Comparative Studies of AlGaAs/InGaAs Enhancement/Depletion-Mode High Electron Mobility Transistors with Virtual Channel Layers by Hybrid Gate Recesses Approaches *

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Unlike the conventional GaAs- and InP-based enhancement/depletion-mode (E/D-mode) transistors, the improved gate characteristics of the AlGaAs/InGaAs E-mode high electron mobility transistors (HEMTs) by way of hybrid gate recesses to remove the n-AlAs/i-GaAs/n-AlGaAs virtual channel layers upon 2DEG channels are demonstrated. As compared to the D-mode device (sample A), the gate reverse currents are effectively reduced by 45 and 102 times for the E-mode devices with additional gate recess time of 24 sec (sample B) and 30 sec (sample C) to remove part of the virtual channel layers, respectively. Under gate forward bias, the hybrid gate recesses also enable the gate turn-on voltages to increase. Furthermore, the threshold voltages of -1.25, 0.09, and 0.22 V are observed in the samples A, B, and C, respectively. The maximum transconductances of 187.3, 209.2, and 243.4 mS/mm and saturation current density of 482.8, 410.6, and 347.4 mA/mm are obtained in the samples A, B, and C, respectively.

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