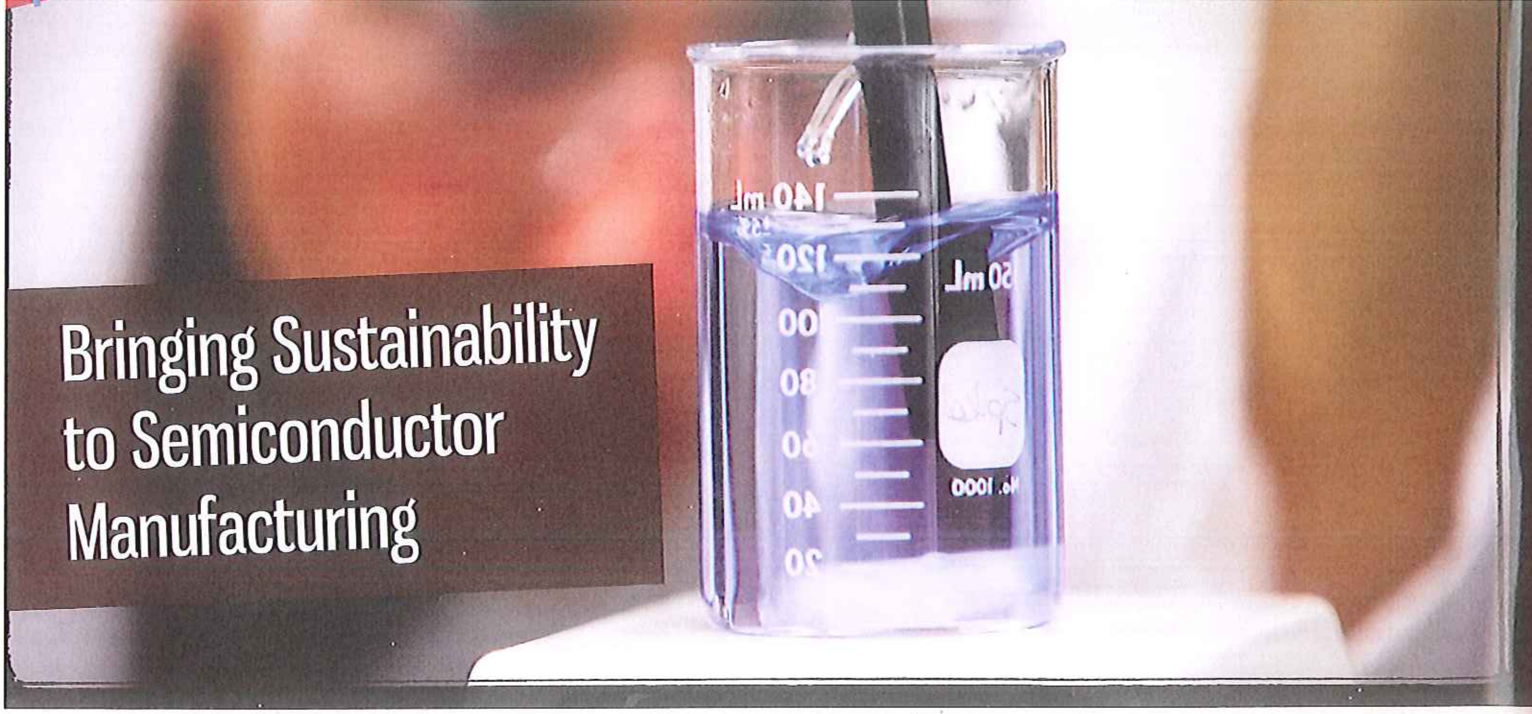


Bringing Sustainability to Semiconductor Manufacturing

For 18 years, the Engineering Research Center for Environmentally Benign Semiconductor Manufacturing has been finding safer, more efficient, cost-effective ways to improve semiconductor manufacturing.

Semiconductor plants are hungry.

Each day, a typical facility producing semiconductors on 6-inch wafers uses 240,000 kilowatt hours of electricity.

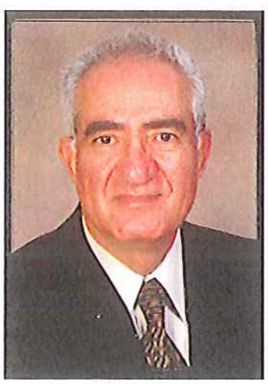
They're also thirsty.

Those 6-inch wafer plants consume more than 2 million gallons of water each day. Newer facilities that produce 8-inch and 12-inch wafers consume even more, with some daily estimates as high as 3 million gallons.

Then there's the waste problem. And clean doesn't come cheap.

Companies have responded to the hazards by closely monitoring chemical use, minimizing consumption, and developing recycling and reprocessing techniques. While many of the chemicals used in semiconductor production aren't expensive, keeping them ultraclean is.

At the UA an interdisciplinary team of researchers has for the last 18 years been working with colleagues at other universities to improve semiconductor manufacturing. They're part of the Engineering Research Center for Environmentally Benign Semiconductor Manufacturing, or ERC, which is focused on developing safe, sustainable materials and processes for semiconductor manufacturing and studying nano-scale manufacturing.



