Welcome to the 16th Annual Meeting of the *SRC/Sematech*

Engineering Research Center for Environmentally Benign Semiconductor Manufacturing

March 20-22, 2012

ERC: A Pioneer in University-Industry Collaborative Research on the ESH Aspects of SC Manufacturing

Founding Universities (1996)

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

16 years of Experience

Other University members

- Arizona State U (1998 -)
- Columbia (2006 - 2009)
- Cornell (1998 -)
- Georgia Inst. of Tech. (2009 -)
- U Maryland (1999-2003)
- U Massachusetts (2006 - 2009)
- U North Carolina (2009 -)
- Purdue (2003 - 2008)
- U Texas - Dallas (2009 -)
- Tufts (2005 - 2008)
- U Washington (2008-)
- U Wisconsin (2009-)
- UCLA (2011 -)
- North Carolina A&T (2012 -)
- Johns Hopkins (2012 -)
- Colorado School of Mines (2012 -)

Welcome to
The New University Partners

- Colorado School of Mines
- Johns Hopkins University
- North Carolina State A&T
- UCLA
- U North Carolina/Greensboro

Sources of Funding

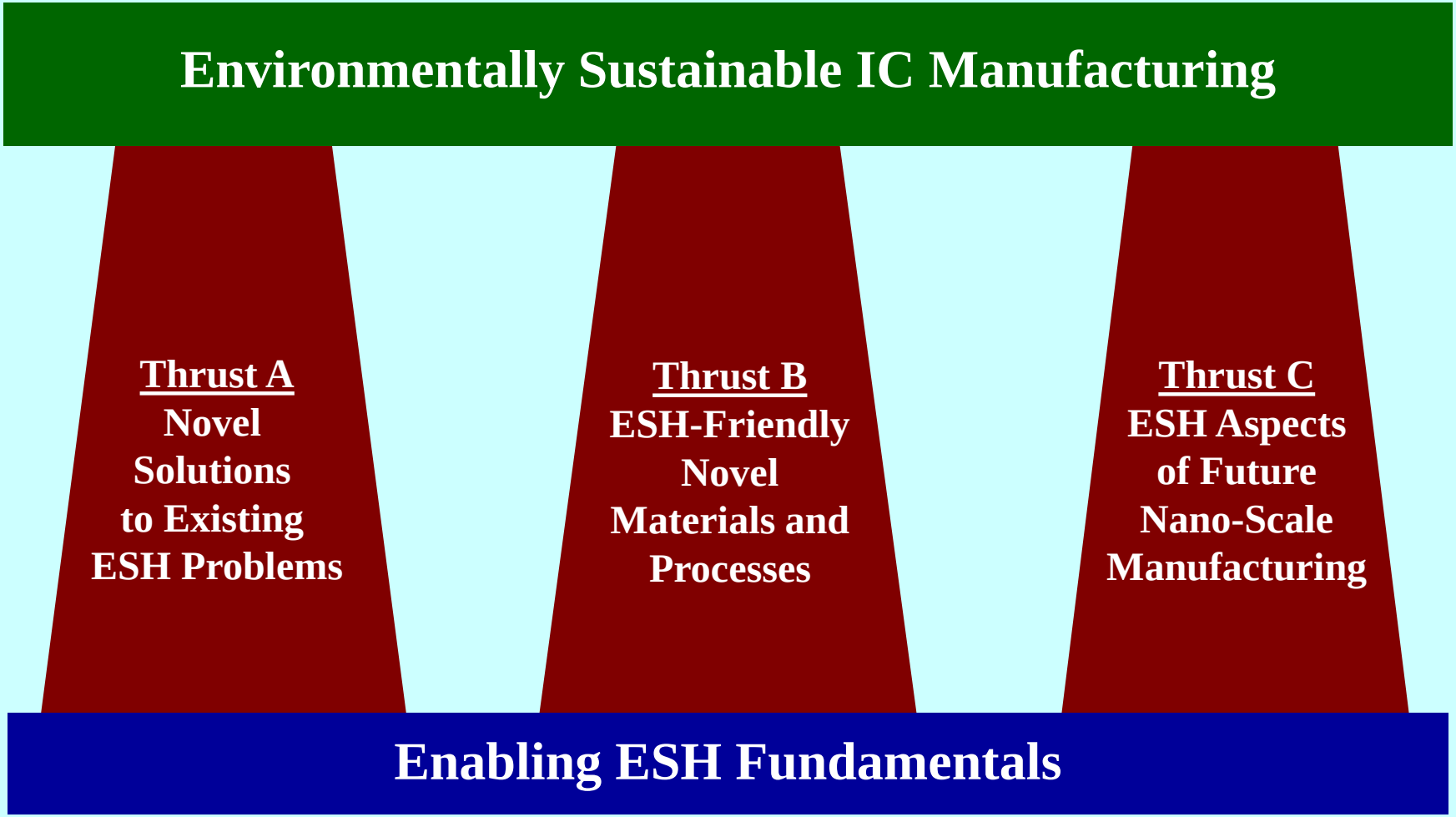
- **SRC (core)**
- **Sematech (core)**
- **Industrial members (membership)**
- **Customized projects (including Intel/ERC new HVnM initiative, Sematech and SRC customized projects, etc)**
- **Cost sharing by participating universities**
- **Grants from Federal and State agencies (NSF, SFAz, WSP, etc.)**
- **Donations (Koshiyama Planarization Chair by Fujimi; Simon Karecki memorial Endowment; Ella Philipossian memorial endowment, etc.)**

