



**KHALIFA**  
SEMICONDUCTOR  
RESEARCH CENTER

Khalifa University  
Semiconductor Research Center  
**KSRC**

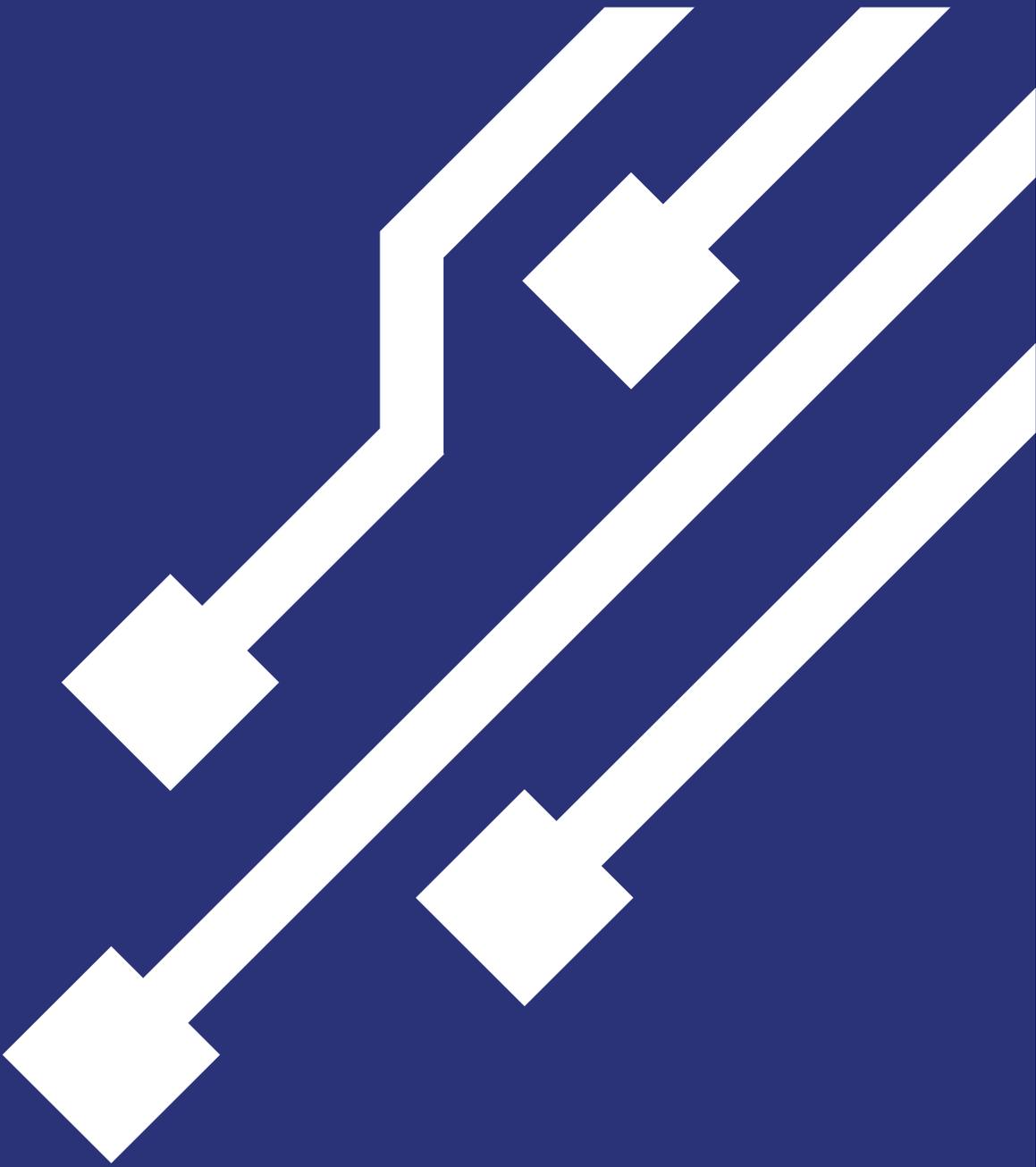


**KHALIFA**  
UNIVERSITY

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A Khalifa University  
**RESEARCH CENTER**

Nurturing tomorrow's leaders..  
Growing the knowledge economy.



