North Carolina)

Customized Projects in 2008-2009

- **Nano-Manufacturing of S/C Devices by Biologically-Inspired Processes**
  Muscat, McEvoy, Mansuripur (UA)
  Co-sponsored by Science Foundation Arizona, ASM, SEZ, Arizona TRIF
- **Electro-Coagulation Applied to Water Conservation & Wastewater Treatment**
  Baygents, Farrell (UA)
  Co-sponsored by WSP and Intel
- **Effect of Polisher Kinematics in Reducing Average Shear Force and Increasing Removal Rate in Copper CMP**
  Philipossian (UA), Boning (MIT)
  Sponsored by Hitachi Chemical
- **Impact of Fluoride and Copper in Wastewater on Publicly-Owned Treatment Works**
  Sierra (UA)
  Sponsored by Sematech
- **A Survey of Water Use, Reuse, and Policies Affecting Semiconductor Industry in Semi-Arid Areas**
  Megdal (WRRC)
  Sponsored by Arizona TRIF Initiative

Customized Projects in 2008-2009

- **Reducing Water and Chemical Usage in Large Wafer (450mm) Single-Wafer Processing Tools**
  Vermeire (ASU)
  Sponsored by EMC
- **EHS Assessment of Chelators and Biocides Utilized in Semiconductor Manufacturing**
  Sierra (UA)
  Sponsored by Sematech
- **Low-Energy-Hybrid Technology for Ultra-Purification and Recycling of Water**
  Shadman (UA)
  Sponsored by ERC, Pall Corp, and Arizona TRIF Initiative
- **Fate of CMP Nano-Particles in Typical Wastewater Treatment Systems**
  Sierra (UA)
  Suggested by ISMI; jointly planned and initiated by ISMI/ERC

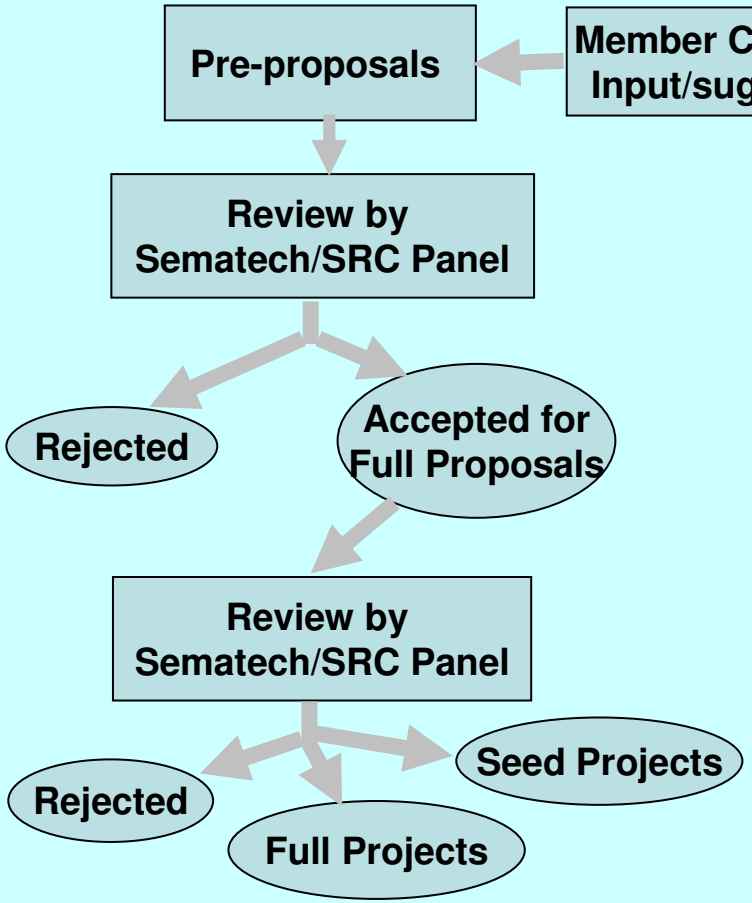
Customized Program on: High-Volume Nano-Manufacturing (HVnM)

Initiated and Currently Sponsored by Intel

- **Lowering Slurry Use and Waste in CMP Processes: Investigation of the Relationship between Planarization & Pad Surface Micro-Topography; *Philipossian***
- **Lowering Waste in CMP Processes: Retaining Ring and Conditioner Interactions; *Philipossian***
- **Contamination Control in Gas Distribution Systems of Semiconductor Fabs; *Shadman***
- **Develop an AFM-Based Methodology to Optimize APM Composition for Removing Particles from Surfaces; *Raghavan***
- **Integrated Electrochemical Treatment of CMP Waste Streams for Water Reclaim and Conservation; *Baygents, Farrell***

