



## Kinetic Monte Carlo simulation for semiconductor processing: A review



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### ABSTRACT

The Kinetic Monte Carlo (KMC) algorithm is a particularly apt technique to simulate the complex processing of semiconductor devices. In this review, some of the main processes used for semiconductor industries to manufacture transistor from semiconductor materials, namely implantation, annealing and epitaxial growth are reviewed. The evolution of defects created during such processing for the particular, and well known case, of silicon, is commented. Kinetic Monte Carlo modeling is introduced and contrasted briefly with a continuum approach. Particular models of different phenomena, using both object and lattice KMC, are shown: point defect migration, cluster formation, dopant activation and deactivation, damage accumulation, amorphization, recrystallization, solid phase and selective epitaxial regrowth, etc.

In this work we describe the models, its implementation into KMC, and we show several comparisons with significant experimental data validating the KMC approach and showing its capabilities. How extra capabilities can be included by extending the models to current problems in the semiconductor industry is also commented, in particular the use of SiGe alloys and the introduction of stress dependencies.

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## 1. Introduction and motivation

The simulation of front-end wafer processing has considerable economic and technological value. The success and pervasive influence of the microelectronics industry is largely built upon the techniques for processing silicon and a few related materials into progressively faster and more functional solid-state circuits. With successive generations of silicon technologies, the process complexity and development cost has risen considerably. Moreover, as transistor dimensions shrink it has become increasingly difficult and expensive to characterize the physical properties of the materials (doping, defect levels, shapes, mechanical stress, etc.) comprising the transistor structure. Both of these factors provide a strong impetus for the

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