# In 1965

Gordon E. Moore, co-founder of Intel Corporation, observed that, throughout the history of computing hardware, the number of transistors in a dense integrated circuit doubles approximately every two years. This observation became known as Moore's law. The Khalifa University Semiconductor Research Center (KSRC) was established with the aim of finding energy solutions that will extend and strengthen Moore's law allowing the UAE and the region to move into a post-Moore's law era of computing.

At KSRC we believe we are living in the age of transition from "only CMOS technology" (which is the technology underpinning current integrated circuits) to "augmented-CMOS" and beyond. KSRC aims to make critical country-wide and regional contributions that will take the UAE and KU into the family of nations and research institutes that actively contribute to the solution of these problems. While CMOS-based technologies enable iPads, mobile phones, and computers. It is the post-CMOS technologies that are needed to continue this path of improving people's life, health, and creative work.

KSRC is engaged in multidisciplinary research efforts to advance the state of semiconductor technology and propel the UAE into a knowledge-based economy via the development and commercialization of innovative electronic solutions. On the nano-science and nanotechnology front, KSRC members are conducting research on the physics of transistors and energetics of nano-contacts, which are the building blocks of modern electronic devices. This effort has resulted in significant reductions in transistor sizes and improvements in their speed and energy efficiency.

Furthermore, KSRC draws from the diverse research backgrounds of its members to develop electronic solutions for applications spanning biotechnology, telecommunications, power management, embedded computing architectures and the Internet of Things (IoT). KSRC members are also pursuing the design of intelligent algorithms to optimize the performance and energy-efficiency of large-scale computing systems to reduce the financial and environmental costs of their excessive energy consumption.

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## A WORD FROM THE PRESIDENT OF KHALIFA UNIVERSITY

Without a doubt, semiconductor technology is one of the most vital areas of scientific exploration in the world today. Semiconductor technology and high-speed transistors are found in almost every piece of technology on the market today, and the speed at which they are developing, getting smaller, faster, and more powerful - is virtually unmatched in any other area of technology.

This is why the Khalifa University Semiconductor Research Center is such an important asset to the UAE. It will act as a dedicated resource to the development and improvement of semi-conductor technology, and become a focal point for innovation in areas of key interest to the leadership of the UAE, and to the world. Certainly the innovation that is produced by KSRC will carry a lasting impact on technology worldwide.

KSRC embodies Khalifa University's strategic focus on research and development in areas that will impact the future development of the UAE as a diversified country producing top technologies and driving technological innovation. Khalifa University views itself as an incubator for human capital and invention, and KSRC is one of the ways in which we drive advancement.

**Dr. Tod Laursen,**  
President Khalifa University



## A MESSAGE FROM KSRC'S FOUNDING DIRECTOR

KSRC was established in 2011 as a world class multidisciplinary research center conducting R&D as part of the Abu Dhabi government's 2030 strategic vision to diversify the economy beyond oil and gas by investing heavily in areas such as semiconductors, biomedical, aerospace and nuclear technologies among others in relation to semiconductors, the government established Global Foundries (GF). KSRC is a key component of an eco-system that complements Global Foundries with a focus on creating a technology hub in the region, cultivating human capital trained in cutting edge technologies and creating innovation-based economic activities by spinning off companies, forging strategic partnerships as well as attracting direct local and foreign investments.

