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 - )
- 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

Performance
Obstacles

Cost

Area of Triangle = Manufacturing Burden to be minimized

Upper Level Constraint

ESH Impact
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 Kareck 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
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)

  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)

- Pre-proposals
  - Member Companies Input/suggestions
  - Review by Sematech/SRC Panel
    - Accepted for Full Proposals
    - Rejected
    - Full Projects
      - Seed Projects
      - Rejected
      - Rejected

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

- Proposal for Joint Projects
  - Internal Review by Sponsors
    - Approved Joint Project
    - Rejected
  - ERC PIs
    - Member Company(ies)

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

Start time and duration: flexible and customized

Member Company(ies)

Approved Joint Project

Rejected

Full Projects

Seed Projects

Accepted for Full Proposals

Rejected

Review by Sematech/SRC Panel

Review by Sematech/SRC Panel

Pre-proposals
Projects Review

Annual Evaluation of All Projects

- Reports to PAGs
- Annual report to members and Sematech/SRC
- Annual site visit
  2-day program review by members and Sematech/SRC

Recommendation and Action:
- Continue, or
- Continue with modification, or
- Phase out, or
- Terminate

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