International Journal of Trendy Research in Engineering and Technology (IJTRET)
Volume 2 Issue 2(1) April 2018

ANALYSE THE PERFORMANCE OF MOSFET WITH HIGH DIELECTRIC GATE OXIDE

Gnanaselvi.G[1], Gopi. B[2]
[1] PG Student ,[2]Principal
Department of Electronics and Communication Engineering,
Arasu Engineering College, Kumbakonam, Tamilnadu, India
gnanaselviganesan@gmail.com
principal@aec.org.in

Abstract

Alternative method for replacing the conventional Silicon dioxide dielectrics in MOSFETs is using high dielectrics for low power applications . The objective of this paper is to analyse the performance of MOSFET with high dielectric gate oxide. In this paper we have shown a comparative study and analysis of n channel MOSFET designed with HFO2 in the place of silicon dioxide. Here we have been discussed the effect of HfO2 gate oxide on drain current of MOSFET. The Design and analysis have been done in the Visual TCAD software.

Keywords - *High dielectrics, N- CHANNEL MOSFET, SiO2, HfO2, Visual TCAD.*

I INTRODUCTION

In this modern day world of Electronics Era, the need for high speed electronic gadgets or systems is inevitable as they have become part of our day to day life. The sizes of these units were very big when they were introduced in the market, virtually because of the size of the CMOS device, which was used to build the above mentioned units. Based on the predictions of MOORE's LAW, the device size has to be reduced. Still this reducing size is burning topic to research. The size reduction so far targets the CMOS device, converging on device parameters like GATE LENGTH (Lg),GATE WIDTH (W) and OXIDE THICKNESS(tox).Right from the day of invention of IC's, the downscaling of this device started and many research papers were published on down scaling of CMOS device, based on any one of these device parameters.

II. DESIGN AND SIMULATION

The general process for 180nm MOSFET design involving the analysis of mesh, electrical testing and fabrication process. The first step to analyse the structure is device drawing. After that device drawing it include the mesh analysis. The numerical device simulation always relies on a mesh grid that divides the device into many small elements.

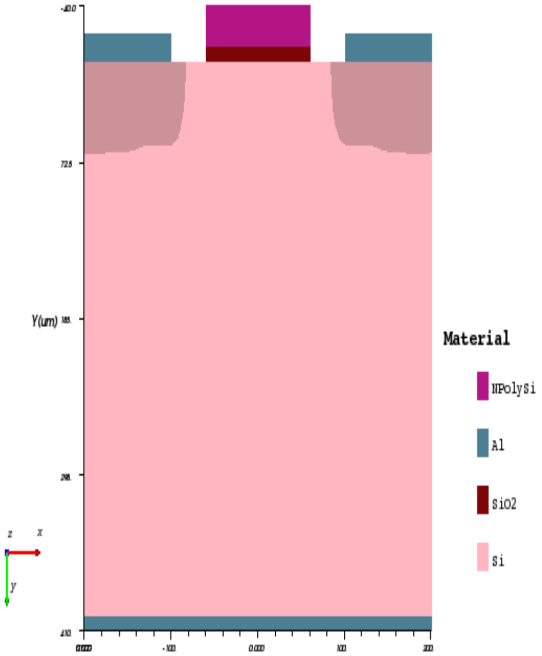

Fig. 1 Basic MOSFET structure with SiO2

The material and doping profile used in this structure as follows. For gate N type Poly Silicon is used for N-Channel Mosfet. The transistor requires a Gate-Source voltage, (VGS) to switch the device "ON". The enhancement mode MOSFET is equivalent to a "Normally Open" switch. This MOSFET operates only in the enhancement mode and has no depletion mode. It operates with large positive gate voltage only. It does not conduct when the gate-source voltage VGS = 0. This is the reason that it is called normally-off MOSFET. In these MOSFET's drain current ID flows only when VGS exceeds VGST [gate-to-source threshold voltage].

