THREE-DIMENSIONAL DEVICE MODELING WITH MINIMOS 5

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Since Silicon VLSI Technology has evolved to a standard that hundreds of thousands transistor devices are integrated in a single chip it has become crucial to understand even second order effects including three dimensional effects of basic device operation.The most recent and completed development of MINIMOS (version 5) allows the fully three-dimensional analysis of MOSFET's with a nonplanar boundary between the silicon surface and the insulator.

It has been tried very hard to find a proper balance between flexibility and simplicity regarding the specifications for the nonplanar three-dimensional interface, because demands on computational resources are a major concern. This holds particularly true because the implemented transport model includes additionally to the "classical" transport model composed of the Poisson equation and the continuity equations for electrons and holes modifications to the current relations and solutions to energy transport equations. This model has been published for the two-dimensional case implemented in earlier versions of MINIMOS [1], [2].

In order to utilize numerical methods applicable for modern vector-concurrent computers the three-dimensional simulation domain is embedded in a cube as indicated in Fig.1. This figure shows a typical "oxide body" for a LOCOS structure. The lower plane denotes the interface between the semiconductor and the oxide (or contact material). The upper plane represents the interface between the oxide and the contact material for the three respective contacts: SOURCE (on the left), GATE (in the middle), DRAIN (on the right). These two interfaces represent inner boundaries which are fitted by superimposed complementary error functions in an analytical manner. Fig.1 shows just one typical interface; the flexibility regarding the specifications can be judged from Fig.2 and Fig.3 which give a description of all the available 22 parameters for the length and width direction respectively. These specifications have proven to be sufficiently general to satisfy all needs of the user community which have been brought to our attention. It should be noted that the discretization of the various interface conditions can be performed exactly on the basis of our specifications. Significant meshing problems are definitely not introduced thereby. All grid generation is done fully automatically and adaptively (firstly) to assure an appropriate mesh for given simulation conditions and (secondly) to relieve users from the tremendous burden of specifying a mesh. The strategy for mesh design is based on the generalization to three space dimensions of equilibrating the local truncation error of the difference approximations to the differential equations (including the energy balance equations).

[1] Hänsch W., Selberherr S., **"MINIMOS 3: A MOSFET Simulator that Includes Energy Balance"**, *IEEE Trans.Electron Devices*, Vol.ED-34, pp.1074-1078, 1987.
[2] Selberherr S., **"MOS Device Modeling at 77K"**, *IEEE Trans.Electron Devices*, Vol.ED-36, pp.xxx-xxx, 1989.

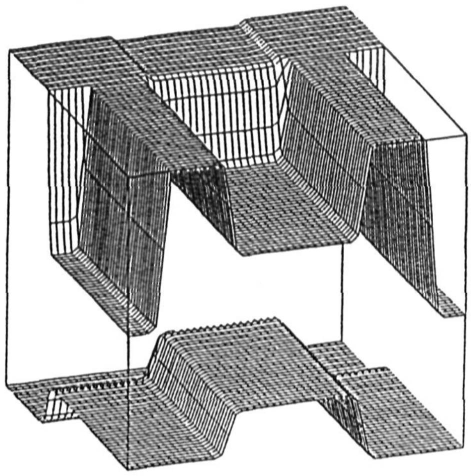

Fig.1 Typical oxide body

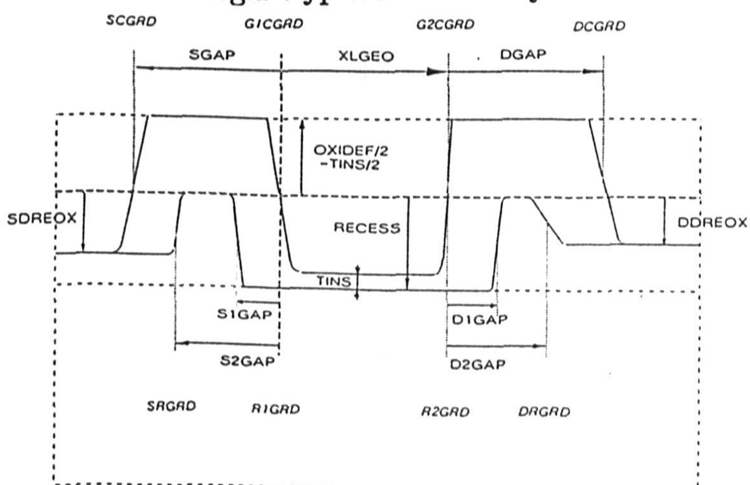

Fig.2 Oxide body parameters in length direction

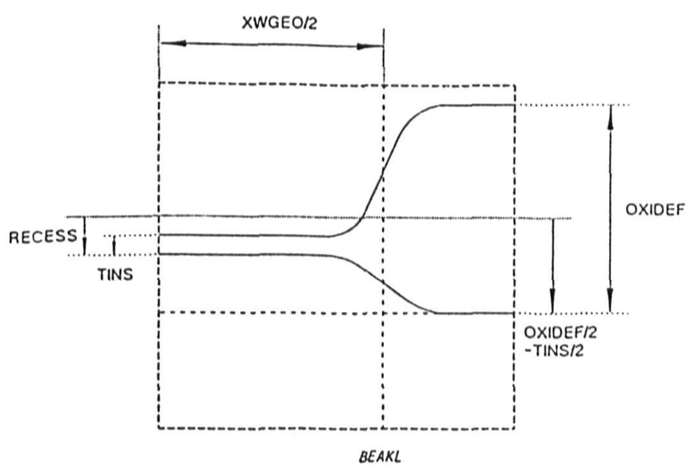

Fig.3 Oxide body parameters in width direction