Etching Process Simulation using Dissipative Cellular Automata

Mehdy Bohlool
Engineering Department, Chamran University of Ahvaz
Bohlool@scu.ac.ir

Mohammad Reza Meybodi
Computer Department, Amirkabir University of technology
and Institute for Studies in Theoretical Physics and Mathematics(IPM)
Computer Science Department
mmeybodi@aut.ac.ir

Abstract: Etching Process is one of fundamental processes in manufacturing Micro Electronic Mechanical Systems (MEMS) that usually simulated by Cellular Automata. The main problem of existing simulation using CA is that All cells updates synchronously that is not confirm with real world processes, and there is more than one real crystal cell in one single simulation cell that will reduce simulation accuracy. In this paper a simulation model based on Dissipative Cellular Automata proposed and well implemented. The result of this simulating compared with Scattering Electro Microscope (SEM) pictures and shows good matching.

Keywords: Cellular Automata, Etching Process, Dissipative Cellular Automata, Dissipative Systems, Micro Electronic Mechanical Systems.

Brief Simulation Result

For this paper, a simulation program implemented using visual studio 6 and Direct3D technology. Simulation is based on considering one cell of crystals (figure 1) in each cell of Dissipative Cellular Automata.

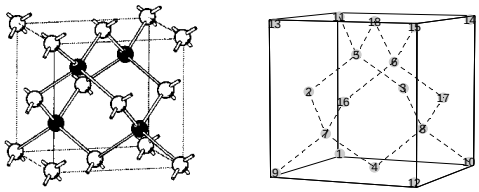

Figure 1- diamond Crystal

Etching Rules applied to each cell based on its type that shown (figure 2). Because etching process is *anisotropic*, etching rate is not equal in different crystalline planes. To incorporate this feature, Cell-Type is used to determine cell's plate in the crystal network. This feature determined by the number of etched cells in neighborhood of a cell.

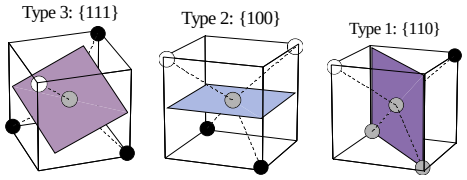

Figure 2- Three type of cells based on crystalline plane.

Simple masks were used to test simulation result. Asynchronous and Synchronous simulations were done for comparison (figure 3).

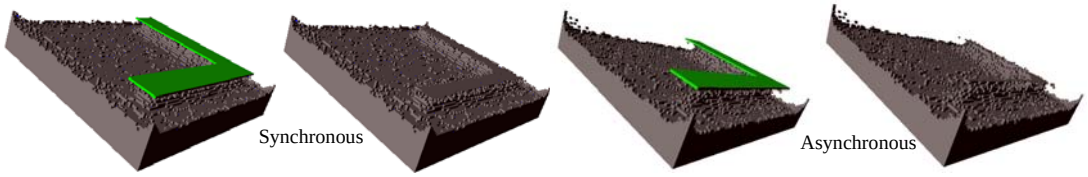

Figure 3- Results for simple L mask.

To compare simulation with real etching two SEM images of real etchings considered and their masks were used for simulation (Figure 4). The result of simulation is shown in (Figure 5). Sharp peaks in the result of the asynchronous simulation shows that this type of simulation has better matching with real etching process.

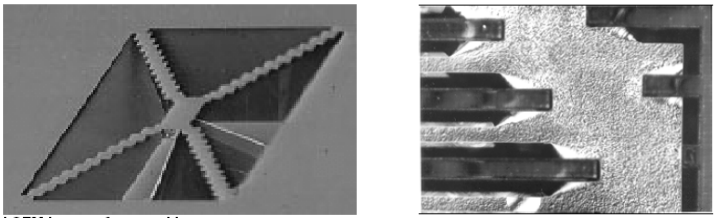

Figure 4- Scattering Electro Microscope images of two real etching

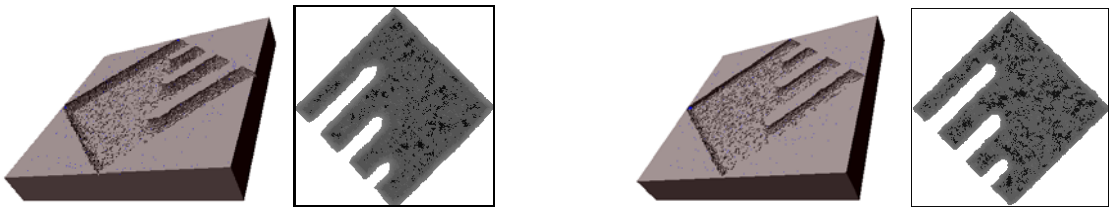

Figure 5- Result of beam mask for asynchronous and synchronous simulation. Consider the sharp peaks in real etching and asynchronous simulation.

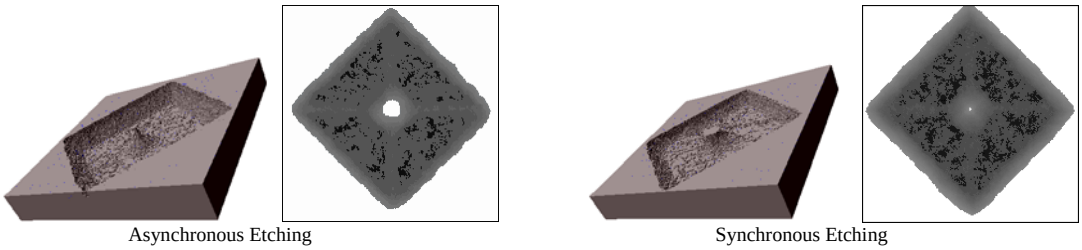

Figure 6- Result for cross mask, also sharp peaks are considerable in asynchronous simulation.

In conclusion, Simulation of etching process using asynchronous cellular automata shows good matching with real etching process and can be used to reduce the cost of designing Micro Electronic Mechanical Systems.