KSRC has faculty with diversified backgrounds and with years of experience at leading academic institutions in the USA, Canada, Australia and at semiconductor companies like Intel, Qualcomm, Synopsis, to name a few. Our faculty and students come from different departments across Khalifa University (ECE, Biomedical, Mechanical, Aerospace and applied Math and Sciences) and conduct truly multidisciplinary research spanning materials research, nanotechnology, nano-scale CMOS and beyond CMOS devices such as Graphene, SiC, Spintronics devices, self-powered circuits and minimum energy microsystems. The target applications range from wireless chip sets, biochips, integrated sensors, wearable devices to circuits and microsystems for ambient intelligence, safety and security and the Internet of Things.

As a leading world class center, KSRC partners with researchers at leading institutions in the region and the world such as the University of Waterloo (Canada), Stanford University, Ohio State University, RPI and Georgia Tech in the US, KTH in Sweden and AUC in Egypt. Our faculty also work closely with researchers at other UAE institutions such as Masdar, AUS, NY University and UAEU. Our current industrial partners include Global Foundries, Cadence, Mentor Graphics, Synopsis, Intel, Texas Instruments, IBM and Freescale.

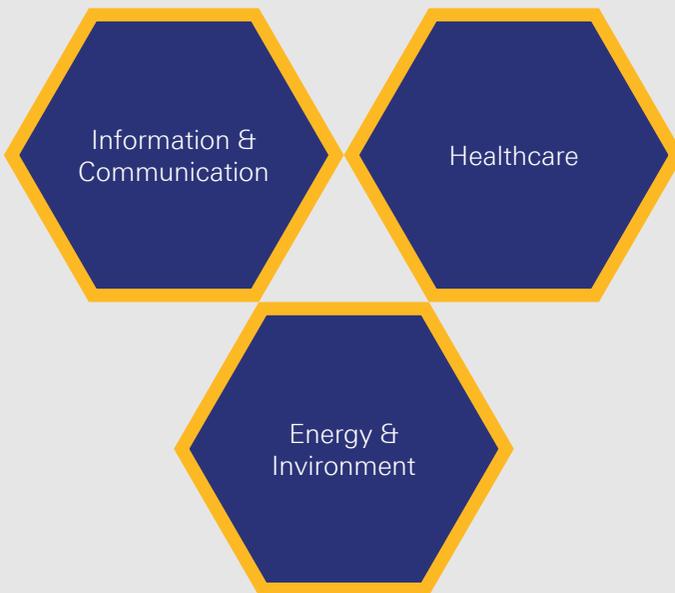
We are pleased to be contributing to the development of the knowledge and innovation economy, and look forward to working with our partners in academia, industry and the government.

**Dr. Mohammed Ismail Elnaggar,**  
Fellow IEEE  
Director, KSRC

## INTERDISCIPLINARY NATURE OF KSRC EFFORTS

By the nature of the research problems and methods addressed through KSRC, most of its members are faculty in Khalifa University's ECE Dept. However, researchers from several other departments are also involved in KSRC projects. From the Applied Math and Science Department side, these projects address fundamental aspects of micro- and nano-electronics devices design. These efforts intend to address the functionality of novel devices for information processing and storage, such as research and development of novel contacts shapes and geometries, as well as improved energy performance of memory devices. Another KU department with appreciable involvement in KSRC is the Biomedical Engineering Department, where some of the devices under development within ACE4S Center will be tested. For example, minimal energy wearable electronics for metabolism and health monitoring is a major research area for KSRC which addresses the healthcare needs of the UAE and the broader Gulf Region. One example of our recent research work is the development of a ground breaking patented technology for predicting ventricular arrhythmia. This technology is implemented in a system on chip (SoC) powered by harvesting the human thermal energy. as such the technology lends itself to a self-powered wearable device alerting patients of a heart attack hours before it begins, thus saving lives.

### Chip Photos



Among the five strategic research areas at Khalifa University, KSRC projects and principal investigators cover three

## ACE4S

KSRC is engaged in developing innovative applications for energy efficient systems on chip (SoC) as part of the newly established UAE SRC (Semiconductor Research Corp) Center of Excellence on Energy Efficient Electronic Systems , or ACE4S <http://www.src.org/program/grc/ace4s> led by Khalifa University in partnership with MASDAR Institute.

