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Study of Device and Process Simulation with Technology Computer Aided Design

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Abstract

From the new Era of semiconductor industry [1] and the enhancement of new of devices from low scale to very large scale integration there is need of improvement for different properties of devices from traditional devices to short channel devices. There is need of Platform to perform from device simulation to process simulation .as requirement of Semiconductor industry. A new Platform as virtual fabrication available in different packages from different vendors known as technology computer aided design available in different models package for characterization of devices. Device simulation of Self heating[4] done for the short channel device from the package MEDICI.

Keywords: *T-CAD , SOI EDA, Self heating*

INTRODUCTION

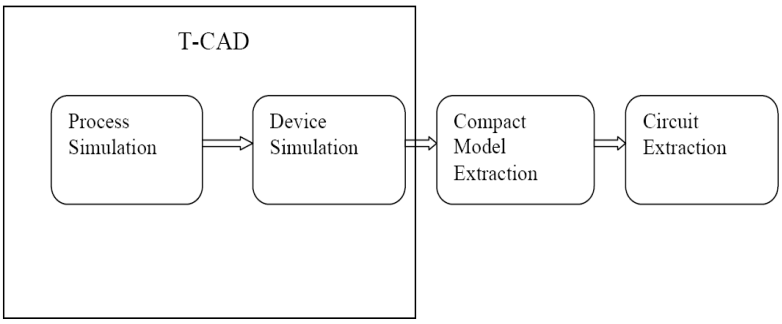

Figure: 1

The application of software tools in the development of new process and novel device structure has become a Worth While challenging alternative to the experiments route. Fabricating one chip in a modern process can cost considerably more than 10,000 dollars, and can take weeks or even months of effort .the use of accurate tool in proper computing environment allows for comparatively Inexpensive. the need of TCAD in industry is clear.Experiment have become extremely time consuming and escalating equipment cost have steadily reduced the number of experimental wafer that can be processed. Since the complexity of IC process to grow,computer based experiment using TCAD are essential for countering this experimental short fall if process is to be continue TCAD is powerful tool for development and production of integrated circuits. Strong connection to process technology process integration Characterisation design. due to complex processes even the most experienced process integration engineers may not be able to predict the impact of a process modification on the final device.

I MEDICI[8]

Medici is a powerful device simulation programe that can be used to simulate the behavior of MOS and bipolar transisitors and other semiconductor device. Medice models the 2-dimensional distribution of potential and carrier concentration in a a device. The programme can be used to predict electrical characterstics for arbitrary bias conditions.

MEDICI device simulation capabilities consist of electrical characterstics of 2D structure under specified operating conditions . Medici features an advanced automatic boundary conforming (ABC) meshing capability that generates meshes ideal for device simulation. This capability

will utilize the topography obtained from process simulation results and will create a mesh that conforms to interfaces between reg and to metallurgical junctions. This allows complex device structures to be meshed easily and efficiently for accurate and fast device simulation results.

MODELS AVAILABLE IN MEDICI

Input models are: Mesh generation

Physical models: mobility modelsolution and boundary specification electrical analysis,parameter extraction and optimization output models are: structure,mesh boundary,junction location depletion region solution specification mesh are:discretization,,gummel'smethod,Newton method's, Continuation method's

1) Mobility models available in Medici

2) Low-fieldmobility models,Concentration dependent mobility(CONMOB)

3) Analyticmobilitymodel(ANALYTIC),Carrier-carrier scattering model(CCSMOB)

4) Philips unified mobility model(PHUMOB)

5) Surface mobility models:

6) Surfacemobilitymodel(SRFMOB)Enhanced surfaced mobility models(SRFMOB2)

PHYSICAL MODEL AVAILABLE IN MEDICI [8]

Analytic

Specifies that concentration and temperature dependent mobility calculated.

SRFMOB2

An enhance surface mobility is used along semiconductor insulator surface which accounts for phonon scattering ,surface roughness scattering and charged impurity scattering.

TMPMOB

Specifies that a mobility model using a carrier temperatures –based effective field is used.

Stress2

Specifies that stress-induces change in the band gap are included in the solution. shifts of the conduction band are computed using deformation potential theory and shifts to the valence band are computed .

MESHING IN MEDICI

Medici features an advance automatic boundary conforming(ABC) [8]meshing capability that generates meshes for ideal device simulation.self consisitently solves poisson's equation the electron and hole continuity equation.

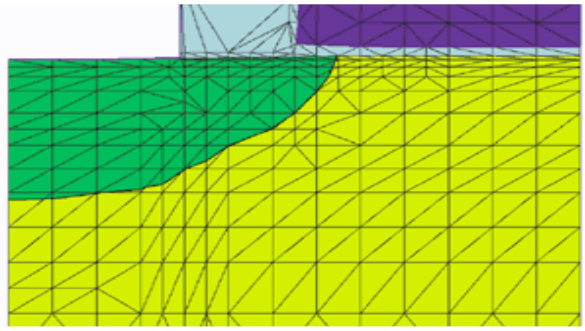

Fig:2

II. PROCESS SIMULATION [11]

Sentarus device is the new fully featured 2D and 3D device simulator that provides you with the ability to simulate a broad range of devices.Sentarus device is a multidimesnsional,electrothermal,mixed mode device and circuit simulator for one dimensional,two dimesnsional and three dimensional semiconductor devices.it incorporates advanced physical models and robust numeric method for the simulation of most types of semiconductor device from very deep sub-micron silicon mosfet to large bipolar power structure.

