High Electron Mobility Transistors (HEMT) based on III-Nitrides have demonstrated excellent microwave performance as power transistors, owing to the large bandgaps of the materials they are as made of, as well as the high band offset and high electron mobility observed in the AlGaN/GaN heterojunctions. Nevertheless, the microwave performance of GaN HEMTs is still largely determined by their surface condition due to the inherent high polarization fields present in their epistucture. Such performance degradation mechanisms are often referred as Gate-lag.

In this paper, different surface engineering approaches for mitigating negative surface influence on the device performance are investigated. Different passivation materials, dielectric deposition methods, device fabrication technique and epistucture (GaN Cap layers) device (recess) have been studied for the optimization of GaN device performances. As a result, optimized structures have demonstrated about 6 W/mm and 10 W/mm of CW output power density for GaN HEMTs grown on sapphire and SiC respectively.