Success in creating research leverage for S/C industry

Types of ERC Research Projects

- **Two types of projects:**
  - ***Core projects*** **(mainly funded by the core ERC contract; cost shared by other ERC funds)**
  - ***Customized projects*** **(non-core funding)**
- **Core projects were selected through RFP process, proposals, and review/selection by a panel appointed by SRC.**
- **Customized projects are added throughout the year. Review and selection procedures are set by the ERC and the sponsors.**

ERC Thrust Areas



Core Project in (2009 – 2012)

A) ESH Challenges of Existing Processes (4 Universities)

- **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)

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

Core Project in (2009 – 2012)

B) ESH-Friendly Novel Materials and Process (3 Universities)

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

- **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)

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

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

Core Project in (2009 – 2012)

C) ESH Aspects of Nano-Materials (6 Universities)

- **Development of Quantitative Structure-Activity Relationship for Prediction of Biological Effects of Nanoparticles Associated with Semiconductor Industries**
  PIs: Yongsheng Chen (Georgia Inst. of Technology), 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)

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

- **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 Projects (2012- 2015)

A) ESH Challenges of Existing Processes

- **ESH-Friendly Cleaning and Rinsing of Multi-Material Surfaces and Structures:** *Srini Raghavan, Manish Keswani, and Farhang Shadman (U Arizona)*

- **Cell-based Toxicity Assay-on-Chip for the Next-Generation CMOS Technology:** *Shyam Aravamudhan and Shanthi Iyer (North Carolina State A&T); Adam Hall and Ethan Taylor (U North Carolina/Greensboro)*

New Projects (2012- 2015)

B) ESH-Friendly Novel Materials and Process

- **Non-PFC Plasma Chemistries for Patterning Complex Materials and Structures:** *Jane Chang (UCLA)*

- **Pad-in-a-Bottle: Planarization with Slurries Containing Suspended Polyurethane Beads:** *Ara Philipossian (UA) and Duane Boning (MIT)*

New Projects (2012 - 2015)

C) ESH Aspects of Nano-Materials

- **Interactions of Chemical Mechanical Planarization Nanoparticles with Model Cell Membranes: Implications for Nanoparticle Toxicity:** *Kai Loon Chen (Johns Hopkins)*

- **Dispersion, Bioaccumulation, and Mechanisms of Nanoparticle (NP) Toxicity:** *Steven Nielsen, Rockford Draper, Paul Pantano, Inga Musselman, and Gregg Dieckmann (U Texas/Dallas)*

- **Computer-Aided Design of Nanomaterials with the Desired Bioactivity and Safety Profiles:** *Alex Tropsha, and Denis Fourches (U North Carolian/Chapel Hill)*

- **Detection of Engineered Nanomaterials at Semi-Conductor Facilities and Consumer Products:** *Paul Westerhoff and Pierre Herckes (Arizona State U); Jonathan Posner (U. Washington); James Ranville, and Chris Higgins (Colorado School of Mines)*

