Title:

TCAD Simulations of 3D Effects in Nonvolatile Memory Structures

Abstract:

The evolution of nonvolatile memories (NVMs) toward higher levels of integration is mainly based on decreasing the cell size, optimizing the geometry of the layer system, and introducing new materials. To meet these new technology requirements, more sophisticated TCAD simulation tools based on realistic and accurate models are needed to take into account the increasing relevance of three-dimensional (3D) effects.

In the present work, we apply 3D TCAD process and device simulations to flash nonvolatile memories to predict the impact of geometry-related issues on cell performances.

In particular, we show the geometric impact of polysilicon reoxidation and deposition of the oxide-nitride-oxide layers and we compare the effectiveness of different technology adaptations.

Further, we quantify, by comprehensive 3D device simulations, the effects on the cell performances due to the polysilicon overetch, that is, penetration of the floating gate into the shallow trench isolation and the rounding effects.

Finally, we extract by full 3D simulation the coupling coefficients of the flash cells and we investigate the impact of the shape and the material of the spacer. The proposed methodology is assessed and compared with the methods currently used in the industry.

All simulations are performed by an innovative device simulation tool and a 3D process emulator that generates boundary-conforming grids allowing for very fine descriptions of the complex geometry.

Authors:

Yves SAAD
Ph.D Student
ISE Integrated Systems Engineering AG
Affolternstrasse 52
CH-8050 Zurich / Switzerland
email: saad@ise.ch
Phone: +41 44 389 9737
FAX: +41 44 389 9797

Clement TAVERNIER
Manager Technical Support and Sales
ISE Integrated Systems Engineering AG
Affolternstrasse 52
CH-8050 Zurich / Switzerland
email: clement@ise.ch
Phone: +41 44 389 9707
FAX: +41 44 389 9797

Prof. Dr. Wolfgang FICHTNER
Integrated Systems Laboratory
ETH Zentrum, ETZ
Gloriastrasse 35
CH-8092 Zurich / Switzerland
email: fichtner@iis.ee.ethz.ch
Phone: +41 1 632 5333
FAX: +41 1 632 1194

Dr. Mauro CIAPPA
Integrated Systems Laboratory
ETH Zentrum, ETZ
Gloriastrasse 35
CH-8092 Zurich / Switzerland
email: ciappa@iis.ee.ethz.ch
Phone: +41 1 632 2436
FAX: +41 1 632 1194