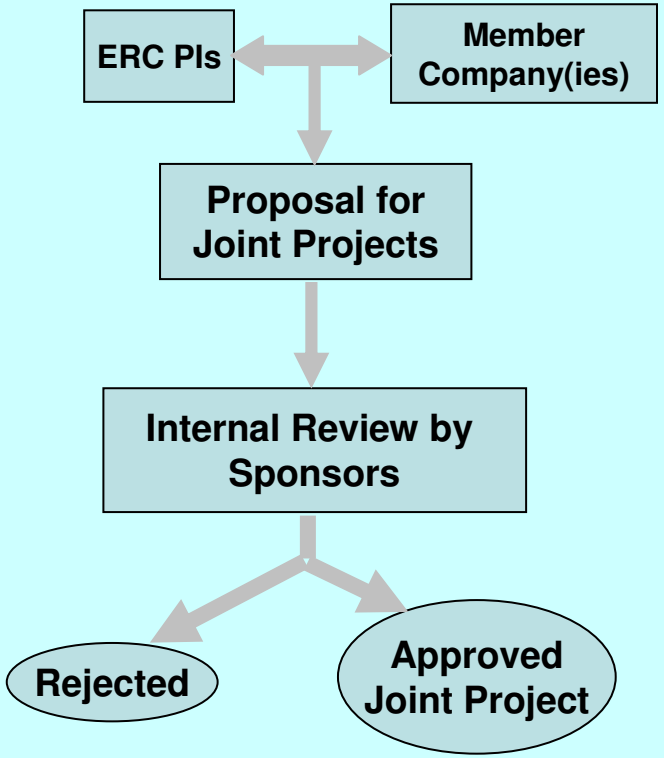
New Projects Selection

Core Projects (funded by Sematech/SRC)



Planning cycle: 3 years
11 new projects selected for 2009-2012
1-2 new projects every year

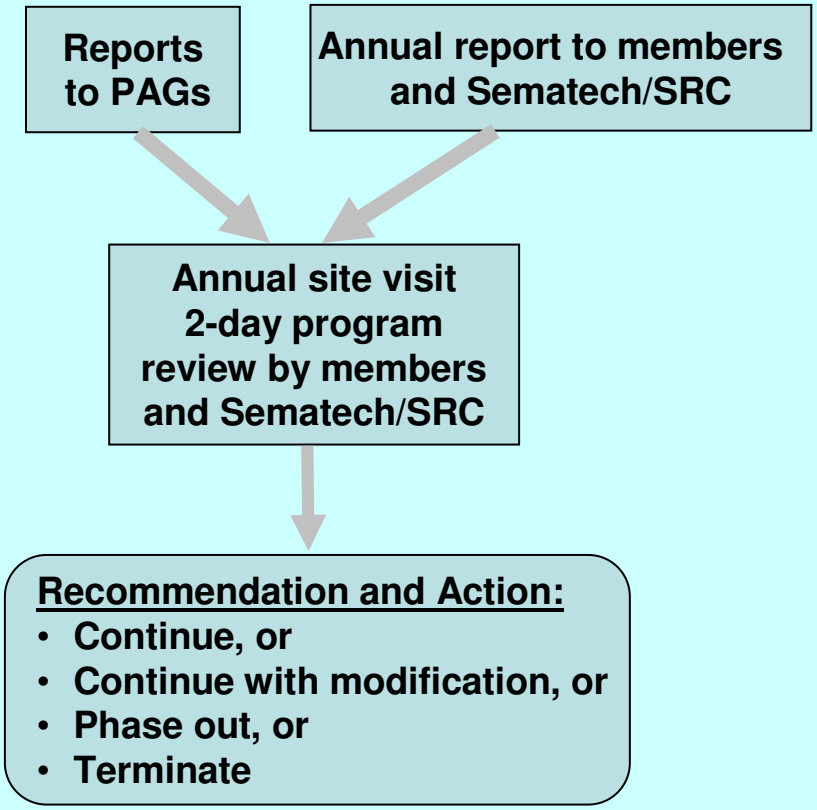
Customized Projects (funded by one or a group of member companies)



Start time and duration: flexible and customized

Projects Review

Annual Evaluation of All Projects



On-going Industry Involvement, Evaluation, and Monitoring

- Industrial Advisory Board and Executive Advisory Boards
- Sematech and SRC task-forces and PAGs
- Industrial liaison, mentors, and assignees
- Company visits and presentations
- Bi-weekly teleseminar series