Fabrication and Simulation of $Ga_{0.51}In_{0.49}P/In_xGa_{1-x}As$ Doped-Channel FET's and MMIC Amplifiers Grown by GSMBE

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ABSTRACT

The *first* $Ga_{0.51}In_{0.49}P/In_xGa_{1-x}As$ ($0 \leq x \leq 0.22$) doped-channel FET's (DCFET's) grown by GSMBE (see Fig. 1) exhibiting excellent dc (see Fig. 2) and microwave (see Fig. 3) characteristics were successfully fabricated. A high g_m of 400 mS/mm, a high f_t of 47 GHz, and a high f_{max} of 94 GHz were achieved at 300 K for a $Ga_{0.51}In_{0.49}P/In_{0.15}Ga_{0.85}As$ DCFET with a 0.5 μm-long gate. The device also showed a very high maximum current density (650 mA/mm) and a very high gate-to-drain breakdown voltage (31 V). These values were quite high compared with other works of InGaAs channel DCFET's, MODFET's and HFET's [1-3]. Moreover, wide and flat characteristics of g_m, f_t and f_{max} versus drain current (or gate voltage) were attained for all DCFET's (see Fig. 3). Power performance of $Ga_{0.51}In_{0.49}P/GaAs$ DCFET, $Al_{0.3}Ga_{0.7}As/ In_{0.2}Ga_{0.8}As$ DCFET and HEMT were calculated. It is found that $Ga_{0.51}In_{0.49}P/GaAs$ DCFET provides the largest power among these three devices (see Fig. 4). These results demonstrate that high transconductance, high linearity, high speed and high breakdown voltage could be achieved by using $In_xGa_{1-x}As$ and $Ga_{0.51}In_{0.49}P$ as the channel and insulator materials, respectively.

The *first* MMIC local drive amplifier (LDA) (see Fig. 5) using $Ga_{0.51}In_{0.49}P/In_xGa_{1-x}As$ DCFET with x=0 as active component was successfully fabricated and exhibited excellent input and output VSWRs. The measured input and output VSWRs at central frequency were 1.19 and 1.12, respectively and were very consistent with the simulated results. The measured and simulated S parameters of this amplifier agreed very well as shown in Fig. 6. All these results indicate the great potential of using $Ga_{0.51}In_{0.49}P/In_xGa_{1-x}As$ DCFET's for microwave integrated circuit application.

REFERENCE

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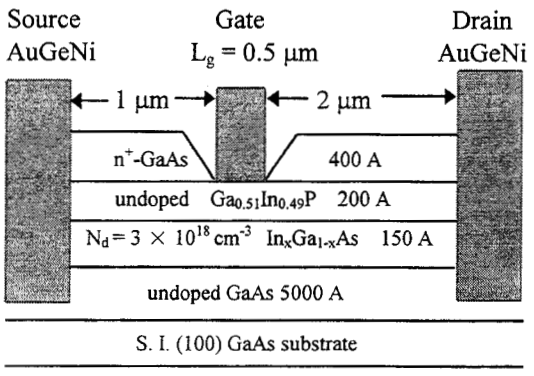

Fig. 1 Device cross-section of the GaInP/ $In_xGa_{1-x}As$ doped-channel FET's.

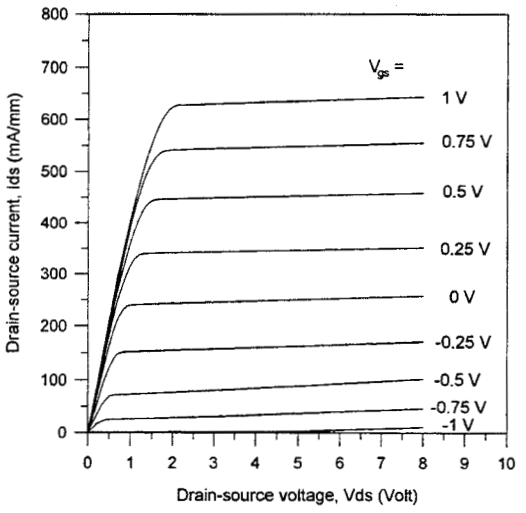

Fig. 2 Typical I_{ds}-V_{ds} characteristics of the GaInP/$In_{0.15}Ga_{0.85}As$ doped-channel FET's.

