Electronic Transport and Noise in Field Effect Transistors with Two-dimensional Atomically Thin Materials

Suprem R. Das, K-State

Field Effect Transistors (FETs) form the basis for modern integrated circuits (ICs), that are the building blocks of every computing and communication device. The need for faster and energy efficient microprocessors has enabled continuous development of novel device architectures with the state-of-the art micro/nano-fabrication technologies, aiming for a transistor feature size of ≈3 nm and beyond. However, scaling down the device dimension below 3 nm brings added challenges due to various fundamental physical limits, thus demanding a paradigm shift in materials and device fabrication techniques. Two-dimensional (2D) atomically thin materials along with their heterostructures have shown exceptional electrical, optical, mechanical, thermal, and chemical properties that provide avenues to innovate newer and smaller devices with promise for delivering higher performance and energy efficiency. However, fundamental understanding of carrier transport in terms of their microscopic origin and their scattering mechanisms are necessary to elucidate the device physics of such 2D transistors. This talk will discuss about the design and fabrication of 2D heterostructure graphene field effect transistor (2D-HGFET) devices, understanding their electrical transport properties by investigating various carrier scattering mechanisms, and characterize the fluctuations in the carrier transport by studying the electrical noise also called as 1/f low-frequency noise. I will discuss a comprehensive description on the correlation between electrical transport and 1/f noise in 2D-HGFET devices that my group is doing in relating to graphene and hexagonal boron nitride materials. Both noise analysis and transport properties were used to estimate the trap energy levels in the devices.

Bio:

Suprem Das is currently an associate professor in Industrial and Manufacturing Systems Engineering at Kansas State University. His research area is Carbon Nanomaterials and other 2D materials for fundamental research as well as applied to electronics, sensing, and energy. His research is split into 2 areas: device physics (today's talk) as well as scalable manufacturing for sensing and energy. He is the recipient of a number of awards such as NSF CAREER Award, NSF-UKRI Award to study signal in the soils, K-State GRIP award, and more recently NSF Global Center Award that will start from January 2025. He received PhD in Physics from Purdue University in 2023 and from Fall 2017 he has been in K-State Engineering.