"New materials bring with them new environmental, safety and health issues. And these new materials need to be studied."

Farhang Shadman, Regents' Professor in chemical and environmental engineering and ERC founding director

Farhang Shadman, UA Regents' Professor in chemical and environmental engineering, is the ERC's founding director. Since its inception in 1996, the ERC's work has involved 21 universities, 241 doctoral and master's students, 216 undergraduate students, 13 academic disciplines, and 35 industrial members. More than 80 percent of ERC graduates have joined semiconductor-related companies.

Mission Accomplished: Successful Industrial Collaboration and Tech Transfer

A decade ago, no one would have predicted the popularity of mobile tablets. That's because they weren't available then.

Likewise, the smartphone. Ten years ago, mobile phones were for making calls and little else.

Both of these semiconductor-intensive devices point to one of the opportunities – and challenges – facing the industry. It's fast-moving, and the pace of innovation shows no signs of slowing.

That's why the ERC balances high-risk, high-payoff projects with smaller efforts that have more immediate applications. The center aims to get its research into commercial use as quickly as possible.

For example, since its founding, ERC has been working on perfluoro compound

ERC Universities

Founders
University of Arizona
Massachusetts Institute of Technology
University of California, Berkeley
Stanford University

Members

Current
Arizona State University
University of Washington
University of North Carolina, Chapel Hill
University of Texas, Dallas
University of California, Los Angeles
North Carolina A&T State University
Johns Hopkins University
Colorado School of Mines
University of North Carolina, Greensboro

Past
Cornell University
University of Maryland
Purdue University
Tufts University
University of Massachusetts
Columbia University
Georgia Institute of Technology
University of Wisconsin

Member Companies

Air Products and Chemicals Inc.
ASM America Inc.
Cabot Microelectronics Corp.
Entegris Inc.
Freescale Semiconductor Inc.
General Tool Co.
GLOBALFOUNDRIES Inc.
Hewlett-Packard Development Co.
Hitachi Chemical Co. Ltd.
IBM Corp.
Infineon Technologies
INOAC USA Inc.
Intel Corp.
Matheson
Morgan Technical Ceramics
National Institute of Standards and Technology
Novellus Systems Inc.
Pall Corp.
Samsung Electronics Co. Ltd.
Texas Instruments Inc.
Tokyo Electron

Engineering's ERC Researchers

Jim Field, chair of chemical and environmental engineering, evaluates the environmental fate and toxicity of nanoparticles during biological wastewater treatment.

Manish Keswani, materials science and engineering, researches and develops novel wet cleaning systems for both front and back ends of the line processing in semiconductor fabrication.

Ara Philipossian, chemical and environmental engineering, studies the environmental aspects of planarization (surface smoothing) with a focus on slurry, pad, water and chemical use reduction. Philipossian holds the Koshiyama Chair of Planarization and is co-founder, president and CEO of Araca Inc., which provides services and equipment to the polishing and planarization industry.

Srini Raghavan, materials science and engineering, develops environmentally benign methods for wet chemical processing in semiconductor manufacturing.

Farhang Shadman, chemical and environmental engineering, studies surface contamination during semiconductor processing using experimental methods and process modeling.

Reyes Sierra, chemical and environmental engineering, investigates and develops processes that rely on microorganisms for hazardous contaminants treatment.

alternatives, and several chemistries developed in the program have been adopted by industry. Additionally, the transfer of UA-developed reactive filter technology to the Pall Corp. led to the commercialization of the Pall part per trillion filter-purifier only three years after research began. ERC research has created new businesses as well. The Environmental Metrology Corp. arose out of water use reduction technology that was developed and patented by ERC. The company's Electro-Chemical Residue Sensor was a Semiconductor International Editors' Choice Best Product Award Winner in 2009. And the GVD Corp. was formed to commercialize low-energy solvent-free deposition technology. ERC research also led to the founding of Araca Inc., Cambridge Metrology Inc., Picogen Inc., and Praegasus Inc.

Silicon Valley Won't Have to Change Its Name – Yet

Back in 1965, Intel co-founder Gordon Moore said that the number of transistors on a silicon chip would double every two years. Time for an update.

The doubling period is closer to 18 months, and a limit will eventually be reached with silicon, Shadman said. Although silicon is still the main substrate in semiconductor manufacturing, new materials are coming to the fore, which makes the ERC's work even more important.

"New materials bring with them new environmental, safety and health issues," said Shadman. "And these new materials need to be studied."

Initially, ERC's funding came from the National Science Foundation. Nowadays, the center is supported primarily by industry.

That's highly unusual.

"NSF usually funds these centers for nine or 10 years, and very few centers survive past that point," said Shadman.

Not only has the ERC survived, it brings in about $4 million a year. Each dollar is leveraged with more than $1.70 from elsewhere. Some of ERC's private funding comes from its member and affiliate companies, ranging from semiconductor manufacturers to chemical and equipment suppliers.

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