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## Room temperature polariton lasers and Bose-Einstein condensation in wide bandgap semiconductor nanowires

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Bose-Einstein condensation is a dramatic phenomenon in which many particles act as though they were a single entity. The first Bose-Einstein condensate produced in the laboratory used rubidium atoms at very cold temperatures—works that was awarded the 2001 Nobel Prize in physics. Other materials, like superconductors, exhibit similar behavior through particle interactions. These systems typically require temperatures near absolute zero. But we have now used a nanoscale wire to produce an excitation known as a polariton. These polaritons formed a Bose-Einstein condensate at room temperature, potentially opening up a new avenue for studying systems that otherwise require expensive cooling and trapping. In this process, we also demonstrate lasing at an ultra-low threshold that is three orders of magnitude lower than any conventional lasers. This opens up a wide range of potential applications in daily consumer goods to quantum computers. The active medium is a single GaN nanowire which is 700 nm in length and has a diameter of 60 nm and is free of extended defects, has no alloy fluctuation to introduce inhomogeneous broadening, has a small surface recombination velocity, very small surface depletion and thus is easily reproducible. The structure is easy to fabricate and has a large Rabi splitting originating from large exciton oscillator strength and a modified cavity field that concentrates within the nanowire.

### Biography

Ayan Das has completed his Ph.D. from University of Michigan, Ann Arbor in 2013 and is currently a senior metrology engineer at Intel Labs in Oregon. He is a fellow of APS and IEEE Photonics society; he has published more than 25 journal and conference papers in reputed peer-reviewed journals. His research area includes quantum nanophotonics and nanoopto-electronics and is the first to demonstrate Bose-Einstein condensation at room temperature and electrically powered polariton lasers that can reduce the energy efficiency of lasers by three orders of magnitude.

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## Synthesis and Metrology of Graphene Materials

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Graphene is a one atom thick two-dimensional material that exhibits exceptional physical and electronic properties, and is offering new avenues of applications in nanoelectronics, sensors and energy storage. I talk will describe innovative approaches for synchronous synthesis of graphene-carbon nanotube hybrid materials which are envisioned for future ultra large surface area applications. The graphene-carbon nanotube hybrids have tunable nano-architectures, which are essential for application-oriented design of hierarchical graphene structures. As a nano-patterning tool, we demonstrated the use of block copolymer self-assembly patterning for designing such nano-architectures. Such versatility provides us with a powerful method to control the diameter and separation distance of carbon nanotube pillars and facilitates the adjustment of the final effective surface area of the carbon hybrid. The second part of the talk will focus on the utilization of a recently developed technique called fluorescence quenching microscopy (FQM) for quick visualization of defects and doping in large-area graphene layers. We employed 4-(dicyanomethylene)-2-methyl-6-(4-dimethylaminostyryl)-4H-pyran (DCM) as the fluorescence agent. The emission of DCM is quenched to a different extent by doped and non-doped regions of graphene, which provides the imaging contrast essential for industrial metrology applications. The results of comparative investigation on steady-state and time-resolved fluorescence parameters of dye-coated pristine graphene and fluorinated graphene samples will be discussed. Segmented FQM can be employed to address the significant need for having a graphene metrology technique capable of seeing the features that are processed.

### Biography

Cengiz S. Ozkan is a Professor of Mechanical Engineering and a co-faculty of Materials Science and Engineering, Electrical Engineering and Biochemistry at the University of California Riverside. He holds a Ph.D. degree in Materials Science and Engineering from Stanford University. After completing his Ph.D. studies, he worked for Applied Micro Circuits Corporation in San Diego, and concurrently served as a consulting professor at Stanford University and a lecturer in Electrical Engineering at University of California San Diego. His areas of expertise include nanomaterials processing, energy storage technologies, nanoelectronics, and biochemical sensors. He has more than 200 technical publications, over 50 patent disclosures, has given more than 100 presentations worldwide. He organized and chaired 14 scientific and international conferences.

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