The step involves from device to fabrication is the process simulation .another package which is available in TCAD is Sentarus simulator from the vendor Synopsys.Sentarus process is complete and highly flexible ,multidimensional ,process modeling environment.sentarus process accept input a sequence of commands that is either entered from standard input or composed in command file.

Sentarus process[9] is deisgned to address the challenges of integrated circuit process modeling .as technology development continuous ,the need for new process models increases.Sentarus process perform the mesh and geometry operations.in two dimensional MGOALS library performs geometric etching and Deposition.Anistropic,Isotropic,Directional, Polygonal and crystallographic types of etching is performed.

III SELF HEATING SIMULATION[10]

According to the study of self-heating is proportional to the square root of the buffer thickness. Increasing the buffer thickness reduces defect levels and achieves the higher degrees of relaxation but adversely increases self-heating and fabrication cost. Reducing the buffer thickness potentially reduces the self-heating.

Three major effect of SELF-HEATING EFFECT[3] are:

1) Decrease in carrier mobility.
2) A drop of threshold voltage.
3) Increase in saturation velocity.

As the comparison is based on a SOI device with and without self heating effect and the simulation results are achieved from MEDICI the temperature distribution obtained under the simulations is consistent with the output characterstics.

It exhibits the three dimensional temperature distribution of the SOI device .the x and y axes represent the horizontal and vertical dimensions of the device respectively the temperature in the substrate is minimum but because of self-heating the channel temperature rises . or we can say that there is rise in temperature of channel due to low thermal-conductivity of the buried oxide layer.

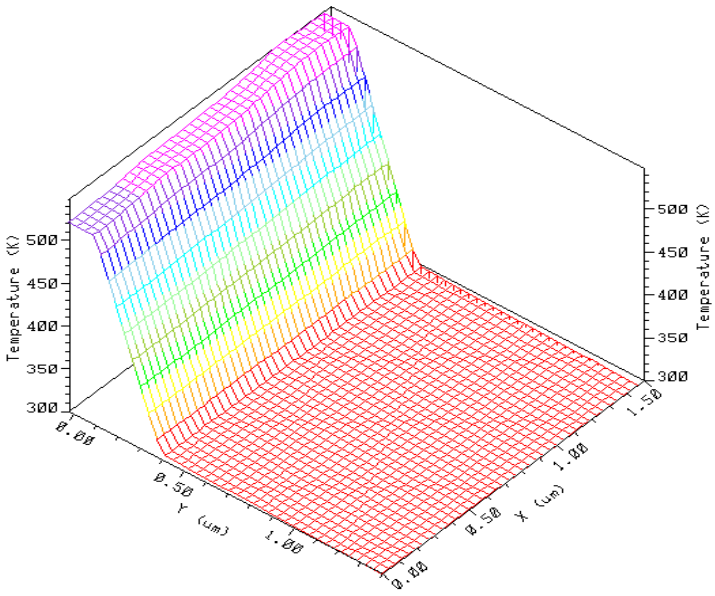

Fig:3

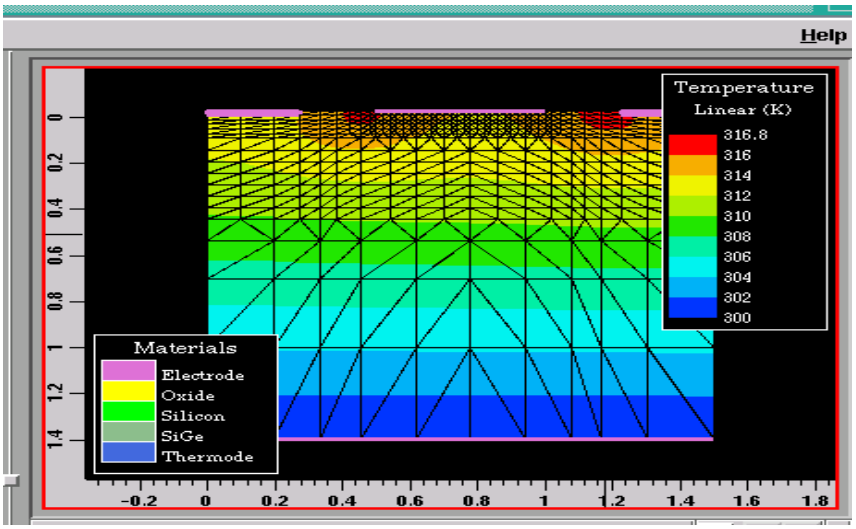

Fig:4

The full view of the temperature region variation in different region of the device.

CONCLUSION

The literature survey of TCAD simulator for the package MEDICI and Sentarus process editor has been mention with different models.For the theoretical investigation the self-heating effect there is modification of Poisson's equation and electron/hole current density equations and couple them with the heat flow equation used in MEDICI and the simulation of self-heating effect phenomena has been observed.the future work is focussed on various device structure and their geometry .and many issues like self-heating,stress generation,mobility can be resolved by using both device and process simulator .and the parameter value can be also extracted from the same plateform.

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