SRC®

DRIVING *change.*
CREATING *opportunity.*

A MESSAGE *from the President*

CHANGE is the byword of our times. Advances in semiconductor technology continue to change the world — enabling new capabilities, new products, and new solutions to challenges facing humanity. These advances are at the core of the success of SRC member companies, which must constantly innovate and change in order to remain competitive. SRC plays a vital role in the discovery of future technologies fundamental to change — discoveries that benefit its members, the industry and, ultimately, the world.

2013 began a significant transition for SRC … existing programs were substantially revitalized and new programs were initiated.

For instance, Global Research Collaboration provided the framework for two new research thrusts. Semiconductor Synthetic Biology (SemiSynBio) seeks to translate the secrets of living cells — their energy efficiency, computational capability, and manufacturing prowess — to advance semiconductor technologies. Also new in 2013 was Trustworthy and Secure Semiconductors and Systems (T3S), aimed at research on strategies, techniques and tools for the design and manufacture of chips and systems that are assured, trustworthy, secure, and resistant to attack or counterfeiting.

The STARnet program, co-funded with DARPA, kicked off six multi-disciplinary, multi-university centers that are researching smart integrated sensor networks, application-driven architectures leveraging emerging technologies for connections and memory, and radical alternatives for computing inspired by neural networks and information theory. In collaboration with NSF and NIST, the Nanoelectronics Research Initiative entered a new phase of exploratory research seeking novel device concepts with the potential to take computing beyond the limits of current technology. Many of the device concepts are based on collective properties of materials such as magnetoelectricity, ferroelectricity, piezoelectricity, and spin dynamics — properties that have never before been exploited in digital electronics.

In 2013 SRC has begun to pivot toward a new set of research challenges. In the coming year, we will be making more changes to ensure that the consortium continues to provide high value that attracts and retains a diverse membership. The SRC community of member companies, university faculty and students, and government agencies is well positioned to fuel vital industry change through the production of valuable research results and the graduation of outstanding students. Opportunity awaits and we look forward to the future.

LARRY SUMNEY, *President & CEO*

STUDENT *Programs*

Attracting and educating students of science and engineering through use-inspired research and industry connections, promoting their transition into careers that make a difference.

GRADUATE STUDENTS

2326
students on record

186
PhDs completed

1719
résumés

URO

99%
retention

67%
female & under-represented minorities

41%
continuing to graduate school

In 2013 SRC's comprehensive student programs touched the lives of over 2300 students, including undergraduates, Master's, PhD and post-doctoral candidates. Contributing new approaches and innovative thinking to semiconductor research, our students help drive the industry forward through the financial support and resources provided by the SRC Education Alliance and Student Relations programs. Over the past year, our Student Relations team has focused on partnering more closely with member-company workforce representatives, tailoring the approach to maximize each company's engagement with SRC. As always, we remain committed to assisting our members in identifying, educating and recruiting tomorrow's leaders.

With a variety of scholarship and research support programs, SRC has prepared over 10,000 students for scientific careers through exposure to a meaningful network of professors, industry professionals, and like-minded students. These types of relationships help propel SRC-sponsored students ahead, while simultaneously making great impact on the industry and SRC members. Through our **Master's Scholar and Graduate Fellowship Programs**, students are engaged at a high level of research innovation — a level that will impact the semiconductor industry today, tomorrow and for years to come.

Undergraduate students also make a profound impact on SRC and the ongoing pipeline of talent through our **Undergraduate Research Opportunities Program (URO)**. These students benefit from hands-on research and mentoring, assistance in applying to graduate programs, and opportunities for internship at the nation's top corporations. Each individual receives careful attention in a learning community that encourages them to pursue further degrees and careers in related fields.

TECHCON 2013: The 15th Annual TECHCON, SRC's annual technical conference, was held in Austin, Texas in September. Engaging SRC students beyond their classroom and laboratory experiences, TECHCON is an opportunity for students to present research at a national level. Within this collaborative environment, students also learn about cutting-edge research at other universities, meet graduate students from a variety of universities, and to engage with industry leaders who can provide insight on career options. To the 438 in attendance, TECHCON 2013 successfully showcased the quality of the SRC research portfolio, as well as the excellence of SRC students and faculty.

