Antimonide Superlattices and Avalanche Photodiodes: Paving the Way for the 4th Gen of Infrared Detectors?

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Photonic infrared detectors have witnessed three generations of development since their first reports in 1950s-60s. The detectors have evolved from single element to linear to large format 2D arrays. In this talk we will discuss a vision for the fourth generation of infrared detectors that incorporate on demand functionality like gain, color, polarization at the pixel level. A low noise linear mode avalanche photodiodes (LmAPDs) is a critically enabling component for eye-safe long range LiDAR and remote sensing applications. Unlike PIN diodes, APDs provide internal gain that can lead to increased signal to noise ratio and suppress downstream circuit noise. The highest performing infrared APDs are based on interband transitions in mercury cadmium telluride (MCT, HgCdTe). Commercial APDs use an InGaAs absorber with an InAlAs or InP multipliers. We are investigating two antimonide based multipliers, AlGaAsSb and AlInAsSb, on InP substrates. We have recently demonstrated separate absorber charge and multiplier (SACM) APDs using an InGaAs/GaAsSb Type-II superlattice absorber and an AlGaAsSb multiplier[i]. We will discuss the technical challenges associated with the design, growth, fabrication and test of these LmAPDs and the potential for the development of these critical APD arrays for longer wavelengths.

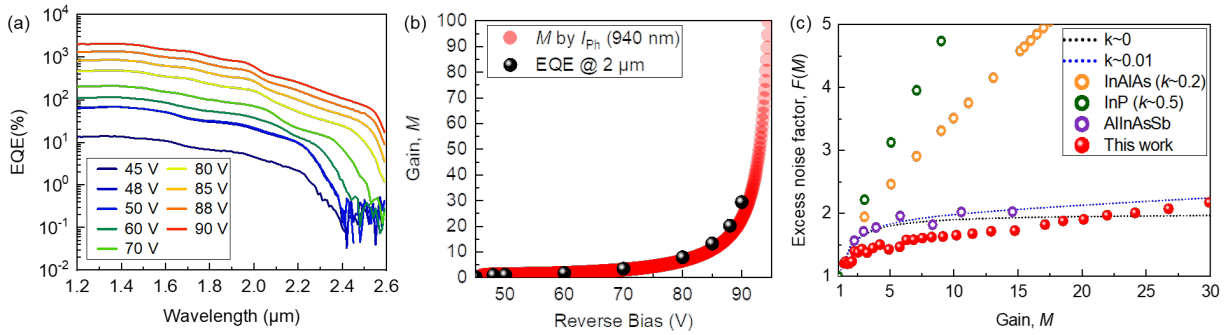

Fig. 1 (a) Equivalent quantum efficiency of extended short wave infrared SWIR SACM APD at various applied biases, and (b) extracted gain from EQE at 2 μm compared to the gain obtained by photocurrent under 940 nm laser illumination as a function of reverse bias. (c) Measured excess noise as a function of gain with other emerging III-V-based APDs

Biography of the Speaker: Sanjay Krishna is the George R Smith Professor of Engineering in the ECE department at the Ohio State University. He was previously the Director of the Center for High Technology Materials and Professor and Regents Lecturer in the Department of Electrical and Computer Engineering at the University of New Mexico. Sanjay received his M.S. in Electrical Engineering and PhD in Applied Physics from the University of Michigan following which he joined UNM as a tenure track faculty member. Sanjay has received several awards including the Gold Medal from Indian Institute of Technology, Madras, Defense Intelligence Agency Chief Scientist Award for Excellence, North American Molecular Beam Epitaxy Best Student Paper award and NAMBE Young Investigator Award, SPIE Technology Achievement Award, NAMBE Innovator Award, UNM Teacher of the Year award, IEEE Aron Kressel Award and Ralph Boyer Award for Excellence in Undergraduate Education. Sanjay has graduated 31PhD students, published over 300 peer-reviewed journal articles (h-index=59) ten issued patents and several keynote and invited talks. He is the co-founder and CTO of SK Infrared, a start-up involved with the use of IR imaging for defense, aerospace and commercial applications. He is a visiting faculty at IIT Bombay. He is a Fellow of IEEE, OSA and SPIE.

[i] Jung et al " Low Excess Noise, High Quantum Efficiency Avalanche Photodiodes for Beyond 2 μm Wavelength Detection (Nature Photonics in review, 2024).