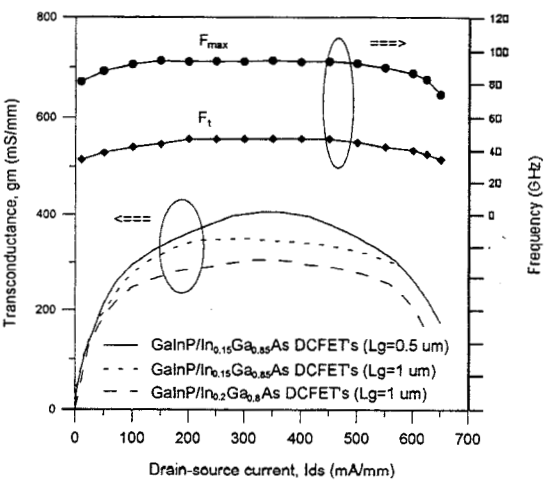

Fig. 3 The g_m, f_t and f_{max} v.s. I_{ds} characteristics of GaInP/$In_xGa_{1-x}A$ doped-channel FET's.

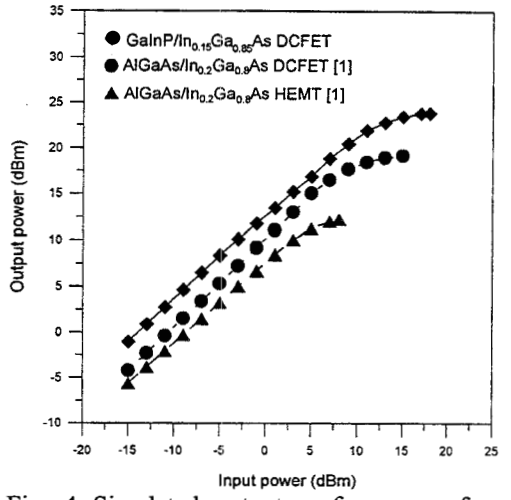

Fig. 4 Simulated output performance of power amplifiers at 2.4 GHz. (gate dimension : 1×100 μm^2)

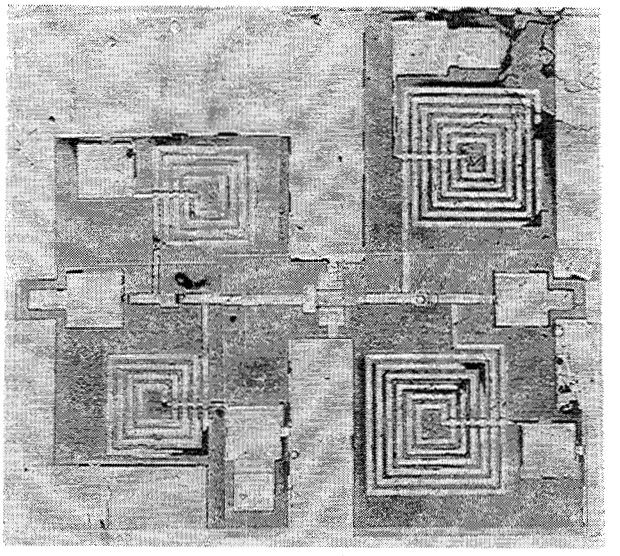

Fig. 5 Photograph of the GaInP/GaAs MMIC local drive amplifier.

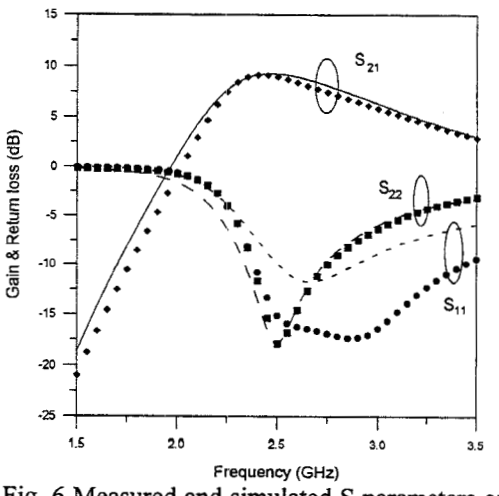

Fig. 6 Measured and simulated S parameters of the GaInP/GaAs MMIC local drive amplifier.