Berkeley EECS Solid State Seminar, November 2nd, 2018

Polylithic Integration for the Next Era of Moore's Law:
Design Considerations and Technology Demonstrations

Muhannad S. Bakir
School of ECE - Georgia Tech

Abstract:
Polylithic integration of heterogeneous ICs is projected to be a key driver for the next era of Moore's Law. This presentation will discuss polylithic integration approaches using 2.5D and 3D IC technologies. Specifically, we first discuss various 2.5D approaches including Heterogeneous Interconnect Stitching Technology (HIST), which enables the interconnection of multiple dice of various functionalities (including photonics) in a manner that mimics monolithic-like performance, yet utilizes advanced off-chip interconnects and packaging to provide flexibility in IC fabrication and design, improved scalability, reduced development time, and reduced cost. A key feature of HIST is the ability to place a 'stitch chip' between adjacent ICs on the surface of an organic/ceramic package and use multi-height I/Os to interface the active dice to the package and stitch chips simultaneously. Design considerations and benchmarking of power delivery, signaling, and thermal are described. Moreover, we show how such design considerations drive technology development in 2.5D/3D ICs along with experimental demonstrations. Secondly, we demonstrate embedded microfluidic cooling in 3D ICs along with TSV integration approaches to enable dense electronics with no thermal limits; a 28nm Stratix-V FPGA with monolithic microfluidic cooling along with its performance benefits will also be shown. TSVs with sub-micron diameters are also shown for fine-grain 3D heterogeneous integration. Third, and lastly, we discuss 3D IC applications in CMOS multimodal biosensors.

Biography:

Muhannad S. Bakir is a Professor in the School of Electrical and Computer Engineering at Georgia Tech. Dr. Bakir and his research group have received thirty conference and student paper awards including six from the IEEE Electronic Components and Technology Conference (ECTC), four from the IEEE International Interconnect Technology Conference (IITC), and one from the IEEE Custom Integrated Circuits Conference (CICC). Dr. Bakir's group was awarded the 2014 and 2017 Best Papers of the IEEE Transactions on Components Packaging and Manufacturing Technology (TCPMT). Dr. Bakir is the recipient of the 2013 Intel Early Career Faculty Honor Award, 2012 DARPA Young Faculty Award, 2011 IEEE CPMT Society Outstanding Young Engineer Award, and was an Invited Participant in the 2012 National Academy of Engineering Frontiers of Engineering Symposium. Dr. Bakir is the recipient of the 2018 IEEE Electronics Packaging Society (EPS) Exceptional Technical Achievement Award "for contributions to 2.5D and 3D IC heterogeneous integration, with focus on interconnect technologies." He is also the co-recipient of the 2018 McKnight Foundation Technological Innovations in Neuroscience Awards.

Dr. Bakir serves on the editorial board of IEEE Transactions on Components, Packaging and Manufacturing Technology (TCPMT) and IEEE Transactions on Electron Devices (TED). Dr. Bakir serves as a Distinguished Lecturer for IEEE EPS.