ACE4S involves researchers from 5 UAE Universities who are looking at developing new technologies aimed at innovative self-powered wireless sensing and monitoring techniques. The research targets applications in self powered chip sets for use in public health, ambient intelligence, safety and security and water quality. ACE4S is the first SRC center of excellence outside the USA. The effort involves over 50 researchers involved in 20 research tasks on energy harvesting, power management, wireless RF, Digital SoCs and sensing and monitoring technologies. Each task has one or more industrial liaisons from a leading semiconductor company such as Global Foundries, Intel, IBM, Texas Instruments, Mentor Graphics and Free scale.

Liaisons meet with our staff regularly to guide the research effort so that it is timely and relevant. As such our faculty and students benefit greatly from the direct interaction with top engineers and researchers from industry and learn firsthand the challenges in the innovation process which, when overcome, could lead to successful products in the market place.

The work lends itself naturally to self-powered systems on chip for the Internet of Things (IoT). Our future plans are to extend our work to IoT platforms, targeting applications in food security and safety, medicine inventory, logistics and supply chains and mobile hospitals, among others.

## Graduate Students and Research Associates

### Curtis J. O'Kelly

Is a materials scientist with expertise in nano-scale semiconductor physics and chemistry. His work focuses on developing next generation non-volatile memory for low power and neuro-morphic applications.

### Dima Kilani

Is a PhD student in the ECE Department whose expertise focuses on low-power mixed signal integrated circuit design for ultra-low power applications. Her main interest is in power delivery and Power Management Unit design, including DC-DC power converters targeting high power efficiency.

### Mohammad Alhawari

Is a PhD student in the ECE Department. He has expertise in chip design, from schematic, simulation to layout and verification. His PhD research focuses on high efficient DC-DC converters for energy harvesting applications.

### Yasmin Halawani

Is a PhD student in the ECE Department. Her research focuses on combining bio-inspired solutions with the power of memristor for neuromorphic architectures to gain a deeper understanding of biological phenomena.

### Kholoud Eledlebi

Is a PhD student in the ECE Department whose interest lies in low power nanoscale transistors and switches. She recently defended her MSc degree.

### Hoda Abdelsalam

Is a graduate research associate in the electronics field specifically in analog/RF circuits design track. She is now working on the analog front-end in the SoC For ECG signal processing.

### Ahmed Ali

Is an MSc student working on low power electron and ion emitters and related nanoscale surface science problems.

### Maisam Wahbah

Is a PhD student in the ECE Department. Her MSc results focused on harvesting kinetic energy from human body-based vibrations based on the piezo electric energy harvester. Maisam's research interests include designing integrated circuits, analog and mixed signals, low power circuit design, VLSI systems and applications.

### Temesghen Tekeste

Is a PhD student in the ECE Department with expertise in digital integrated circuit design, with the main role of designing ultra-low power digital circuits For Biomedical Applications. He has developed an ECG Processing System including model creation and preparation of the final tape out.

### Vikas Kumar

is a research associate with the ECE department at Khalifa University. His research interest includes nanotechnology, nano-science and micro and nano-fabrication. Currently, he is working on the memristors project (KURIF-L2) supervised by Dr. Baker.

### Yonatan Kifle

Is a research associate at the Khalifa University Semiconductor Research Center (KSRC). He is an expert in Analog and Mixed signal circuit design. He is currently involved in the SRC funded research for Self-Calibrating and Self-Adjusting RF amplitude detector for RF and mm Wave systems.

### Ilyas Farhat

Recently defended his MSc degree demonstrating how novel design of nano-patterned interfaces contributes to lower energy cost of operating MTJs for STT-MRAM. He also contributes to work on nano-contacts in Prof. Isakovic's group.

### Tamador Elboshra

Recently defended her MSc degree working on MEMS-based sensors for biological applications.

