Extended Abstracts of the 2006 International Conference on Solid State Devices and Materials, Yokohama, 2006, pp. 624-625

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Highly-Stable Thermal Characteristics of a High Electron-Mobility Transistor with a Novel $In_{0.3}Ga_{0.7}As_{0.99}N_{0.01}$(Sb) Dilute Channel

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Abstract

This work reports, a high electron-mobility transistor (HEMT) using a dilute nitride $In_{0.3}Ga_{0.7}As_{0.99}N_{0.01}$(Sb) channel, grown by the molecular beam epitaxy (MBE) system. The advantages by introducing the surfactant-like Sb atoms during growth of InGaAsN/GaAs quantum well (QW) consist of the suppression of the three-dimensional growth and the improved interfacial quality of the QW heterostructure. Besides, the present device exhibits highly stable thermal characteristics due to the improvement in the channel confinement capability by using a novel, low-gap and dilute $In_{0.3}Ga_{0.7}AsN_{0.01}$(Sb) channel. The thermal threshold coefficient ($\partial V_{th}/\partial T$) is superiorly low to be -0.807 mV/K, with improved high-temperature linearity ($\partial GVS/\partial T$) of only -0.053 mV/K. Distinguished high-temperature device characteristics, including the peak extrinsic transconductance ($g_{m,\,max}$) of 96 (109) mS/mm and the gate-voltage swing (GVS) of 0.653 (0.661) V at 450 (300) K, respectively, have been achieved in this work.

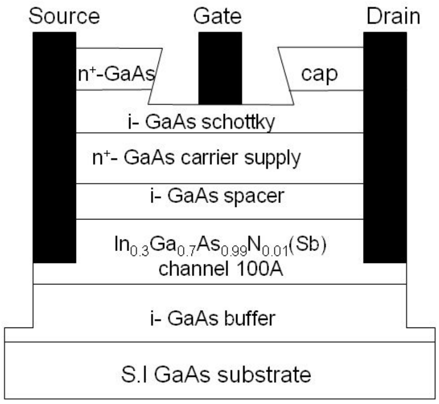

Fig.1 The schematic cross section of the studied GaAs/InGaAsN(Sb) device.

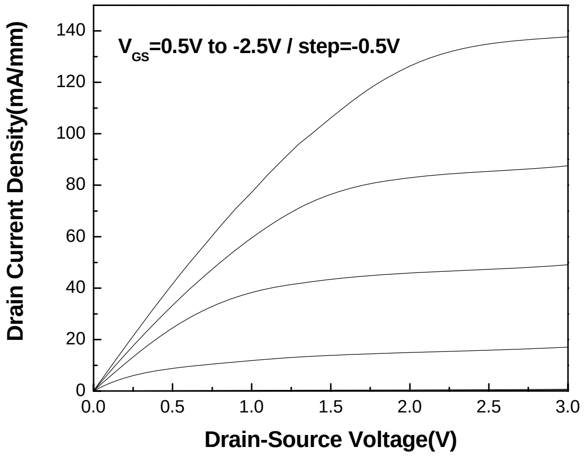

Fig.2 Common-source I-V characteristics of the studied device at room temperature.

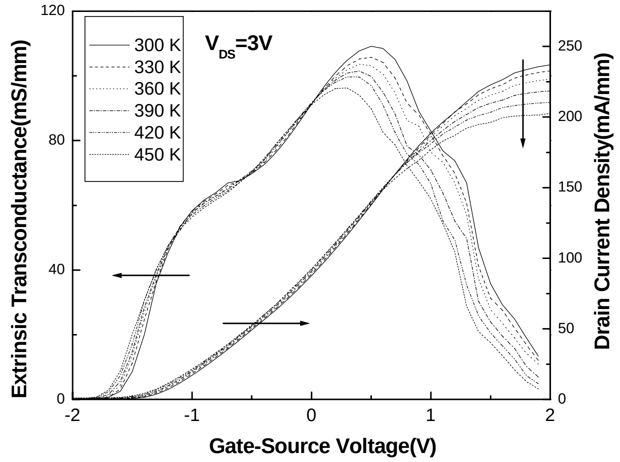

Fig.3 Extrinsic transconductance and the drain-source saturation current density as a function of the gate-source bias (V_{GS}) at elevated temperatures.

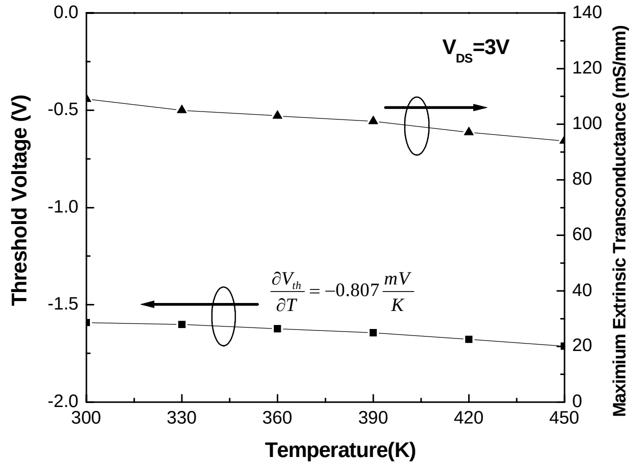

Fig.4 Maximum extrinsic transconductance and threshold voltage variation as a function of temperatures at V_{DS} = 3 V.