TABLE I

Region	Material	Mesh Size
Source/Drain	Al	0.01
Body	Si	0.03
Substrate Contact	Al	0.01
Gate	NPolySi	0.04
OOX	SiO2	0.003

Table 2: Doping Profile for MOSFET

Profile Name	Doping Name	Doping Species	Peak Concentration
SD/DD	Gaussian	Donor	1e+20
VT	Gaussian	Acceptor	1e+19
BODYDOPING	Uniform	Acceptor	1e+19

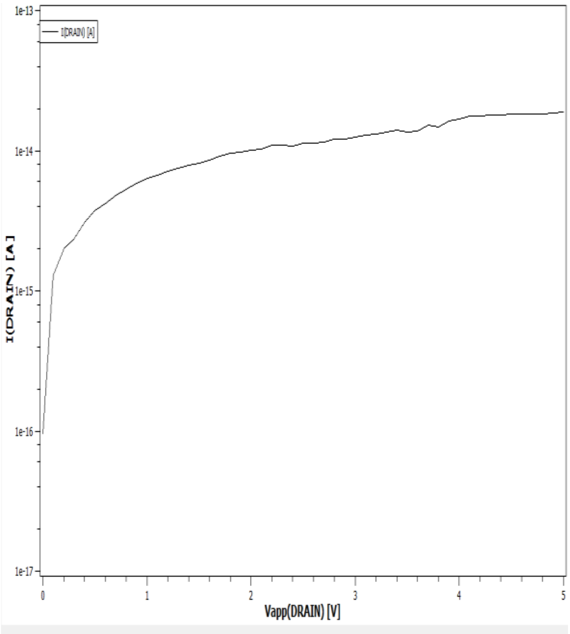

Fig. 2 Drain characteristic curve for MOSFET

The above figure shows the drain characteristic curve for basic MOSFET without altering the device parameter. The analysis is performed on drain current.

III. RESULT AND ANALYSIS

Gate oxide material that is silicon dioxide is replaced with Hafnium Dioxide. The figure shows the HfO2 as gate oxide without altering basic parameter. It gives the drain current analysis. The below figure shows the HfO2 used device.

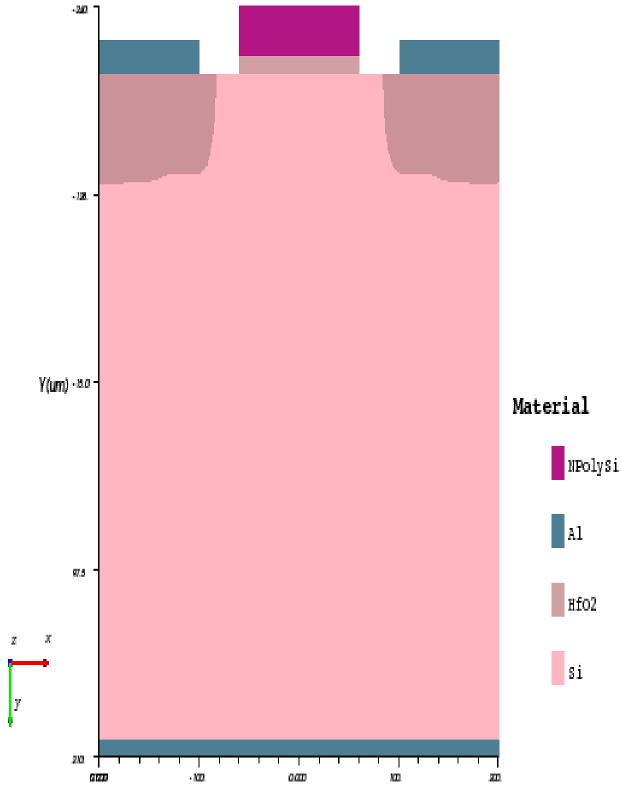

Fig. 3 HfO2 dielectric instead of SiO2

The mesh. Doping profile and material are also same as that of the Basic MOSFET except the gate oxide material.