### Heba Abunahla

Is a PhD candidate whose main interest is in memristor devices. Her research focuses on building and verifying mathematical models for memristors. She is also working on fabricating and characterizing low power devices to be deployed in security applications.

## Our Alumni

Despite its recent start up, KSRC is proud to boast that several of its Bachelor of Science graduates have been admitted to, and are successfully pursuing, advanced research degrees at major institutions in North America and Europe. Among our students are, Zainab Moazzam, a Biomedical Engineering graduate, currently in the second year of her PhD in Neurobiological Engineering at the University of Toronto. Another Mechanical Engineering graduate, Mohammed Muneer, is currently pursuing a Ph D degree in Mechanical Engineering at Texas A&M University, and Noaf Salah, another Biomedical Engineering graduate, is currently in graduate training at EPFL in Lausanne, Switzerland. A number of our early graduates attend specialized post-BSc training at KAIST and other Korean and Far Eastern institutions.

We are especially proud of two students whose early undergraduate research training happened with our KSRC faculty. After receiving his initial research training from Prof. Sami Muhaidat on signal processing, Omar Ahmad Al Hussein, has graduated with a MSc in Applied Sciences in Engineering from Simon Fraser University and is now enrolled to start his PhD at the University of Waterloo.

Amina Belkadi worked in Prof. Isakovic Lab since her sophomore year, where she studied limitations to current nano- transport and nano-contacts models, and has recently defended her MSc this past spring at the University of Colorado at Boulder. She is now pursuing her PhD degree at the same university. It is a strategic goal of KSRC to continue the emphasis on human capital development and training of both undergraduate and graduate students in novel materials and devices, as well as, integrated circuits and systems technologies.

## Our Researchers



### Ahsan Khandoker

Is an Electrical Engineering Scientist working on biomedical applications. He is currently collaborating with Dr Hani Saleh on various projects in the area of assessing the severity of cardiac autonomic neuropathy in diabetic patients, non-invasive blood glucose monitoring and predicting ventricular arrhythmias by using Electrocardiogram Signal Processing techniques.



### Baker Mohammad

Is an ECE professional with over 16 years of industrial experience with world leading companies in the state of the art electronic system design. He is currently leading research in the following topics: Energy Harvesting and Power Management, Low Power Design, Memory Design and emerging memory/electronic technologies **RRAM/Memristor/STTRAM** and Embedded Systems.



### Hani Saleh

is an ECE professional with over 18 years of industrial experience with world leading companies in the state of the art electronic system design such as Apple, Intel, AMD, Qualcomm, Synopsys, and Motorola. His main areas of interest and expertise are: Biomedical chip design, ASIC design, Low Power Design, Computer Arithmetic Design, Algorithm Development and Realization in Hardware, Computer Architecture, uProcessor and uController design, and Embedded System.



### Habiba Al Safar

Is an Emirati research scholar whose research interest is in constructing the genomic structures of individuals of Arab descent to identify genomic segments that carry gene(s) that are predisposed to disease. Specifically, her research addresses diseases that are prevalent amongst the local UAE communities. Dr. Alsafar has identified a gene strongly associated with the prevalence of Type 2 diabetes among the Emirati population. Dr. Alsafar's research is the first Genome Wide Association Study of the UAE Bedouin population, and the first of its kind in the Middle East.

## Our Researchers



### Shakti Singh

Singh is a researcher interested in design, modeling, fabrication and characterization of semiconductor devices and integrated circuits. His current work focuses on wide band-gap semiconductors, including SiC power devices, and integrated circuits for high-power, high-temperature, and high-speed applications.



### Kinda Khalaf

Currently conducts research in the areas of Orthopedic Biomechanics, Computational Biomechanics, and Biomedical Devices and Biomaterials. She has also co-established an interdisciplinary education research group at Khalifa University focusing on implementing curricular innovative pedagogies and the design of quantitative assessment instruments in engineering education



### Nazar Ali

Is a researcher currently working on Adaptive Concurrent Companding and Bias Control Techniques for Power Efficient OFDM Systems. This research is conducted with the aim of improving the efficiency of wireless communication systems based on OFDM such as 4G and 5G mobile systems.



