Reducing Thermal Crosstalk in Multi-Finger AlGaN/GaN HEMTs Through Central Source Length Modulation

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This study investigates the thermal and DC characteristics of single-finger, two-finger, and four-finger AlGaN/GaN high-electron-mobility transistors (HEMTs) by considering the self-heating effect and thermal crosstalk, which arise in multi-finger HEMTs degrading the device performance. As the number of fingers increases, the maximum channel lattice temperature of the device increases due to the thermal crosstalk between gate fingers, leading to decreased maximum drain current. To investigate electrical operational degradation caused by thermal crosstalk in multi-finger HEMTs, we first compare the distribution of channel lattice temperatures across the multiple fingers and analyze how this affects their DC characteristics. Then, we simulate the time-dependent global device temperature of the three structures with transient thermal analysis to define device operation stability. To overcome the deteriorated thermal characteristics and DC performances of the four-finger HEMTs, we propose a multi-finger design to mitigate thermal crosstalk by modulating the centrally located source contact length to distribute the heat effectively. This design increases the distance between the second and third gate fingers, where the most dominant crosstalk occurs, demonstrating the potential for enhanced thermal stability in devices using this new configuration. These comprehensive insights into four-finger HEMTs, addressing both thermal behavior and degradation mechanisms, offer promising solutions to overcome the reliability and performance challenges posed by thermal effects in AlGaN/GaN HEMTs and other power devices.

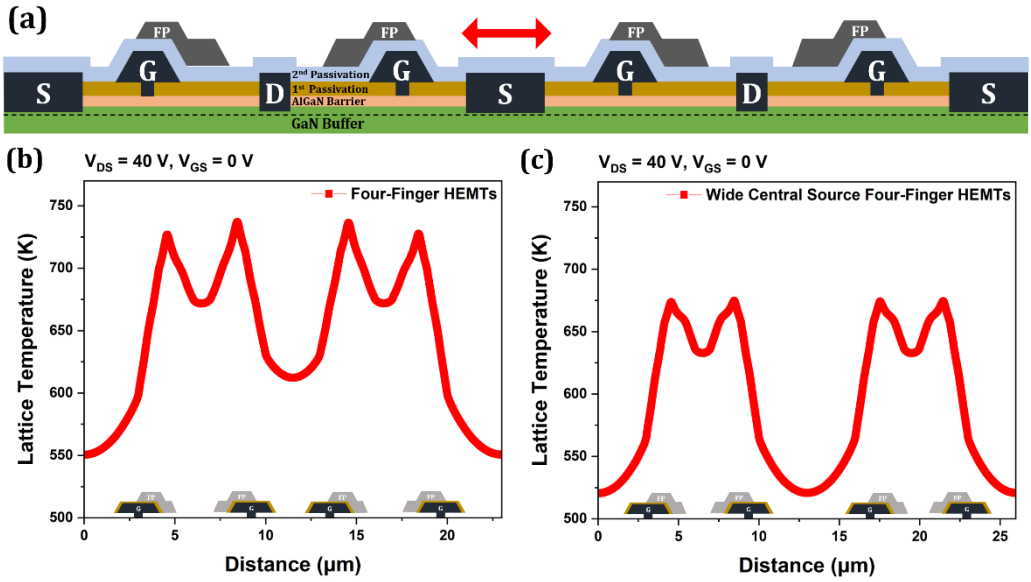

Figure 1. Two dimensional schematic diagram and lateral lattice temperature in the two-dimensional electron gas (2-DEG) channel of AlGaN/GaN HEMTs: (a) four-finger HEMTs; (b) lateral lattice temperature in four-finger HEMTs; (c) lateral lattice temperature in wide central source four-finger HEMTs

Acknowledgments This work was supported by Institute of Information & communications Technology Planning & Evaluation(IITP) grant funded by the Korea government(MSIT) (No. 2021-0-00760), as well as the Institute of Civil Military Technology Cooperation, funded by the Defense Acquisition Program Administration under grant No. 22-CM-15.