The Future of Computing Hardware

Superconducting Digital Computing

Q. Herr
Scientific Director
IMEC, Leuven, Belgium

Abstract
Superconducting Digital Computing based on Single-Flux-Quantum data encoding is a cryogenic, beyond-CMOS technology with near-term development potential relative to Quantum Computing. Superconducting digital offers 10x improved clock rate and 100x improved power efficiency relative to advanced-node CMOS at scale. The superlative properties of superconducting logic and interconnect give power densities of less than 1W per square cm, enabling 3D packaging with unprecedented computational density. Circuit demonstrations to date have shown progress but remain modest by CMOS standards, scaling the technology will require development of a fabrication stack using novel materials, which would also be applicable to superconducting Quantum implementations.

Biography
I have spent my career in technology development of superconductor integrated circuits, which has application in beyond-CMOS digital, mixed-signal, and quantum computing. After several years as a staff scientist at TRW in Los Angeles and as a Northrop Grumman Fellow in Baltimore, I am very pleased to be part of imec as a Scientific Director on a team focused on superconductor digital systems, circuits, and materials. My experience has included technical leadership of projects large and small, mentoring the next generation, and teaching seminars on superconductor technology. I have written about 40 peer-reviewed publications and 50 patents, and hold an MA in Physics and a Ph.D. in Electrical Engineering from the University of Rochester.

Frugal Artificial Intelligence For Edge Devices

T. Signamarcheix
Vice President Strategic Development
CEA-Leti, Grenoble, France

Abstract
Considering the huge demand for edge devices, frugality has become a critical challenge and still require deep innovation . Thomas Signamarcheix, CEA-Leti's Vice President Strategic Development, will present how new hardware could provide disruptive solutions for edge devices and especially event based sensors .

Biography
Joined CEA-Leti in 2008 and was named manager of a research laboratory on substrates engineering in 2011. From 2015 to 2019, he was promoted to business development management for Leti's Silicon Component Division and Architecture and Embedded Software Division. Also, as Key Account Manager of several strategic collaborations, he directly managed a wide range of activity (semiconductor, alternative energy, sensor, radio-frequency, etc.) promoting innovation at both hardware and architectures level. He has served as vice president of CEA-Leti's strategic development since 2020, managing Leti's strategic program (Quantum Electronic, Artificial Intelligence, wearable healthcare devices and mixed reality) and strategic partnerships. He has a Ph.D. degree in the physics of semiconductor devices from Grenoble Institute of Technology (INPG).

Quantum computing hardware

G. Fagas
Head of the CMOS++ Research Cluster
Tyndall National Institute, Cork, Ireland

Abstract
Coming soon

Biography
Dr. Giorgos Fagas MBA is Head of the CMOS++ Research Cluster at Tyndall National Institute, a strategic initiative addressing emerging materials, devices, and architectures for next-generation information processing interfacing with CMOS and beyond. Giorgos is also Head of EU Programmes and a member of Tyndall's Institutional Leadership Team. Giorgos has been instrumental in the setting up and launch of the Tyndall Quantum Computer Engineering Centre (QCEC), of which is currently the acting Head.

Prior to joining Tyndall in 2004, Giorgos received a PhD in Physics from Lancaster University (UK) and he was Guest Scientist at the Max-Planck-Institut-PKS and Humboldt Fellow at the University of Regensburg (Germany). Giorgos holds prominent positions in various research policy and industry groups such as the Quantum Community Network, the AENEAS Scientific Council, European Platform of Smart System (EPoSS) and MIDAS, the Irish industry association for the micro and nano-electronics based systems sector.

Giorgos has been leading activities in quantum devices and energy-efficient nanoelectronics. His work has been published in over 70 peer-reviewed articles. He is editor of a reference book on Molecular Electronics and two books on ICT-Energy Concepts. He has also made significant contributions to strategic research agendas and technology roadmaps. Giorgos currently leads the EU-funded programme of ASCENT+ Access to European Infrastructure in Nanoelectronics which prominently features quantum devices as one of its three pillars.

Giorgos received the 2019 UCC Leadership Award because of his outstanding stewardship in driving Tyndall's successful engagement in EU Programmes and motivating internal collaboration to achieve alignment around large scale programmes.

