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ANALYSING THE PERFORMANCE OF MOSFET BY VARYING THE SUBSTRATE MATERIALS

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Abstract: A numerical study on MOSFET an important electronic device has been investigated in this paper. Aluminium is used as gate material and the substrate material is varied. Different characteristics such as output characteristics, transfer characteristics andon state resistance are obtained for each of these devices. The results are then compared and analyzed. The performance of the devices can be identified with these characteristics and the device which suits the required specifications can be identified based on these analysis.

Keyword: MOSFET, output characteristics, transfer characteristics and on state resistance.

I.INTRODUCTION

MOSFET is considered as backbone of electronics. Ingenious engineering has allowed its size to be shrunk again and again without change to its structural design. Yet the IC design window of performance, dynamic power, static power, and device variation has shrunk to the point that major investment for a new transistor structure can be justified[1]. As gate length shrinks,MOSFET's Id-Vg characteristics degrade[2]. By varying the substrate material current value can be reduced without reducing the size of the device. This is done by simulation.

II.DEVICE DESIGN

Single gate MOSFET has one gate and Aluminium is taken as gate material. The substrate material is varied.

Source material: Aluminium
Drain material: Aluminum
Channel doping:1e+18 cm^-3
Gate material: Aluminium
Gate oxide: Silicon di oxide
Substrate materials: Silicon, Gallium arsenide and Aluminium Gallium Arsenide

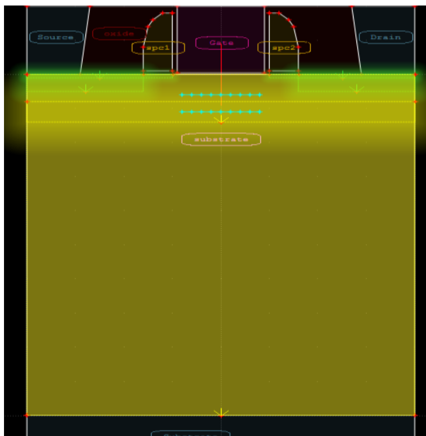

FIGURE 1:STRUCTURE OF MOSFET

III.SIMULATION RESULTS

In this section the output characteristic, transfer characteristics, on state resistance and power dissipation of MOSFET for various substrate material is calculated.

OUTPUT CHARACTERISTICS:
This plots the graph between drain voltage(VDS)and drain current (ID) for varying gate voltage (VGS)

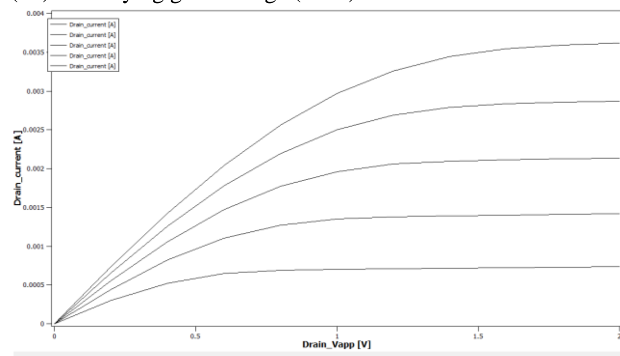

FIGURE 2:OUTPUT CHARACTERISTICS OF SILICON

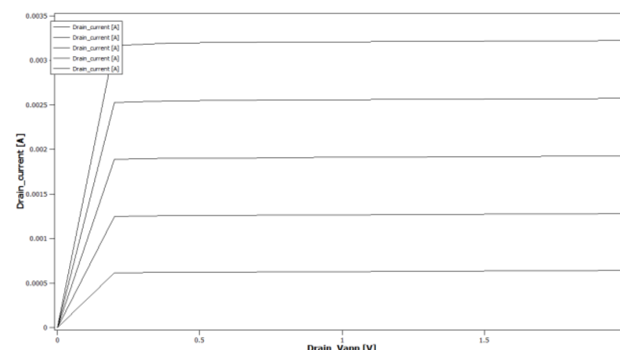

FIGURE 3:OUTPUT CHARACTERISTICS OF GALLIUM ARSENIDE

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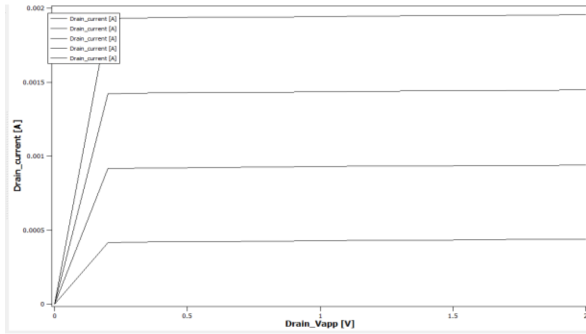

FIGURE 4:OUTPUT CHARACTERISTICS OF ALUMINIUM GALLIUM ARSENIDE

It can be seen from the graph that the drain current saturates early in case of Gallium Arsenide and Aluminium Gallium Arsenide. The response of those are an ideal one.

TRANSFER CHARECTERISTICS

This plots the graph between gate voltage (VGS) and drain current (ID) for a given drain voltage (VDS).