GLOBAL RESEARCH *Collaboration*

Global Research Collaboration (GRC) programs address the most critical challenges for the semiconductor industry, delivering the solutions that drive the industry's growth. And with the ever-changing nature of the industry, our program emphasis has responded accordingly during 2013. **GRC is currently undertaking new research directions to cover the evolving interest of our members, as well as to adapt to more targeted research directions, enhancing the relevance to both our current and future members.**

Although we are maintaining research focused on the current priorities of the semiconductor industry, including the continued scaling of semiconductor technologies and finding diverse applications for this technology, we have expanded our traditional research topics in 2013 into new application space and time horizon, increasing the breadth of our research portfolio. For example, **we've created a new thrust in Semiconductor Synthetic Biology (SemiSynBio). This university research that seeks to learn from living cells how to benefit semiconductor technologies, helping us make more energy efficient devices, determine better manufacturing techniques and improve architectural approaches to computational capability.**

Another new thrust is **Trustworthy and Secure Semiconductors and Systems (T3S). The goal of this thrust is to develop strategies and tools to design and manufacture chips and systems that are reliable, trustworthy, secure and resistant to attack or counterfeiting.** This exciting topic has an appeal beyond our current membership and paves a way for new membership and participation options. A cross-disciplinary topic, T3S is one of several possible new areas of research that involve multiple science fields. Research in **advanced connectivity** was also initiated in 2013 with the goal of investigating novel system architectures directly driving new interconnect functionality. This involves new conductor and dielectric materials, as well as novel circuit designs and microarchitectures, and requires a coordinated effort across multiple disciplines.

The Energy Research Initiative (ERI) program continues to fund research that will have broad benefits as the world strives to meet its future energy needs. **During 2013 ERI research emphasis shifted towards power electronics and the energy grid, with new projects targeting more effective aggregation of intermittent renewal energy resources through the use of microgrids.**

Because of these and other innovative directions, it is now possible for new companies to take part in GRC research where they couldn't do so previously. Within all GRC programs the operational model involves intense industry engagement in formulating, shaping and executing the research agenda, thereby ensuring that programs meet individual member company needs with high-leverage, compelling return-on-investment research. **By working together with these new partner companies to select areas of research needs and establish acceptable member engagements, we can create an attractive value proposition.**

Synergy among researchers and industry members is the cornerstone of GRC, and we are committed to provide novel ways for more companies and industries to benefit from the proven SRC model. **SRC WORKS ... AND GRC IS MAKING IT MORE ACCESSIBLE.**

STARnet

Do you remember FCRP Phase I, II, III, IV, V? What happened to Phase VI? It never happened. ***Something changed!***

In 2013, DARPA and the industry sponsors sunset the FCRP program and kicked off an entirely new program, aimed much farther out — beyond the limits of scaled CMOS. While we don't know exactly where those limits are, we can easily target beyond them. That's what was done to form the new STARnet program.

STARnet consists of three device centers exploring devices beyond CMOS: CSPIN, FAME and LEAST. Three additional centers, CFAR, SONIC and TerraSwarm, explore novel architectures and systems that will enable fully scaled CMOS to perform well beyond what is possible with today's architectures. They also invent new systems to complement the best devices coming out of CSPIN, FAME and LEAST.

STARnet completed its compressed first year in 2013 and delivered exciting results and breakthroughs. One example is that large-scale chemical vapor deposition synthesis has been realized for MoS_2, graphene, and suspended films of large numbers of MoS_2 and graphene layers. This method holds promise to become a reliable one that can be generically used for most van der Waals materials.

Another project on designing a CNFET-based sensor interface demonstrated that an entire capacitive sensor interface circuit can be realized using CNFETs exclusively. At the 2013 ISSCC, the largest to-date CNFET system was presented in a live demonstration of a handshaking robot. This work was recently honored with the 2013 ISSCC Jack Raper Award for Outstanding Technology-Directions Paper.

Dozens of breakthroughs can be reviewed in the STARnet quarterly and annual reports and publications. *Take a closer look to see what has changed!*

NANOELECTRONICS
Research Initiative

Since its inception in 2006, SRC's Nanoelectronics Research Initiative (NRI) has aimed to catalyze the biggest change in the history of the global semiconductor industry — the introduction of new devices that can take computing beyond the fundamental limitations of the field effect transistor.