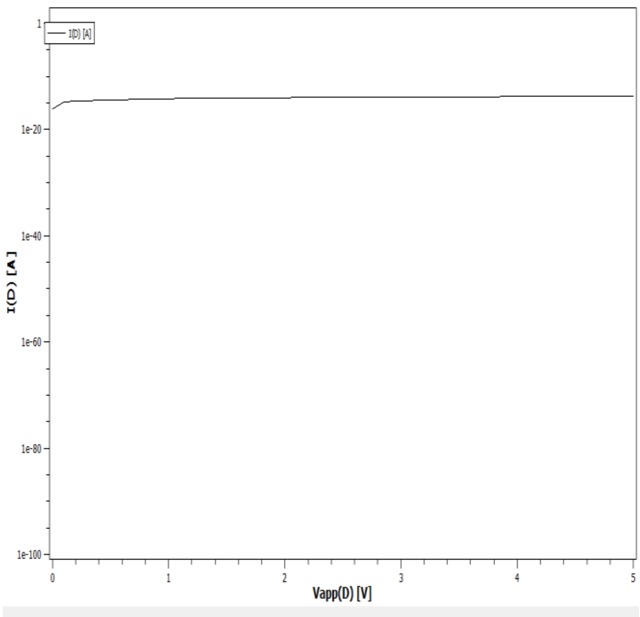

Fig. 4 Drain characteristic curve for HfO2

From above analysis the drain current value is very small than basic MOSFET. When the device current is low it will operate at low power. So the power consumption for this device is low.

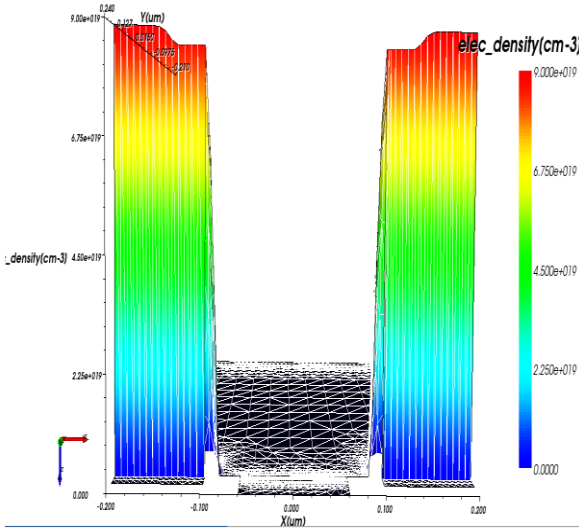

Fig.5 Electron Density of the MOSFET with HfO2

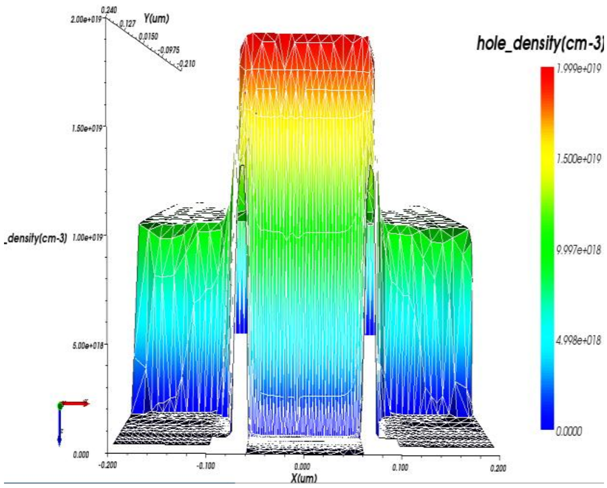

Fig.6 Hole Density of the MOSFET with HfO2

The figure 5 and 6 shows the electron and hole density of the HfO2 dielectric MOSFET.

IV. CONCLUSION

We have investigated that the HfO2 dielectric MOSFET provide a much earlier saturating low valued drain current as compared to Basic MOSFET. In many applications we need earlier saturating higher valued drain current. Our Simulation and analysis reflect that the desirable outcome of drain current can be achieved replaced the SiO2 with HfO2 layer.

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