Two-dimensional Materials in Semiconductor Pilot Lines

M. Lemme
Managing Director
Amo, Aachen, Germany

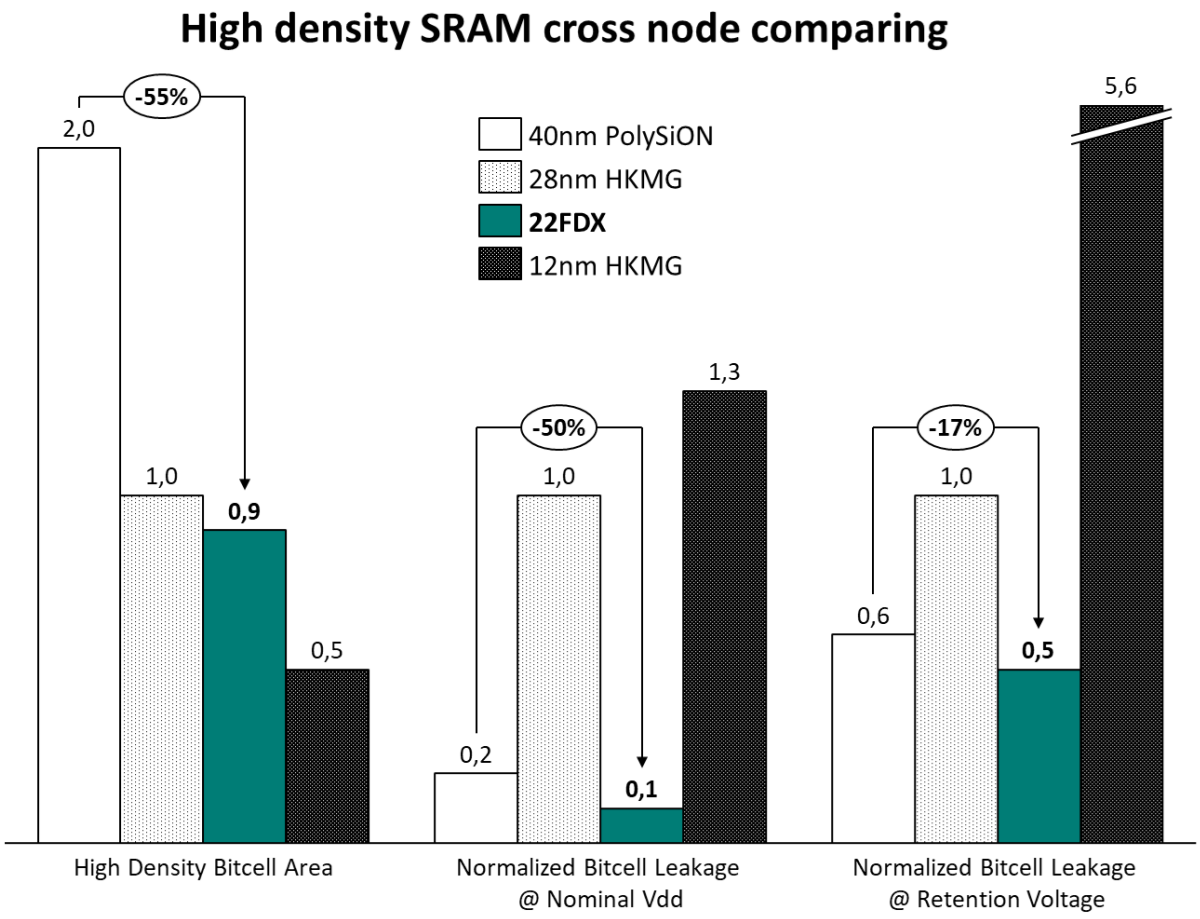
Abstract
The intrinsic electronic, optical and physical properties of the two-dimensional (2D) material graphene are unrivaled in many aspects and have led to intense research efforts in the past 15 years. A growing range of other 2D materials have since emerged with semiconducting, insulating or semi-metallic properties. Graphene is a semi-metal and hence not suitable for logic transistors [1], but some semiconducting 2D materials are being considered for nanosheet transistors for ultimate CMOS integration [2]. Potential applications for 2D materials in optoelectronics include photonic integrated circuit (PIC)-integrated photodetectors with high frequency performance [3] or high responsivity photodetectors operating tin the infrared regime [4], [5]. Nano and microelectromechanical systems (NEMS/MEMS) may benefit from the ultimate thinness, low mass and high mechanical stability of graphene and other 2D materials class [6]. Despite clear performance advantages of electronic devices based on 2D Materials at the device and laboratory level, the manufacturability of 2D electronic, photonic or sensor systems remains low [7]–[9]. In this talk, I will discuss major challenges towards the integration of graphene and 2D materials into semiconductor processing lines. I will introduce the European Experimental Pilot Line for 2D materials that launched in 2020 with support by the European Commission [10].
Acknowledgement: Funding by the European Union's Horizon 2020 research and innovation programme under grant agreements 952792 (2D-EPL) and 881603 (Graphene Flagship), the German Ministry for Education and Research (BMBF) 16ES1121 (NobleNEMS) and 03XP0210 (GIMMIK) and the German Research Foundation (DFG) LE 2440/11-1 (2DNEMS) is gratefully acknowledged.