New Faculty Co-PIs

- **Arizona State University**
  - ***Paul Westerhoff*** *(Civil and Environmental Engineering)*
  - ***Pierre Herckes*** *(Chemistry and Biochemistry)*
- **Colorado School of Mines**
  - ***Chris Higgins*** *(Environmental Science and Engineering)*
  - ***James Ranville*** *(Chemistry and Geochemistry)*
- **Johns Hopkins University**
  - ***Kai Loon Chen*** *(Geography and Environmental Engineering)*
- **North Carolina State A&T**
  - ***Shyam Aravamudhan*** *(Nanoscience and Nanoengineering)*
  - ***Shanthi Iyer*** *(Electrical and Computer Engineering)*
- **University of California/ Los Angeles**
  - ***Jane Chang*** *(Chemical Engineering)*
- **University of North Carolina/Greensboro**
  - ***Adam Hall*** *(Nanosciences)*
  - ***Ethan Taylor*** *(Chemistry and Biochemistry)*
- **University of Washington**
  - ***Jonathan Posner*** *(Mechanical Engineering, Chemical Engineering)*

AGENDA

2012 SRC/SEMATECH ERC REVIEW MEETING

Wednesday, March 21st

7:00 – 7:45 AM	**Continental Breakfast and Registration *[Pima/Sabino Foyer]***
7:30 – 7:50 AM	**TAB/PAG Caucus *[Ventana Room]***
7:50 – 8:15 AM	***Introduction and Overview*: Farhang Shadman *[Pima/Sabino]***
8:15 – 8:35 AM	***Improvement of ESH Impact of Back End of Line (BEOL) Cleaning Formulations Using Ionic Liquids to Replace Traditional Solvents (425.034)*** **Srini Raghavan (UA)**
8:35 – 8:55 AM	***Development of an All-Wet Benign Process Based on Catalyzed Hydrogen Peroxide (CHP) Chemical System for Stripping of Implanted State-of-the-Art Deep UV Resists (425.033)*** **Srini Raghavan (UA)**
8:55 – 9:35 AM	***Fundamentals of Advanced Planarization: Pad Micro-Texture, Pad Conditioning, Slurry Flow, and Retaining Ring Geometry (425.032)*** **Ara Philipossian (UA); Duane Boning (MIT)**
9:35 – 9:50 AM	**Break *[Pima/SabinoFoyer]***

9:50 – 10:15 AM	***Supercritical Carbon Dioxide Compatible Additives: Design, Synthesis, and Application of an Environmentally Friendly Development Process to Next Generation Lithography (425.030 and 425.031)*** **Chris Ober (Cornell); Juan dePablo (U. Wisconsin)**
10:15 – 10:40 AM	***Sugar-Based Photoacid Generators (Sweet PAGs): Environmentally Friendly Materials for Next Generation Photolithography (425.029)*** **Chris Ober (Cornell); Reyes Sierra (UA)**
10:40 – 11:00 AM	***Low-ESH-Impact Gate Stack Fabrication by Selective Surface Chemistry (425.026)*** **Anthony Muscat (UA)**
11:00 – 11:30 AM	*** *Introduction: Projects on ESH Aspects of Nano-Materials*, Jim Field (UA)** ***Environmental Safety and Health (ESH) Impacts of Emerging Nanoparticles and Byproducts from Semiconductor Manufacturing* (425.023 and 425.024)** **Jim Field, Scott Boitano, Reyes Sierra, Farhang Shadman (UA); Buddy Ratner (U. Washington)**
11:30 AM –1:00PM	**Lunch *[Canyon Rooms]***
1:00 – 1:25 PM	***Development of Quantitative Structure-Activity Relationship for Prediction of Biological Effects of Nanoparticles Associated with Semiconductor Industries (425.025)*** **Yongsheng Chen (Georgia Tech); Jonathan Posner, Trevor Thornton (ASU)**

1:25 – 1:50 PM	***Predicting, Testing, and Neutralizing Nanoparticle Toxicity (425.027)*** **Steven Nielsen, Rockford Draper, Paul Pantano, Inga Musselman, Gregg Dieckmann (UT-Dallas)**
1:50 – 2:15 PM	***High-Throughput Cellular-Based Toxicity Assays for Manufactured Nanoparticles and Nanostructure-Toxicity Relationship Models (425.035)*** **Alex Tropsha (UNC-Chapel Hill)**
2:15 – 2:30 PM	****Summary of Results and Conclusions of Four Nano-Tox Projects*** **Jim Field (UA)**
2:30 – 2:40 PM	**Break** ***[Pima/Sabino Foyer]***
2:40 – 2:55 PM	***Lowering the Environmental Impact of High-k and Metal Gate-Stack Surface Preparation Processes (425.028)*** **Yoshio Nishi (Stanford); Srini Raghavan, Farhang Shadman (UA); Bert Vermeire (ASU)**
2:55 – 3:15 PM	**Customized Projects** ***Novel Methods for Reducing UHP Gas Usage in Fabs: Back Diffusion Minimization*** **Roy Dittler (UA)** ***Other Customized Projects***
3:15 – 3:30 PM	**General Discussion**