### Mahmoud Al-Qutayri

Is involved in research on system-level design of minimal energy electronic systems and devices, such as those based on memristors He has broad experience in other areas of electronics engineering.

## Our Researchers



### Kin Liao

holds a joint appointment in the Departments of Mechanical and Aerospace Engineering. His research group focuses on the problems associated with composite materials, nano-materials, nano mechanics and biomechanics. Recent major contributions from Prof. Liao's group include graphene and graphene oxide large scale composite nano-materials and functional devices based on these composites.



### Nayla El-Kork

Is a physicist with expertise in electronic structure and other properties of diatomic molecules and her current research plans include transferring these studies to nano-scale solid state materials.



### Matthew N. Martin

is a soft matter physicist whose expertise centers on the synthesis and self-assembly of coated nanoparticles for biomedical applications His future plans include development of nanoparticle-based devices.



### Maguy Abu Jaoude

is a chemist who collaborates on SRC funded projects with Dr. Baker Mohamed's group, where she works on memristor devices. She also assists in activities in KU Core Nano-characterization Facilities.

## Our Researchers



### Issam Qattan

Professor Qattan carries out research in theoretical, phenomenological, and experimental nuclear and condensed matter physics. In collaboration with physicists from JUST and the University of Nebraska at Omaha, he works on creating theoretical descriptions of the electronic, optical, and magnetic properties of organic semiconductor materials (DIPAB) based on ab-initio calculations using density and spin-local functional theory approximation. He has strong ties with physicists from Argonne and the Thomas Jefferson National Laboratories



### Mohamed Rezeq

Is solid state physicist with expertise in semiconductor surface science and nanotechnology. He is one of the principal investigators at KSRC, and his main contributions include the proposed development of a nanoparticle based transistor and ultra-sharp tips for electron- and ion-based atomic scale probes. In addition to several recent publications, Prof. Rezeq was awarded with two US patents of direct relevance to the strategic goals of KSRC. He is an adjunct faculty at the ECE Department at the University of Waterloo, Canada.



### Deborah L. Gater

Is an expert in applications of NMR for studies of lipid-protein solutions and her future plans include collaboration on development of energy efficient micrometer scale NMR devices for biomedical applications.



### Dirar Al Homouz

Is a computational physicist who collaborates with Dr. Baker's group on memristor device modeling. Among his contributions of interest to KSRC are several publications and patents. His expertise extends beyond computation into mathematical models and potential biological applications, such as gene expression regulation.

## Our Researchers



### Nawaf AlMoosa

Obtained his Doctorate degree from Georgia Tech and is currently an Assistant Professor in Khalifa University's ECE department. His research interests lie in embedded computing architectures. He pursues research on intelligent algorithms to optimize the performance and energy-efficiency of large-scale computing systems to reduce the financial and environmental costs of their excessive energy consumption.



### Abdel F. Isakovic

Is a condensed matter physicist with expertise in nano-science and nanofabrication. He is the principal investigator on two MEES (Minimal Energy Electronic Systems) projects, for energyefficient nano-contacts and for spintronics, STT-MRAM MTJ nano-devices. Prof. Isakovic contributed to the early development of the ACE4S Center and he has been serving as the Coordinator of KU Core Nano-characterization Facility since its inception. Prof. Isakovic is an affiliate of the Cornell Nanofabrication Center.



