

Star Flex Banner

Size - 36 X 36 Inch - 1 No.



Design and Analysis of Depletion type IGFET device in Visual TCAD

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Introduction

- The IGFET works on higher frequency compare to IGBT and it is use for lower power application [1].
- The Visual TCAD design tool provides new solution for the nature of various integrating circuits manufacturing. Visual TCAD provides the virtual prototyping of various devices in form fabrication and device characterization [2].
- It has been shown Input and output characteristics curves for various value of inputs, doping level, doping profile, simulation, visualization of charge density, electron flow, construction and functionality by using Visual TCAD (VTCAD) tool [3].

An architecture of depletion type IGFET

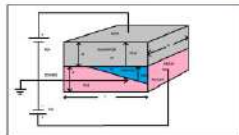


Figure: Depletion type IGFET structure

Depletion type IGFET in Visual TCAD

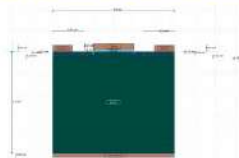


Figure: Depletion type IGFET in Visual TCAD

Reference Model Parameters of IGFET

Table: Reference Model Parameters of IGFET

Layers	Concentration per cubic cm	Material	Doping Species	Doping Profile	Characteristic length (XY ratio)	γ characteristic length
Substrate(body) P-type	$\times 10^{20}$	Aluminum	Acceptor	Uniform	1	Si 0.1 Al 0.1
Drain N type	Hdr2 : $\times 10^{20}$ Ldr2 : $\times 10^{20}$	Aluminum	Donor	Gaussian	Hdr 0.8 Ldr 1	Hdr 0.025 Ldr 0.005
Source N type	Hdr1 : $\times 10^{20}$ Ldr1 : $\times 10^{20}$	Aluminum	Donor	Gaussian	Hdr 0.8 Ldr 1	Hdr 0.025 Ldr 0.005
Vr P type	$\times 10^{15}$	Silicon	Acceptor	Gaussian	1	0.1
GATE	-	NpolySi	-	-	1	0.1
Oxide	-	SiO2	Insulator	-	1	0.005
Channel N-type	$\times 10^{17}$	-	Donor	Gaussian	1	0.005

Input characteristic of IGFET

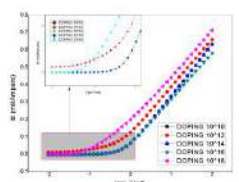


Figure: Input characteristic of IGFET with various concentration

Output characteristic of IGFET

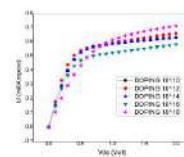


Figure: Output characteristic of IGFET with various concentration

Input characteristics of IGFET

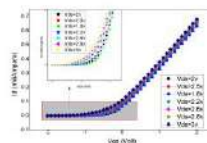


Figure: Input characteristics of IGFET : Id v/s Vgs at different Vds

Output characteristics of IGFET with Vds variation

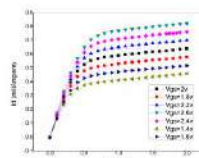


Figure: Output characteristics of IGFET : Id v/s Vds at different Vgs

Conclusion

- From this paper, It has been analyze that as doping of channel will get increases current is increases. Which shows that number of charge carrier will be more to pass the current and same time threshold voltage will also decreases and vice-versa for that case. In the case of constant Vds , by the increasing the value of Vgs channel formation will come in to the picture so up-to some extent or up-to Vgs = Vds occurs at that time device is in the picture so up-to some extent. After that, device come into the linear mode. As Vgs goes increases beyond Vt, current will grow exponentially. In the case of Vgs constant up to the pinch off voltage current grow linearly but beyond the pinch-off voltage device go in to the saturation. After the increment of Vds gives slight effect on the growth of current so, it means charge carrier recombination done at its maximum possible capacity so that device goes into the saturation.

Bibliography

- [1] J. Huang, "Characteristics of a depletion-type igfet," *IEEE Transactions on Electron Devices*, vol. 20, no. 5, pp. 513–514, 1973.
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- [3] Y. Pathak, B. D. Malhotra, and R. Chaujar, "Tcad analysis and simulation of double metal negative capacitance fet (dm ncfet)," in *2021 Devices for Integrated Circuit (DevIC)*, pp. 224–228, IEEE, 2021.