

## **Title: “*Versatility of GaN-based Heterostructure Nano transistors*”**

### **Abstract:**

In recent years the exponential research activities in the field of microelectronics leads to several detrimental effects due to scaling of Si based conventional MOS transistors. Due to excessive scaling it becomes challenging to maintain the performance of such devices. Thus, there is a need to investigate new channel materials with improved device structures. Gallium nitride (GaN) and related alloys, exhibit superior physical properties that can better be an alternative to satisfy the demand of increased power, frequency, switching speeds, operating temperature and high breakdown voltage of the devices.

Although the wide band gap and high breakdown field property of the GaN material, AlGaN/GaN high electron mobility transistors (HEMT) can be used at very high voltage but at the same time the high mobility of GaN channel leads to leakage and current collapse. These limitations can be overcome by replacing with high K dielectric materials between gate and AlGaN, such as HfO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and HfAlO etc. Addition of these gate dielectric materials in the HEMT gives rise to Metal-Oxide Semiconductor High Electron Mobility Transistor (MOS-HEMT). The breakdown voltage of this AlGaN/GaN MOS-HEMT can be further improved by using Field Plate and passivation layer. Due to polarization effect there is a 2DEG in the GaN channel which makes the GaN based HEMTs generally depletion mode type but the introduction of recessed gate technique in AlInN/GaN HEMT with p-GaN back barrier will transferred to enhancement type, which is very helpful for power switching applications. Moreover, after applying the gate engineering technique in enhancement mode n<sup>++</sup>GaN/InAlN/AlN/GaN HEMTs shows enhanced RF performance. Therefore enhancement type GaN based devices are very much useful for various applications such as power switching application, high frequency microwave application, information technology application, LiDAR technology, medical applications and many more.