2.4-V Operated Enhancement-Mode Pseudomorphic HEMT's for Wireless Communications

E. Y. Chang*, S.H.Chen* and S. P. Wang**
*Department of Materials Science,
National ChiaoTung University,
Hsinchu 300, Taiwan, R.O.C.
**Hexawave Inc., Hsinchu 300, Taiwan, R.O.C.

Digital wireless communication systems need single voltage operated power devices with good power performance for handset application. Single-voltage operation devices, such as enhacement–mode GaAs field effect transistors (FET's) and GaAs hetrojunction bipolar transistors (HBT's) are the candidates for this application and enhancement-mode pseudormorphic high electron mobility transistors (E-PHEMT's)(1-2) are believed to be the best solution for the application when the operation voltage of the devices was reduced to below 3 volt.

In this work, high–performance E-PHEMT's for digital wireless communication systems were successfully developed. The wafers used in this study were molecular beam epitaxy (MBE) grown and (1 0 0)-oriented 3 inch wafers. The device process includes mesa isolation, Au/Ge/Ni ohmic contacts formation, wet chemical gate recess, Ti/Pt/Au gate metal formation, silicon nitride passivation, gold-plated airbridge formation, and final wafer backside thinning and metallization for heat dissipation. The manufactured E-PHEMT's have excellent performance in the DC and RF characteristics. Fig. 1 shows the I-V curve of the device with 120 μm gate width. The threshold voltage of the device is 90 mV. The maximum saturation drain current density at Vgs=1.0 V is 361 mA/mm. As shown in Fig. 2, the maximum transconductance measured at Vds=2V is 490 mS/mm. The drain to gate breakdown voltage Vbdg is defined as Vdg at which drain to gate current reaches 1mA/mm. The measured Vbdg is around 6.5 V. RF performance of the E-PHEMT's were measured. Fig. 3 shows the power performance of the 3 mm-wide device. The test frequency is 1.8 GHz and the bias condition is at Vds= 3.6 V with drain idle current of 700 mA. The linear gain is 20.22 dB. The device shows a maximum output of 28.88 dBm with power added efficiency (PAE) of 50 %. The 20 mm-wide devices were also tested. The test frequency is 1.9 GHz. The testing condition is at Vds=2.4 V with drain idle current of 600 mA. As shown in Fig 4, the linear gain is 13.13 dB. The device has a maximum output power of 31.08 with a PAE of 51 %.

The developed E-PHEMT's show high transconductance, high current density, and hence high power gain and excellent power performance at 1.8 GHz. The devices developed are suitable for low voltage single power supply handset application.

ACKNOWLEDGMENTS

The work was sponsored jointly by the Ministry of Education and the National Science Council, R. O. C., under the contact: 89-E-FA06-2-4.

REFERENCES

1. Jin-Ping Ao, Qing-Ming Zeng, Yong-Lin Zhao, Xian-Jie Li, Wei-Ji Liu, Shi-Yong liu and Chun-Guang Liang, IEEE Electron Device Lett., **21**, 200 (2000).
2. Mahajan A, Arafa M, Fay P, Caneau C, Adesida I., IEEE Trans. on Electron Devices, **45**, 2422 (1998).

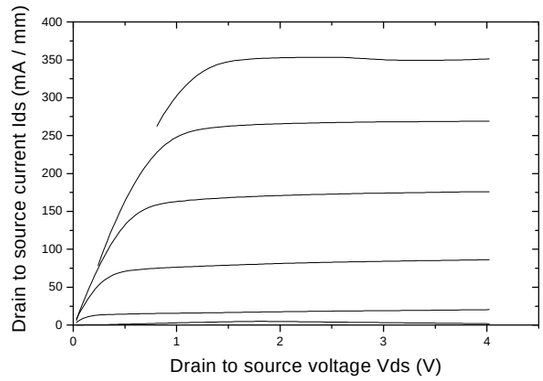

Fig. 1 I-V curves of the 120 μm-wide E-PHEMT. Gate bias voltage is from 1.0 V (top) to 0 V (bottom) with step 0.2 V.

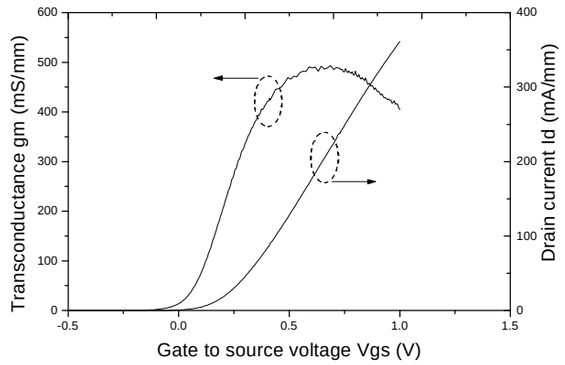

Fig. 2 Transfer characteristic of the 120 μm-wide E-PHEMT at Vds= 2 V.

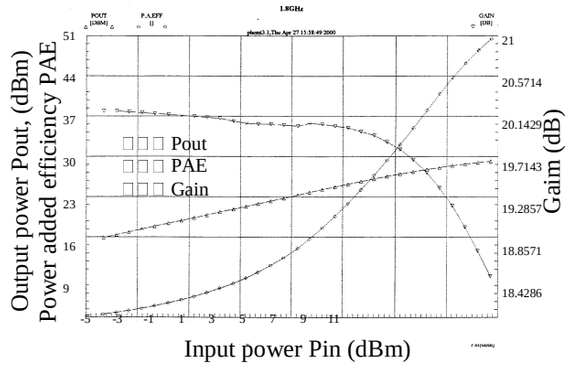

Fig. 3 Power performance of the 3 mm-wide device at 1.8 GHz, Vds=3.6 V, drain idle current=700 mA.

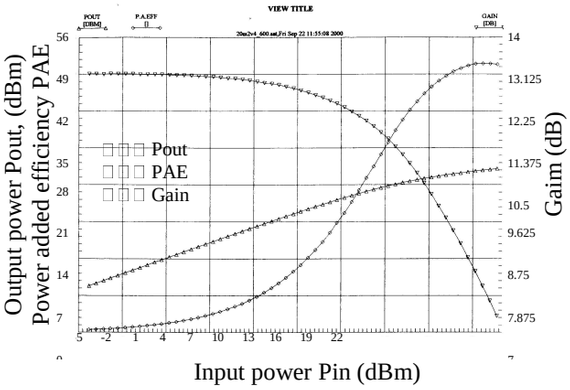

Fig. 4 Power performance of the 20 mm-wide device at 1.9 GHz, Vds=2.4 V, drain idle current=600 mA.