In pursuit of this goal, the program itself continued to change and evolve in 2013. The year began with the selection of three new multi-university, multidisciplinary research centers, CNFD, SWAN and INDEX, co-funded with the National Institute of Science and Technology (NIST). Commencing operations on April 1, these centers were reporting striking research results well before the year's end. For example, CNFD demonstrated a ferroelectric tunnel junction with an on/off resistance ration greater than 1000 — a discovery of potentially great importance for both memory and logic. Both SWAN and INDEX reported advances in fabrication of device structures based on new two-dimensional (2D) materials which are currently of intense interest for fast, low-voltage logic.

The beginning of 2013 was also marked by the publication of rigorous device performance benchmarking results from previous the NRI program. Building on that achievement, benchmarking research was expanded from the NRI centers to include the three new STARnet centers (C-SPIN, FAME, and LEAST), which have joined the NRI centers in the quest for new devices for computing. This expansion roughly doubles the number of distinct device concepts under evaluation. The research was also expanded in technical scope in 2013, with the addition of benchmarks for important device attributes such as stand-by power and functionality for memory.

The NRI Annual Review concluded the year on a high note, with many compliments on the clear, well organized technical presentations, and clear evidence that the more exploratory projects co-funded with National Science Foundation (NSF) were successfully feeding the focused research centers in both NRI and STARnet.

SRC MEMBERSHIP

ABB, Inc., **ERI**

Advanced Micro Devices, Inc., **GRC**

Advanced Technology Investment Company (ATIC), **GRC**

Applied Materials, Inc., **GRC, STARnet, ERI**

First Solar, Inc., **ERI**

Freescale Semiconductor, Inc., **GRC**

GLOBALFOUNDRIES, **GRC, STARnet, NRI**

Hydro One, **ERI**

IBM Corporation, **GRC, STARnet, NRI, ERI**

Intel Corporation, **GRC, STARnet, NRI**

Mentor Graphics Corporation, **GRC**

Micron Technology, Inc., **STARnet, NRI**

NEC Corporation, **ERI**

Nexans, **ERI**

ON Semiconductor, **ERI**

Raytheon Company, **STARnet**

Research Triangle Institute, **GRC**

Robert Bosch, LLC, **ERI**

Texas Instruments, Inc., **GRC, STARnet, NRI**

Tokyo Electron Limited (TEL), **GRC, ERI**

United Technologies, **STARnet**

GOVERNMENT PARTICIPATION

Commonwealth of Virginia, **NRI**

DARPA, **STARnet**

NIST, **GRC, NRI**

NSF, **GRC, NRI**

Project Future — South Bend, Indiana, **NRI**

State of Arizona, **GRC**

State of California, **NRI**

State of Nebraska, **NRI**

State of New York, **GRC, NRI**

State of Texas, **GRC, NRI**

U.S. Air Force Research Laboratory, **STARnet**

Engineering & Physical Sciences Research Council, **GRC**

STRATEGIC PARTNERS

SEMATECH, **GRC**

SEMI, **GRC**

SIA, **GRC, STARnet, NRI**

MOSIS, **GRC**

www.src.org

2013 *Office of the Chief Executive*

LARRY W. SUMNEY
President & Chief Executive Officer

STEVEN HILLENIUS
Executive Vice President, SRC
Executive Director, GRC
Chief Operating Officer, ERI

WILLIAM JOYNER
Senior Director, CADTS

2013 *Board of Directors*

Chekib Akrout (2013 Chairman)
Advanced Micro Devices, Inc.

Om Nalamasu
Applied Materials, Inc.

Sami Issa
Advanced Technology Investment Company

Ken Hansen
Freescale Semiconductor, Inc.

Gregg Bartlett
GLOBALFOUNDRIES

T.C. Chen
IBM Corporation

Michael Mayberry
Intel Corporation

Walden C. Rhines
Mentor Graphics Corporation

James Gibson
Research Triangle Institute

Larry W. Sumney
Semiconductor Research Corporation

Venu Menon
Texas Instruments

Alex Oscilowski
Tokyo Electron Limited (TEL)

EX-OFFICIO

Dan Armbrust
SEMATECH

Brian Toohey
SIA

BOARD SECRETARY

W. Clark McFadden II
Orrick, Herrington & Sutcliffe, LLP