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Comparison of the Electrical Performance of AlN and HfO2 Passivation Layer in AlGaN/GaN HEMT

Abstract

Different material thicknesses with medium and high dielectric constants impacts the performance and reliability of high electron mobility transistor devices. The effect of varying the thickness of the passivation layer on the device performance is still unclear. Two different insulator layers with a medium dielectric and a high dielectric constant, namely Aluminium Nitride and Hafnium Oxide, are used as passivation layers in AlGaN/GaN HEMT. Both material performance, which was simulated via COMSOL software by varying the thickness, and the drain current output were compared. The passivation layer thickness of 10nm at Vds=6 V and Vgs=5 V, HfO2 outperforms AlN with an output drain current of 39 mA compared to 35 mA, respectively. It was observed that HfO2 can attain a higher threshold voltage, Vth, as compared to the AlN because of the influence of its material properties that show a direct proportional relationship between Vth and the dielectric constant. Using a high dielectric constant material like HfO2, we observe the ON-voltage gradually decreases as the thickness of the passivation layer increases. Out of all the thicknesses simulated for HfO2 and AlN, 10 nm produced the highest drain current output instead of a layer thickness of 20nm.

Keywords

AlGaN/GaN; Aluminium Nitride; and HEMT; Dielectric constant; Hafnium Oxide; Passivation layer; Threshold Voltage