A 60GHz high power composite channel GaInAs/InP HEMT on InP substrate with L_G=0.15µm.

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In this paper, we have improved power performances by studying different GaInAs/InP composite channel structure *(figure 1)*. Also, different gate to drain extension devices have been processed. By using composite channel devices, we benefit from a better ionization threshold energy of InP compared to GaInAs (1.69eV against 0.9eV). The difference of conduction band offset between the two materials (ΔE_C=0.2eV) makes possible the electrons transfer from GaInAs to InP layer with the same electronic properties instead of increasing energy and ionizing in GaInAs channel [1-7]. New process technology have been applied to compare these structures [8]. I-V characteristic is given in *figure 2*. The components exhibit a drain current I_{DS}(940mA/mm) at V_{GS}=+1V. The Schottky characteristic in reverse gate to drain diode is –8V. The S-parameters are extracted from 0 to 50GHz. The cut-off frequency F_T is 120GHz and the maximum oscillation frequency F_{MAX} is 270GHz obtained with a 0.15µm gate length. The gate current resulting from the impact ionization phenomena (*figure 3)* were measured. It have been shown that the structure B present a better gate current issued from impact ionization. It is lower to 70µA at V_{DS}=5.5V for a large extension device which constitute the better result among the three structures. Also, we improve power performances at 60GHz by reducing GaInAs channel and substitute the delta doping by a bulk doping. Devices generated 306mW/mm (*structure A*), 422mW/mm (*structure B*) and 385mW/mm (*structure C*) at V_{DS}=3V and V_{GS}=-0.7V.

The structure and the topology play a significant role in term of performances optimization. Our results suggest that the extension of drain reduce the gate currents resulting from impact ionization and the structure optimization improves the power performances by improving carrier confinement in the channel. At 60GHz, we obtained (structure B) a maximum power of 422mW/mm, a 5.4dB gain linear, a 44% of drain efficiency and a 15% of PAE (*figure 4*).

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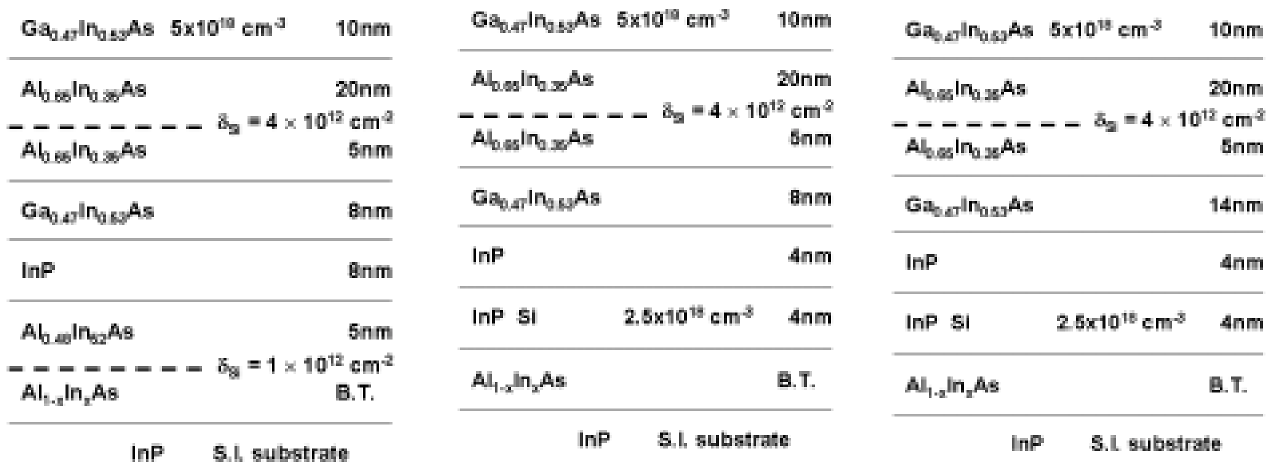

Epitaxy A | Epitaxy B | Epitaxy C

Figure 1: Structure of the HEMT with composite channel on InP substrate

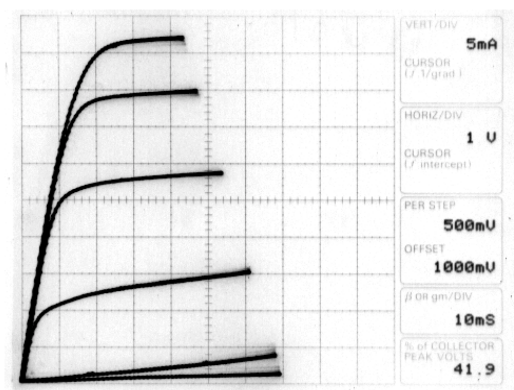

Figure 2: DC I-V of a 0.15x1x50µm^2 composite channel HEMT (V_{GSmax}=1V with a step of 0.5V)

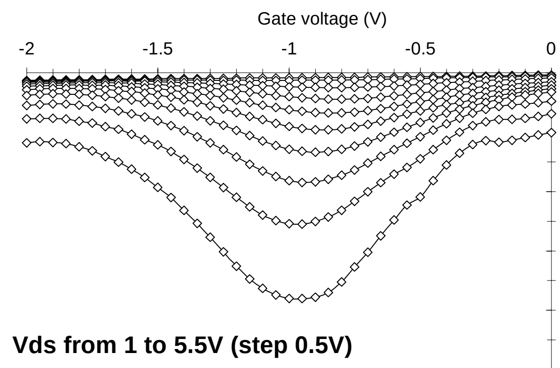

Figure 3: Gate characteristic in transistor operation of a HEMT 0.15x100µm^2

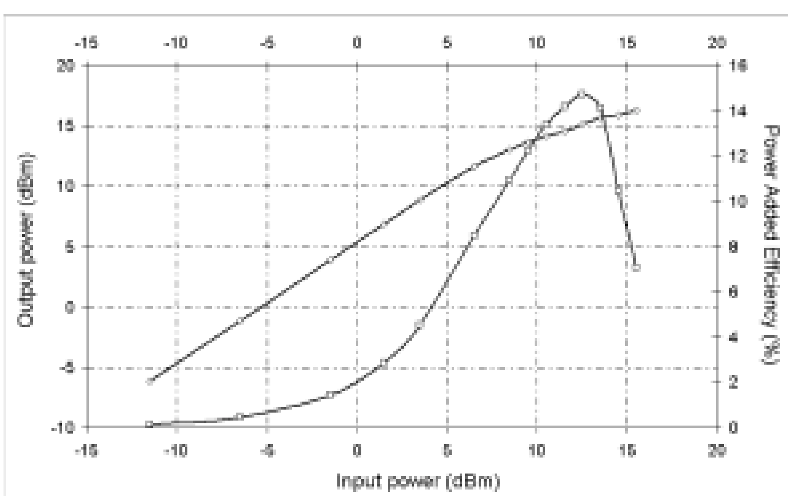

Figure 4 : P_{out}-P_{in} and PAE at 60GHz of a 2x50x0.15µm^2 Composite Channel HEMT (V_{DS}=3V and V_{GS}=-0.7V)