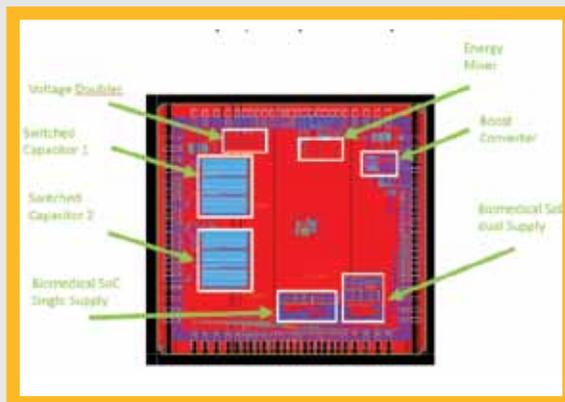
### Mohammed Ismail El Nagger

Is a prolific author and entrepreneur in the field of chip design and test. He spent over 25 years in academia and industry in the U.S. and Europe. He joined Khalifa University, Abu Dhabi, UAE, in 2011, where he holds the Mubadala Technology (formerly ATIC) Professor Chair and is the Founding Chair of the Electrical and Computer Engineering Department. He is the Founding Director of the KSRC and Co-Director of the ATIC-SRC Center of Excellence on Energy Efficient Electronic systems (ACE4S). His current research focuses on "self-healing" design techniques for CMOS RF and mm-wave ICs in deep nanometer nodes, energy harvesting, power management and SoC solutions for wearable biomedical devices, wireless communications and for the Internet of Things (IoT).

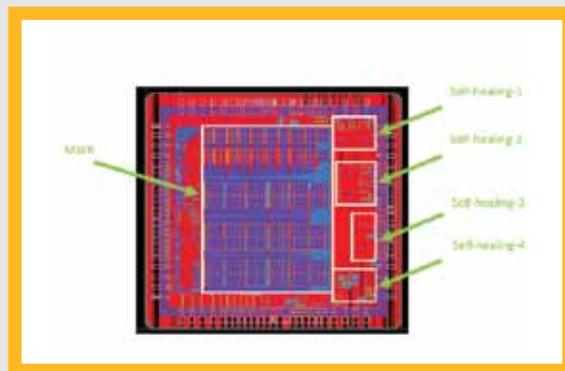
## KSRC International Collaborators

- Dennis Sylvester, University of Michigan, USA
- Ramesh Harjani, University of Minnesota, USA
- Mohamad Sawan, Montreal Polytechnic, Canada
- Mohannad Bakir, Georgia Tech, USA
- Yehea Ismail, American University in Cairo, Egypt
- Ayman Fayed, Ohio State University, USA
- Paul Yoo, Bournemouth University, UK
- Anantha Chandrakasan, MIT, USA
- Hannu Tenhunen, Royal Institute of Technology (KTH), Sweden
- Mona Hella, RPI, USA

