Simulation Standard

Connecting TCAD To Tapeout

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ISEN Advanced Diffusion and Oxidation Models Slated for Inclusion in ATHENA

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Advanced and Accurate New Boron Diffusion Model

BF2 P-channel LDD profiles and Boron Bipolar base implant profiles have been a significant source of error in process simulation. Damage introduced during implantation produces a transient enhanced diffusion effect as the dopant diffusion is coupled with the diffusing point defects. This situation needs to be improved in ATHENA.

A new agreement recently signed between ISEN in Lille, France and SILVACO will extend the capabilities of ATHENA to accommodate better physics to more accurately simulate this phenomena. The work developed at Lille has been well calibrated and includes a complex description of the initial conditions applied to the implant profile. In the case of an amorphising implant, a representative picture of both the point defect distribution and a Boron precipitate profile is introduced. This starting condition is then linked to a fully coupled diffusion model allowing accurate predictions of Transient Enhanced Diffusion.

Resulting sheet resistance calculations have been compared to a matrix of measurements and show very good agreement over a wide range of temperature, time and implant dose conditions.

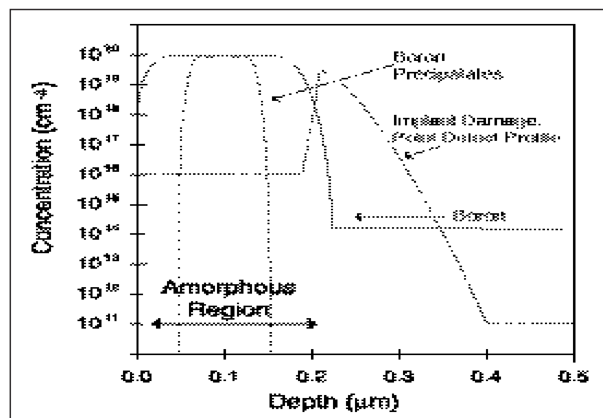

Figure 1. General Limited Conditions after Implantation.

Figure 1 indicates the starting conditions for diffusion. Damage and precipitates are included in the model.

Advanced and Accurate New Viscoelastic Oxidation Model

Many of the processes used in the manufacturing of silicon integrated circuits lead to the generation of stresses in the silicon substrate which are known to be the cause of device degradation or failure. Consequently, it is desirable to calculate this stress and use the result as a parameter for the design of integrated circuits. To be accurate, the simulation has to take into account the mechanical properties of all materials in a very wide range of processing conditions. In this purpose, the viscoelastic behavior is the most suitable.

Under the same agreement with ISEN, Silvaco will be including a new accurate viscoelastic oxidation model in ATHENA. This modeling will incorporate the explicit treatment of the reaction expansion as well as the stress effect on the oxidation kinetics and materials viscosity. Its calibration over a wide range of processing conditions ensures a correct prediction of the oxidation-induced stresses in silicon substrate even for very advanced isolation techniques such as SILO and PBL. These functions will extend the accuracy of the existing oxidation models of ATHENA into the areas of low temperature oxidation and dry oxidation ambients.

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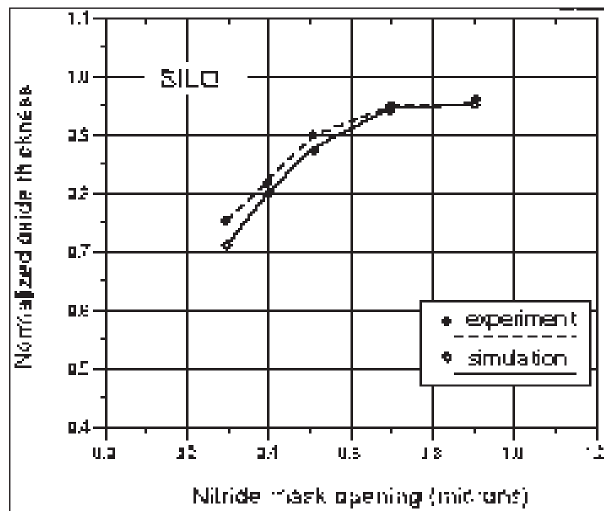

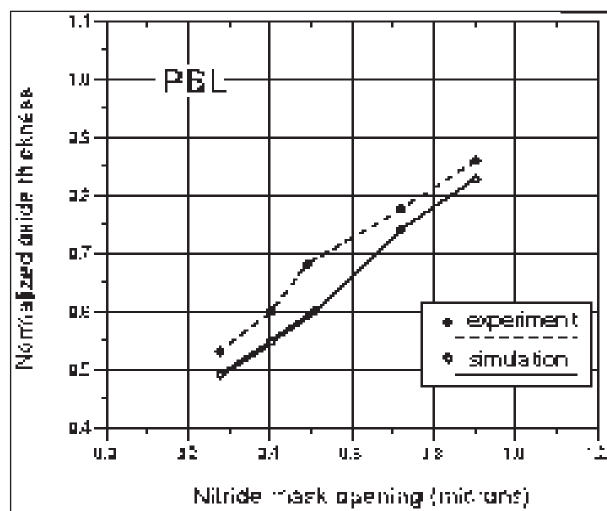

Figure 2. Experimental and simulation results giving the thinning of field oxide for a SILO (950°C) and PBL (1000°C) structures. The experimental data are referenced in [1] for the SILO and in [2] for the PBL.

Figure 2 reports comparisons between experiments and simulations on the thinning of field oxide for SILO and PBL structures.

References

[1] P. Molle S. Deleonibus and F. Martin, “Scaled interface local oxidation by rapid thermal nitridation,” J. Electrochem, Soc., vol. 138. p. 3732, 1991.

[2] J.W. Lutze. A.H. Perera and J.P. Krusius, “Field oxide thinning in poly buffer LOCOS isolation with active area spacing to 0.1mm,” VLSI Se & Tech. 1989, p.744, 1989.