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Engineering new functionality into III-V semiconductors: From atomically-engineered detectors to 'heterogenous' epitaxial integration

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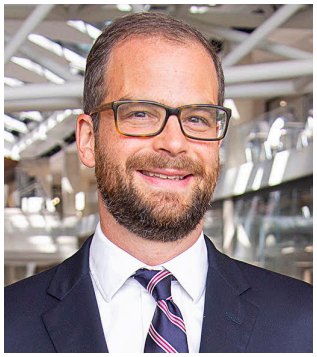
ABSTRACT: We describe our efforts integrating new functionality into epitaxial semiconductor materials, primarily for photonic device applications, using molecular beam epitaxial (MBE) growth. We begin at the atomic scale, where the introduction of boron into (In)GaAs enables the first direct bandgap materials that can be lattice-matched to silicon, a potential enabler for efficient lasers and photodetectors on silicon. We then show how the sensitivity of avalanche photo-diodes (APD) can be enhanced via the impact ionization characteristics by engineering at the few atom-scale using the digital alloy growth method. This approach enables record low noise, sensitivity down to single photon levels, potentially with photon number resolution at room temperature for future quantum information processing systems. At the micro-/nano-scale, epitaxially-integrated high contrast dielectric and plasmonic materials are compelling building blocks for localizing and manipulating light at subwavelength scales. We describe our efforts to monolithically integrate active III-V materials with patterned dielectric/metal structures, as well as crystalline semimetals and doped-semiconductors, to yield new materials platforms for harnessing emergent phenomena to enhance light-matter interactions. We anticipate that these capabilities will enable new paradigms in nanophotonic device design and functionality.



BIOGRAPHY: Prof. Seth R. Bank received the B.S. degree from the University of Illinois at Urbana-Champaign in 1999 and the M.S. and Ph.D. degrees in 2003 and 2006 from Stanford University, all in electrical engineering. In 2006, he was a post-doctoral scholar at the University of California at Santa Barbara. He is currently a Cullen Trust Endowed Professor of Electrical and Computer Engineering at the University of Texas at Austin. His primary research interests are centered around the growth and application of novel heterostructures and nanocomposites to electronic and photonic devices. He has coauthored over 350 papers and presentations in these areas. Dr. Bank is the recipient of a 2010 Young Investigator Program Award from ONR, a 2010 NSF CAREER Award, a 2009 Presidential Early Career Award for Scientists and Engineers (PECASE) nominated by ARO, a 2009 Young Investigator Program Award from AFOSR, the 2009 Young Scientist Award from the International Symposium on Compound Semiconductors, a 2008 DARPA Young Faculty Award, the 2008 Young Investigator Award from the North American MBE Meeting, and his students have received several best paper awards.

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