

The Future of Smart Computing Session

Photonics for Next Generation Computing

T. Tekin
Group Manager
Fraunhofer IZM, SIIT, Berlin, Germany

Abstract

Main bottleneck to the realization of next generation computing systems for all big-, secure-data applications and related industries, including System-in-Package and System-on-Chip based solutions, is the lack of off-chip (off-core) interconnects with low latency, low power, high bandwidth, and high density.

The solution to overcome these challenges is the use of photonics.

Photonics as an underlying technology is addressing the following main technological challenges of the next generation computing systems such as i) Off-chip interconnects, ii) Massive switching matrix, iii) Disruptive system architectures, iv) Cooling concepts, v) New peripheral component interconnect express, vi) Memory fabric, vii) Novel computing functions in order to enable Quantum- & Neuromorphic Computing, AI.

Next Generation Photonics Platform will enable the disruptive computing technology and photonics enabled architectures, leading to faster, cheaper, power efficient, secure, denser solutions for applications and industries. Further, generic co-integration with all building-blocks of computing technology will be possible, since photonic based standard interfaces between building blocks are introduced and implemented.

Biography

Tolga Tekin received the Ph.D. degree in electrical engineering and computer science from the Technical University of Berlin, Germany. He was a Research Scientist with the Optical Signal Processing Department, Fraunhofer HHI, where he was engaged in advanced research on optical signal processing, 3R-regeneration, all-optical switching, clock recovery, and integrated optics. He was a Postdoctoral Researcher on components for O-CDMA and terabit routers with the University of California. He worked at Teles AG on phased-array antennas and their components for skyDSL. At the Fraunhofer Institute for Reliability and Microintegration (IZM) and at Technical University of Berlin, he then led projects on optical interconnects and silicon photonics packaging. He is engaged in photonic integrated system-in-package, photonic interconnects, and 3-D heterogeneous integration research activities. He is group manager of 'Photonics and Plasmonics Systems' and coordinator of 'PhoxLab - Independent Platform for Photonics in Data Centers (PIH)' at Fraunhofer IZM. He is coordinator of European flagship project 'PhoxTroT' and European H2020 project 'L3MATRIX' on optical interconnects for data centers.

Towards wafer-scale Qubits

M. Mongillo
Device Engineer
IMEC, Leuven, Belgium

Abstract

In this talk I will present the recent progress made by IMEC in the fabrication and integration of basic quantum circuits targeting qubits into a 300mm FAB.

Quantum Computing holds promise for solving complex computational problems which are intractable by classical calculators. The basic ingredient for the implementation of a quantum computer is the availability of a two-level system mimicking the classical bit "0" and "1" (the qubit), on which we can encode the basic information.

The exceptional computation power of a Quantum Computer originates by the quantum-mechanical property of superposition, according to which the qubit state is defined as an arbitrary linear combination of the two constituent bit states. At the qubit level, two main solid-state implementations are currently explored at IMEC. They are based on individual spins in Silicon and Superconducting circuits. Spins in silicon have demonstrated the longest coherence time in any solid-state device as a result of the lack of hyperfine interaction coupling the spins of the nuclei and the electronic spins.

Another approach makes use of Superconducting devices, which, to date, represent the most advanced solid-state implementation of a qubit. Although this technology has proven to be mature for the implementation of basic Quantum Algorithms, it presents unique challenges in terms of integration of a large (millions) array of qubits, necessary for error-correction. Given the rather large foot-print of an elemental Superconducting qubit, this platform needs to demonstrate its viability in terms of up-scalability.

In the long term, both qubits platforms need to be integrated into a larger system comprising the control electronics routing the necessary signals to the physical qubit layer. In IMEC we are pursuing these research lines leveraging the extended know-how in terms of large-scale integration and system architecture.

Biography

Massimo Mongillo holds a Master degree in Physics from University of Naples in 2005 and a PhD in Nanophysics from University Joseph Fourier in Grenoble in 2010. His research has focused on the physics of Silicon nanoscaled devices, Quantum Transport and Superconductivity. In 2015 he has joined IMEC to develop devices based on two-dimensional materials. Since 2017 he is in the Quantum Computing group for the integration of Superconducting and spin Qubits.