Biography
Max C. Lemme (M'00–SM'06) received the Dipl.-Ing. and Dr.-Ing. degrees in electrical engineering from RWTH Aachen University, Aachen, Germany. He is currently Professor of Electronic Devices at RWTH Aachen University, the Director of AMO GmbH, Aachen. His current research interests include electronic, optoelectronic and nanoelectromechanical devices and sensors made from novel materials like graphene and related 2-D materials, Perovskites or phase change materials and their integration into the silicon technology platform. He received the German BMBF NanoFutur award in 2006, the Heisenberg Professorship of the German Research Foundation and an ERC Grant in 2012, and an ERC Proof-of-Concept Grant in 2018. He co-founded Black Semiconductor GmbH in Aachen in 2019.

Semiconductor Enabling Vr/AR as the New Dimension Of Human Connection

R. Yan
Business Unit Manager
GLOBALFOUNDRIES, Dresden, Germany

Abstract
As the world Digitalization is rapidly accelerating and providing real benefit to each one of us, a spate of emerging technologies—especially, artificial intelligence (AI), virtual reality (VR), and augmented reality (AR)—are gaining prominence across industries. These technologies have their unique capability to reduce the distance between people and deliver fully immersive experiences in all kinds of environments. The power of VR/AR combined with AI also allows machines to operate at the cognitive level as humans and allows us to interact naturally with machines. Such emerging technologies bring huge opportunities to semiconductor, but also new challenges that need our attentions: see-through near eye microdisplay, real-time image sensing & processing, low-weight low-power for round the day usage. Those requirements are not only challenging for design house, but also for semiconductor technology. Instead of chasing down the advance node, the industry needs to collaborate vertically and find the right trade-off between speed, power and cost. In GlobalFoundries, we are taking up on this challenge with our partners to enable the next-generation VR/AR products based on our unique solutions.
GlobalFoundries® (GF®) Microdisplay solutions are optimized to improve process speed and reduce leakage while enabling enhanced pixel driver functionality.



High density area and leakage reduce with technology node shrinking

It significantly speeds up VR/AR applications to support real-time data analysis and edge computing. Our platform is compatible with multiple display technologies, like LCOS, and microLED.

LCOS	microLED
22FDX Supports pixel size down to 2.5um with up to 2K x 2K resolution. Mirror reflectivity >65% at 450nm-650nm wavelengths.	22FDX Supports pixel size down to 2.5um. Supports ultra-high density ultra-low leakage Memory-In-Pixel design.

Globalfoundries microdisplay solutions

We are aiming to enable our technology down to 22nm to reach 4K resolution within 2 inches diagonal MicroDisplay.
There are still more challenges to overcome before widespread consumer VR/AR applications. However, with our effort to advance foundry technology and collaboration with industry partners, in the not-too-distant future, we will see AR everywhere in our life and connect us in real-time without any “distance”.

Biography
After 10 years working in semiconductor and GLOBALFOUNDRIES® (GF®), I am so proud to be part of this vital industry and hold my exciting position as business line manager for Human-Machine-Interaction (HMI) products. My vision is to reshape HMI technologies all over the world and enable the AR/VR foundry solution with a special focus on MicroDisplay and image sensors. In GF®, we know we cannot do it alone. That is why I am glad to have our industry partners, research institutes, and government bodies support us, especial in Europe.
In addition, we must have human needs in our hearts and do not forget about the minorities. Therefore, I am also a Diversity & Inclusion Partner in our German site to build better technology, a better workplace, and a better society.
I hold an EMBA from ESCP Business school and a Ph.D. in Microelectronic Engineering from the National University of Ireland, Cork.