Theoretical Simulations of Silicon-on-Nothing (SON) Structures

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Abstract

Silicon-On-Insulator (SOI) technology, as a current base for fabrication of metal-oxide-semiconductor devices, enables the reduction of parasitic device capacitances thus improving the performance. An alternative approach for manufacturing wafer configurations based on SOI is given by Silicon-On-Nothing structures (SON). Instead of ion implantation of oxygen or epitaxial layer growing, a thin insulating layer between the bulk substrate and a covering silicon layer results from a shape transformation process which is driven by annealing in hydrogen ambient at low pressure conditions [1]. The shape evolution of a trench patterned silicon substrate results in diverse cavities by varying initial conditions. As described in several studies, the size and the arrangement of the basic trenches are decisive for the transformation process besides the annealing conditions which are, in fact, time and temperature, and the existing pressure values [2]. Thus, the prediction of the shape evolution depending on different conditions improves controllability. Moreover, limitations for shape transformations are able to identify. A physical interpretation is suggested for morphological modifications of the micron-sized trenches using a model of surface migration. The shape transformation is expressed by the normal velocity of the surface. Fundamental driving mechanisms for the mass transport are surface diffusion and evaporation and condensation [3]. Mullins theory of thermal grooving, which describes shape evolution of isotropic surfaces, is used for the description of the normal velocity by considering surface diffusion [4]. Hence the atom flux on the surface, as a base for the normal velocity, is specified by gradients of the Gibbs-Thomson chemical potential. The development of an initial theoretical model based mainly in surface diffusion has been carried out by the use of the specialized simulation software COMSOL Multiphysics. For the execution of this model, custom boundaries PDE equations were used calculate the chemical potential and the velocity of the surface by the adaptation of Mullins' theory equations to the software interface. In addition, to Moving Mesh physics interface was used for transforming those results in a visual evolution of the simulated surface, giving a defined view of the morphological changes in SON evolution. A first result of transformation process is presented in Figure 1. More details and examples will be provided on the poster presentation.

Reference

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[3] K. Sudoh et al., Jpn. J. Appl. Phys. , 43, 5937 (2004).
[4] W. W. Mullins, J. Appl. Phys. , 28, 333 (1957).

Figures used in the abstract

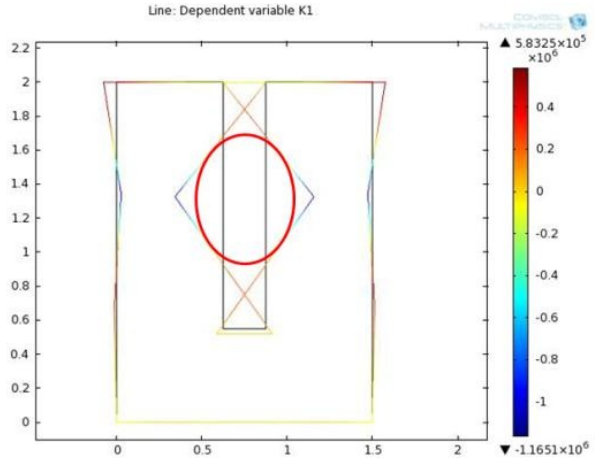

Figure 1: Simulation result at 1150 °C. Black color indicates initial geometry; colored lines are the simulated geometry and red color is the predicted final geometry.