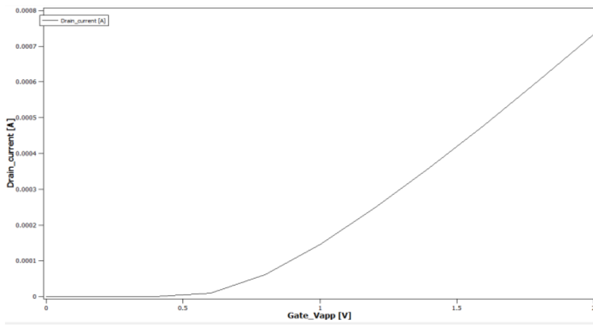

FIGURE 5:TRANSFER CHARACTERISTICS OF SILICON

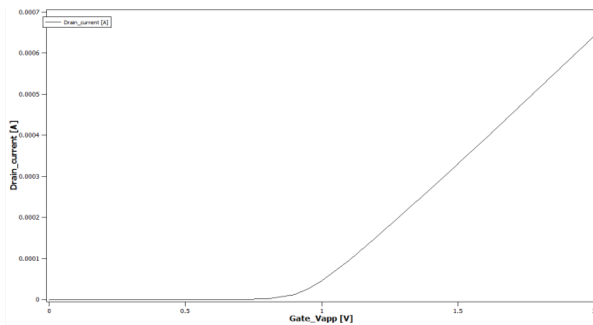

FIGURE 6:TRANSFER CHARACTERISTICS OF GALLIUM ARSENIDE

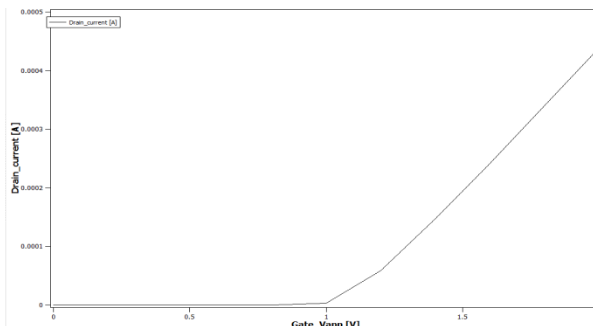

FIGURE 7:TRANSFER CHARACTERISTICS OF ALUMINIUM GALLIUM ARSENIDE

Silicon has lowest threshold voltage of 0.5v.Aluminium Gallium Arsenide has higher threshold voltage of 1v.

ON STATE RESISTANCE:

This implies the resistance of the device.

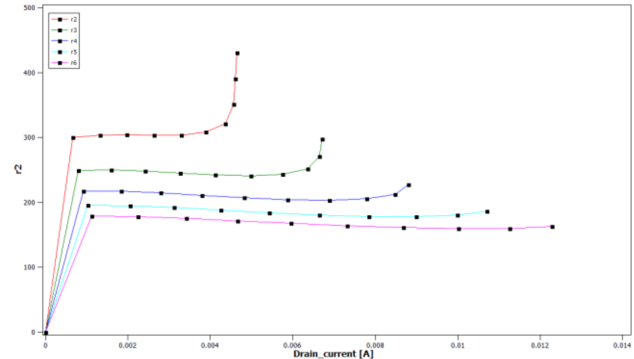

FIGURE 8:ON STATE RESISTANCE OF SILICON

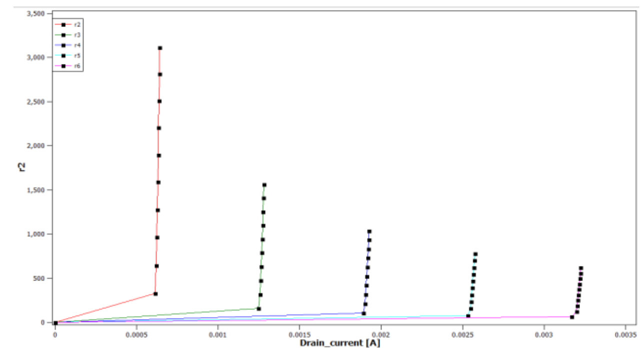

FIGURE 9:ON STATE RESISTANCE OF GaAs

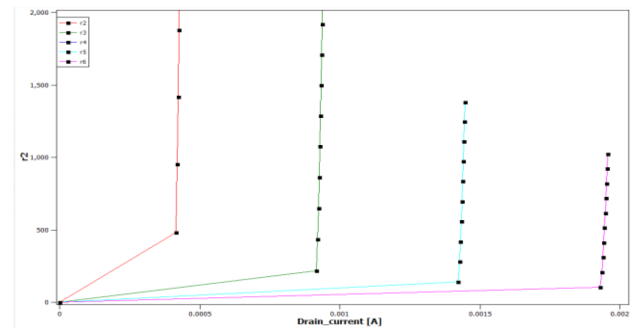

FIGURE 10:ON STATE RESISTANCE OF AlGaAs

The resistance of silicon is almost a constant after certain value.. The response of Gallium Arsenide and Aluminium Gallium Arsenide are similar but the value varies.

IV.CONCLUSION

Thus the various characteristics of MOSFET by varying the substrate materials is studied. Gallium Arsenide has lower drain saturation voltage but has higher threshold voltage. The on resistance of Gallium Arsenide is higher compared to other materials. Each substrate has a good value for one characteristics and moderate value for the other depending on the application we can choose the substrate material accordingly.

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