## KSRC is a Truly Interdisciplinary Research Institute

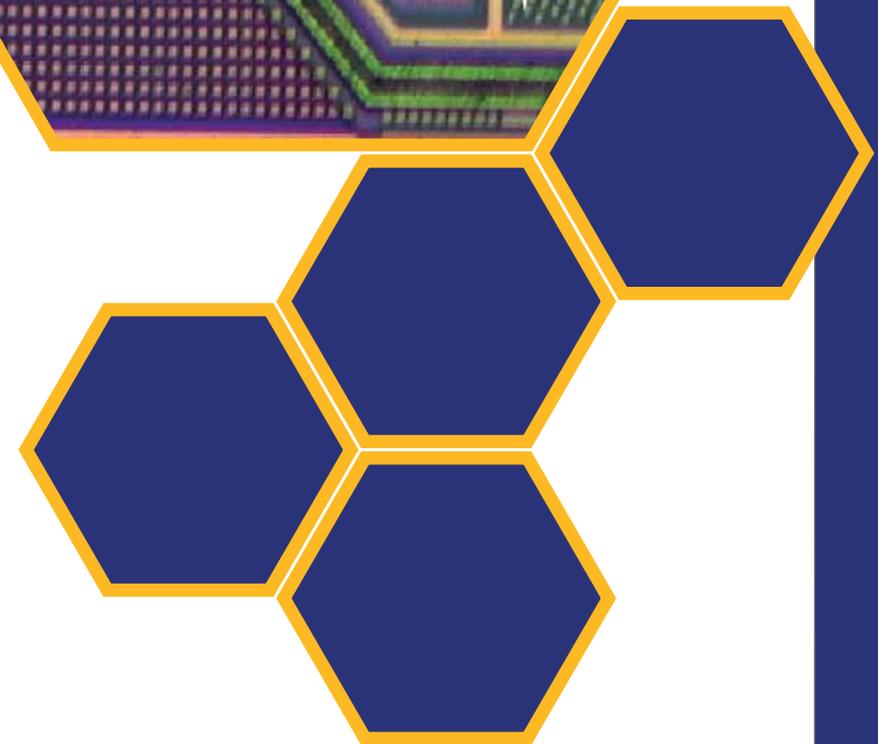
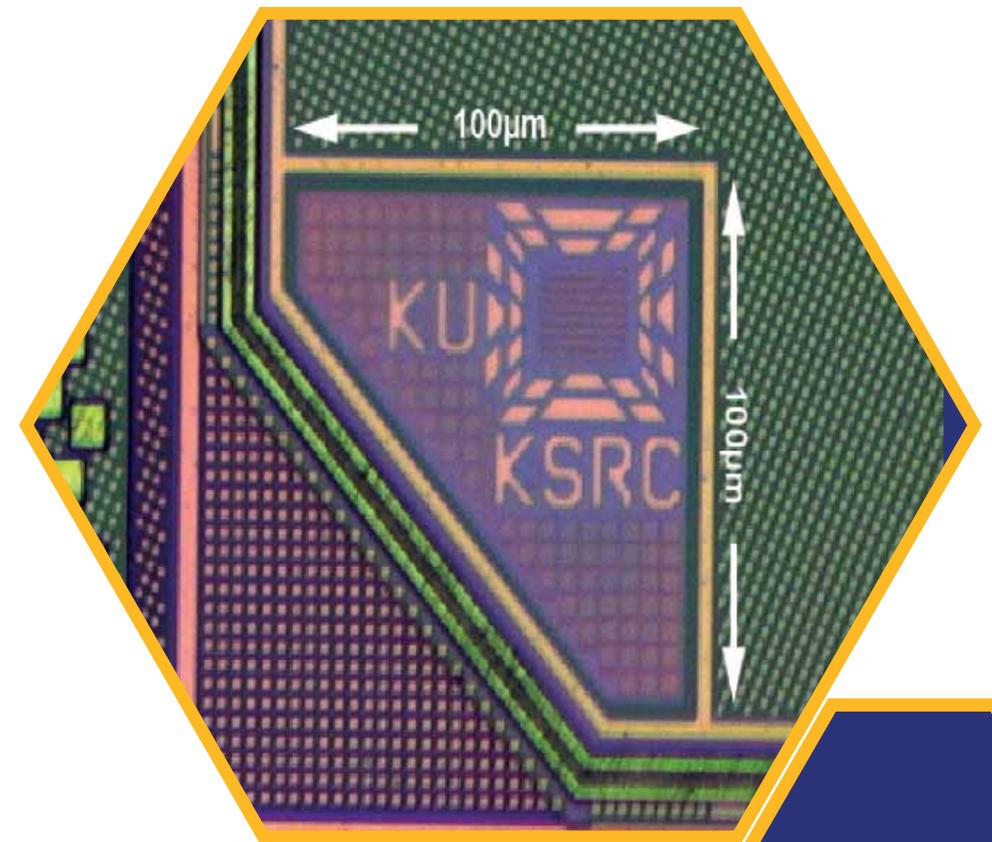


Biomedical Chip



Surveillance Chip

KSRC multi-project chip photo containing blocks for biomedical, image detection and security, energy harvesting and power management Systems-on-Chip (SoCs), fabricated in the Global Foundries 65 nanometer process



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أَسْمَاءً كَمَا يُؤْتِي السَّمَاءَ  
أَسْمَاءَ الْبُرُجِ لِقَوْمٍ يَعْلَمُونَ



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