FETS : THE PAST, THE PRESENT AND THE FUTURE

(Invited paper)

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SUMMARY

The unipolar FET was proposed in 1952 by W. Shockley in a remarkable paper. Since this date, several significant improvements have been introduced in the original FET structure. Among the most significant, we can note:

- the introduction of the Schottky gate instead of a *pn* junction to improve the charge control efficiency,
- the buffer layer introduction and the modulation doped heterostructure to improve the electron transport,
- the recessed structure and the T-gate to reduced the parasitic resistances.

The conventional GaAs MESFET was the most commonly used device structure for microwave and high speed applications. With a reduced gate length, the same device can provide low noise and useful power gain up to the millimetre-wave frequencies. However, reducing the gate length with a constant device aspect ratio (scaling down rule) requires an increase of the doping level in order to maintain a reasonable pinch-off voltage value. The main drawback of this doping level increase is to diminish the low field mobility and, more generally, all the electron transport properties. To overcome this difficulty, the concept of modulation doped heterostructures was introduced in the late 1970s. This concept has led to the realisation of HEMT (High Electron Mobility Transistor) also called MODFET (Modulation Doped FET) or TEGFET (Two Dimensional Electron Gas FET). In this device, the free electrons are spatially separated from their parent donors, which significantly improves the electron transport properties especially at low temperatures. Three main transistor families were developed: the conventional AlGaAs/GaAs. HEMT, the pseudomorphic AlGaAs/InGaAs/GaAS HEMT and the lattice matched AlInAs/InGaAs HEMT grown on InP. The electrical performance of HEMTs is now superior than that of MESFETs for analog and digital as well as optoelectronic applications. Submicrometer gate field effect transistors MESFETs and HEMTs) exhibit outstanding gain, power and low noise performance up to 100GHz, a frequency that was unthinkable only a few years ago .

To further improve the device performance, several ways are explored. The decrease of the gate length, probably limited to 0.05µm to preserve a sufficient aspect ratio, can be associated to new materials (metamorphic growth) , new heterostructures (AlSb/InAs, AlGaN/GaN) as well as new topologies (vertical structures, quantum wire FETs...)

The final paper will be divided in three parts. In the first one, the FET history will be briefly recalled while the state of the art will be given in the second part. The probable future will be described in the last part .