3:30 – 3:45 PM	**Simon Karecki Award Presentation**
3:45 – Open	**Poster Session *[Madera Room]***
4:30 – 5:15 PM	**SRC Student/Industry Networking Event *[Madera/Pima Rooms]***
4:30 – Open	**Hors d'oeuvres *[Madera/Pima Rooms]***
5:00 – Open	**Cash bar *[Madera/Pima Rooms]***
5:15 – 7:45 PM	**TAB/PAG Caucus w/ working dinner *[Sabino Room]***
5:30 – Open	**Buffet Dinner *[Canyon Foyer & Canyon Rooms]***
7:00 – Open	**Special HVnM Planning Meeting *[Ventana Room]***
7:00 – Open	**Meetings of Research Groups *[Canyon Rooms]***

Thursday, March 22nd

6:30 – 7:30 AM	**Continental Breakfast *[Pima/Sabino Foyer]***
7:30 – 7:35 AM	**Dean's Message: Jeff Goldberg, Dean of Engineering, UA**
7:35 – 7:50 AM	**Update on new proposals and initiatives** ***Intel/ERC High-Volume Nano-Manufacturing Initiative*** ***Other Initiatives***
7:50 – 10:00 AM	**Presentation of New Projects:**
7:50 – 8:00	**425.037: *Cell-based Toxicity Assay-on-Chip for the Next-Generation CMOS Technology* -- Shyam Aravamudhan, Shanthi Iyer (NC A&T); Adam Hall, Ethan Taylor (UNC/Greensboro)**
8:00 – 8:20	**425.038: *Non-PFC Plasma Chemistries for Patterning Complex Materials and Structures* -- Jane Chang (UCLA)**
8:20 – 8:30	**425.039: *'Pad-in-a-Bottle': Planarization with Slurries Containing Suspended Polyurethane Beads* -- Ara Philipossian (UA); Duane Boning, MIT)**
8:30 – 8:40	**425.040: *Detection of Engineered Nanomaterials at Semi-Conductor Facilities and Consumer Products* (Paul Westerhoff, Pierre Herckes (ASU); Jonathan Posner (U.Washington); James Ranville, Chris Higgins (Colorado School of Mines)**
8:40 – 8:55 AM	**Break *[Pima/Sabino Foyer]***

8:55 – 9:05	**425.041: *Interactions of Chemical Mechanical Planarization Nanoparticles with Model Cell Membranes: Implications for Nanoparticle Toxicity* (Peng Yi, Kai Loon Chen (Johns Hopkins)**
9:05 – 9:15	**425.042: *Dispersion, Bioaccumulation, and Mechanisms of Nanoparticle (NP) Toxicity* (Steven Nielsen, Rockford Draper, Paul Pantano, Inga Musselman, Gregg Dieckmann (UT/Dallas)**
9:15 – 9:25	**425.043: *ESH-Friendly Cleaning and Rinsing of Multi-Material Surfaces and Structures* (Srini Raghavan, Farhang Shadman, Manish Keswani (UA)**
9:25 – 9:35	**425.044: Computer-Aided Design of Nanomaterials with the Desired Bioactivity and Safety Profiles (Alex Tropsha, Denis Fourches (UNC/Chapel Hill)**
9:35 – 10:00 AM	**Q/A and Comments on New Projects**
10:00 – 11:20 AM	**IAB Meeting *[Ventana]***
10:00 – 11:00 AM	**Meeting of Research Groups *[Canyon]***
11:00 – 11:20 AM	**ISMI Program on ESH (His-An Kwong, ISMI) *[Pima/Sabino]***
11:20 – 12:00 AM	**Feedback to PIs *[Pima/Sabino]***
12:00 – 2:00 PM	**Buffet Lunch *[Pima/Sabino Foyer & Canyon Rooms]***
12:30 – 2:00 PM	**Executive Advisory Board Meeting *[Board Room]***
2:00 PM	**Program End**