Electrical & Computer ENGINEERING

SEMINAR

THURSDAY
MAY 1, 2008

Scaife Hall Auditorium
Room 125

4:30 p.m.
Refreshments—4:00 p.m.

Ritesh Agarwal
PROFESSOR
UNIVERSITY OF PENNSYLVANIA

Ritesh Agarwal earned his undergraduate degree from the Indian Institute of Technology, Kanpur in 1996, and a master's degree in chemistry from the University of Chicago. He received his PhD in physical chemistry from the University of California at Berkeley in 2001. After completing his PhD., Ritesh was a postdoctoral fellow at Harvard where he studied the optical and photonic properties of semiconductor nanowires. His work led to the development of electrically-driven single nanowire lasers and avalanche photodiodes.

Ritesh is currently an assistant professor in the Department of Materials Science and Engineering at the University of Pennsylvania. His research interests include quantum confined optics and electronics in nanowire heterostructures, and studying phase transitions and electronic memory switching at the nanoscale. Ritesh is the recipient of the NSF CAREER award in 2007.

Nanowire Optoelectronics and Electronic Memory

Semiconductor nanowires offer a unique approach for the bottom up assembly of electronic and photonic devices with the potential of integrating photonics with existing technologies. In the first part of my talk I will focus on the synthesis, directed assembly and fabrication of subwavelength photonic devices for the generation, waveguiding, and detection of light at the nanoscale. Two specific photonic devices, namely, electrically driven single nanowire lasers and avalanche photodiodes (APDs) will be discussed in detail. The nano APDs exhibit exceedingly high current multiplication leading to extremely low light sensitivitiy. The small size of nanowire leads to APDs with an active area of less than 500 nm thereby enabling them to be used for high spatial resolution detection with polarization sensitivity. The potential for combining both nanoscale light sources and detectors, such as for optoelectronic coupling and lab-on-a-chip devices will be discussed.

In the second part of my talk I will discuss our efforts in studying reversible crystalline to amorphous phase transitions in chalcogenide nanowires (GeTe, $Ge_2Sb_2Te_5$), which are becoming important materials for Phase Change Memory (PCM) devices. Of the different memory device concepts being currently explored, PCM devices based on Ge-Sb-Te alloys are very promising for scalable device size, high-speed operation with nonvolatile random accessing capability. However, the top-down nature of thin-film device fabrication and etching-induced material damage leads to scalability problems at sub-100 nm size. Therefore, there is great interest in developing new materials and processing techniques to overcome this barrier. Self-assembled nanowires devices are particularly promising owing to their sub-lithographic sizes and unique geometry that is free of etch-induced damage. Reversible phase transitions in single-crystalline nanowire devices scaled down to 20 nm sizes are observed with dramatic reduction in switching currents and power consumption. Size-dependent spontaneous recrystallization dynamics is studied systematically and activation energies are obtained and our result demonstrates non-volatile data retention capabilities at 20 nm length scales. Our results show that nanowires are promising candidates for scalable nonvolatile memory applications and studying intrinsic properties of current-induced phase transitions in nanoscale systems.

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