Photonic Device Design from the Complex Plane to the Microprocessor: Keeping Information, Energy and Entropy Under Control

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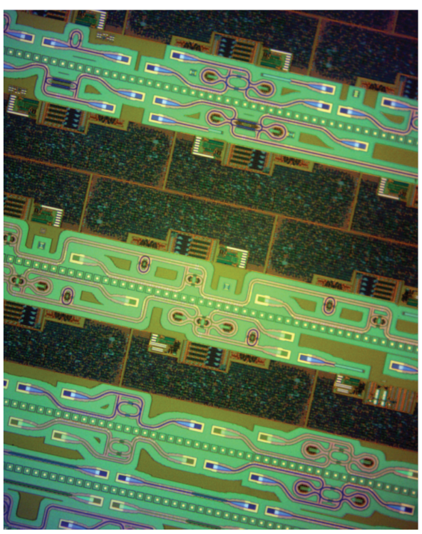
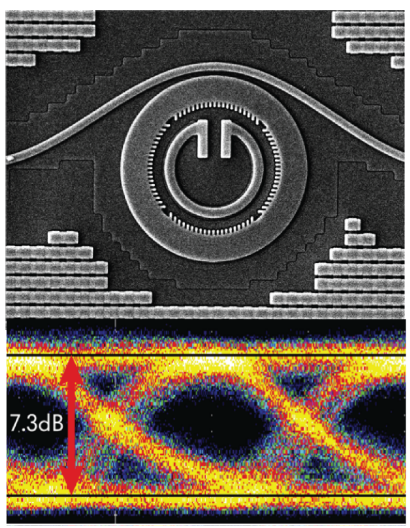
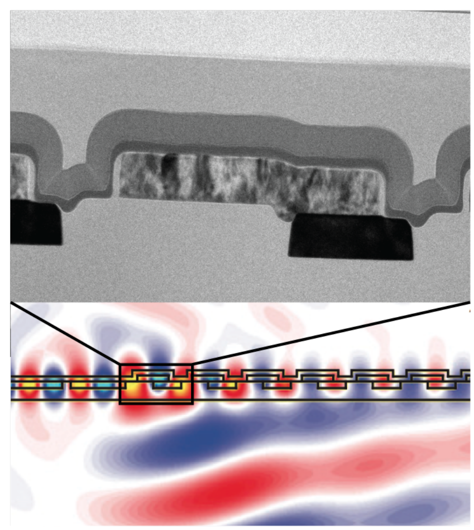
Abstract: Four decades on from the pioneering first steps at Bell Labs, microphotonics is at a transition from a few components to large-scale integrated systems on chip. In the near term, this means substantial improvements at a system level to complex electronic systems – through integration with relatively simple but efficient photonic systems. But in the longer term, it also means complex passive, active and nonlinear photonic structures with novel functions will become practical and may enable a new generation of integrated systems-on-chip.

In the first part of my talk, I will describe photonic device designs within advanced-node CMOS micro-electronics technology that enabled millions of transistors and thousands of photonic devices to coexist for the first time, and produce efficient electronic-photonic systems including record-energy optical transmitters, receivers and links, and the first microprocessor with photonic I/O.

In the second part of my talk, I will use this VLSI photonics concept as a springboard to talk about photonic device concepts that expose and address fundamental challenges and apparent limitations in optical signal processing. I will talk about the "dark state laser" concept that leverages imaginary coupling, a new type of coupling mechanism, to enable compact, tunable lasers; the fundamental limits of modulators and breaking their speed-energy tradeoff; and the "entropy pump", a nonlinear photonic device designed to passively manipulate the coherence of light, and, for example, denoise a laser with high efficiency. These devices enable new capabilities for a next generation of optical signal processors.







Biography: Miloš Popović is an Assistant Professor of Electrical Engineering and GE/Donnelly Faculty Fellow at the University of Colorado Boulder. He received his B.Sc.E. in Electrical Engineering from Queen's University, Canada in 1999, and the M.S. and Ph.D. degrees at MIT in 2002 and 2007. His research interests include first-principles theory and design of integrated photonic devices for telecom and on-chip interconnect applications, CMOS photonics integration, nanooptomechanical devices based on light forces and acoustic wave engineering, and nonlinear and quantum integrated photonics. He is author or coauthor of over 25 patents and 150 journal and conference papers. In 2012, he was named a Fellow of the David & Lucile Packard Foundation for work in optical forces and nonlinear effects on the nanoscale.