Detection of nuclear materials such as U and Pu is often accomplished by utilizing their natural or induced neutron emission. Such systems typically use thermal neutron detectors inside a plastic moderator. In order to achieve high detection efficiency $^3$He filled thermal neutron detectors are currently utilized; these detectors require high voltage bias for operation, which complicates the system when tens of detectors are used. In addition, there is a shortage in $^3$He supply and the detectors have become more expensive. A better type of detector would be an inexpensive solid-state detector that can be massively produced like any other computer chips.

This talk presents current research advances at RPI on the fabrication and characterization of large area solid state thermal neutron detector module with thermal neutron detection efficiency exceeding 30%. The detector here utilizes three dimensional honeycomb silicon micro-structures with continuous p$^+$-n junction diode filled with enriched boron (99% of $^{10}$B) as a converter material for thermal neutron detection. Since neutrons cannot be detected like other radiation by only using conventional semiconductor pn junction, a converter material is used which interacts with the neutrons and emits energetic charged particles, $\alpha$ particles and $^7$Li ions that are then detected by silicon pn junction. The very low leakage current density of the fabricated pn junction device helps to increase the detector surface area greater than 16 cm$^2$. Further, these detector modules operate under no external bias, showing the promise of achieving highly efficient large area solid state thermal neutron detectors with low gamma sensitivity at low cost using matured silicon processing technology for future homeland security applications.

Bio: Prof. Bhat received his PhD degree in 1985 from RPI where his doctoral work was in the growth and characterization of II-VI semiconductor materials. He joined the Electrical, Computer and Systems Engineering Department in 1985 and is currently Full Professor. He is an expert in materials and device research, particularly in CVD of various semiconductor materials and device fabrications. He has over 30 years of experience in the design and fabrication of various semiconductor devices such as solar cells, thermophotovoltaic devices, infrared devices and neutron detectors. Prof. Bhat has published more than 100 refereed journal articles in the area of semiconductor devices and processes.