THREE-DIMENSIONAL TOPOGRAPHY SIMULATION FOR ETCHING

M. Fujinaga, N. Kotani, T. Kunikiyo, H. Oda, M. Shirahata and Y. Akasaka

LSI R&D Lab.,Mitsubishi Electric Corporation
4-1, Mizuhara, Itami, Hyogo, 664 JAPAN

To cope with the effect of edge topography on device characteristcs due to the high integration of VLSIs, accurate 3D-topography simulators are required. The most well-known topography simulation models are the (1) String model[1,2], (2) Ray-Tracing model[3] and (3) Cell-Removal model [4]. However, there are some difficulties in extending these models to 3D-models. In this paper, a new etching model using a differential equation is introduced [5]. This model is simple and it is possible to simulate 3D-topography accurately.

As shown in Fig. 1, when the etching is restricted by the diffusion of etchant, the etch front surface is nearly equal to the contour surface at the place of etchant concentration. Therefore, etch rate and etching time are given, and then the differential equations are derived as follows.

$$\sqrt{Di} = k1 \cdot Vi \quad (1)$$

$$\sqrt{t} = k2 \cdot T \quad (2)$$

$$\partial C/\partial t = -\Sigma_i \, (\partial Ji/\partial Xi) \quad (3)$$

$$Ji = -Di \cdot (\partial C/\partial Xi) \quad (4)$$

$$i = x, y, z \quad (5)$$

Where Vi is etch rate, T is etching time and k1 and k2 are constants. The formulations of (3) and (4) correspond to diffusion equations. Contour surfaces can be derived by solving these equations. One of the contour surfaces corresponds to the etch front surface.

This model is applied in photo-lithography and wet/dry etching processes. The simulation results of photo-lithography are illustrated in Fig. 2. Diffraction and standing wave effects can be found in the 3D-topography of developed photoresist. Figure 3 shows the etch front topography which is dependent on mask width. This etching process is simulated in three-dimensions. The contact hole is simulated and the result is shown in Fig. 4. The contact hole is fabricated by wet etching which is followed by dry etching to obtain a good step coverage.

The calculation time for each of these simulations is several minutes with 15 MIPS CPU. This new model is suitable for 3D-models. Accordingly, the 3D-topography simulator is expected to have practical applications.

ACKNOWLEDGMENTS

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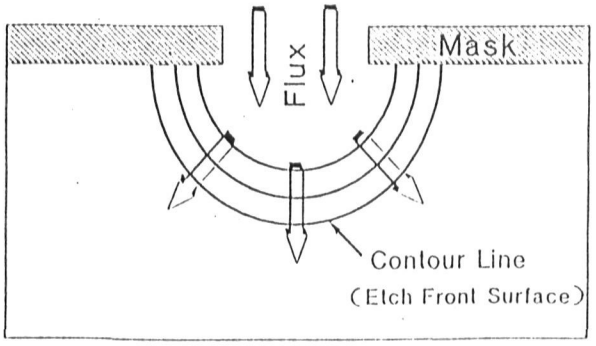

Fig. 1 Etching model

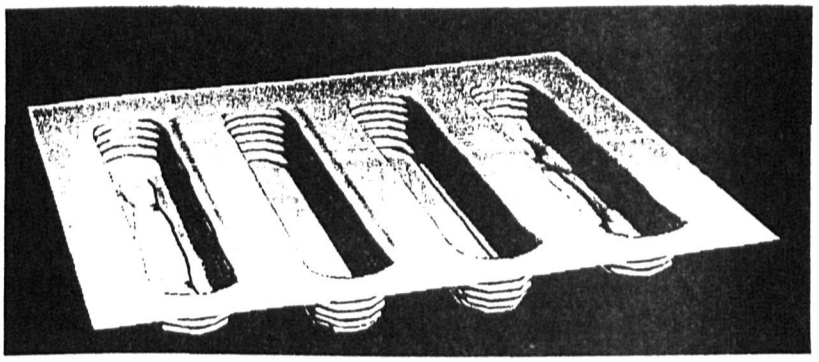

Fig. 2 Simulation of photoresist topography (Bird's-eye view)

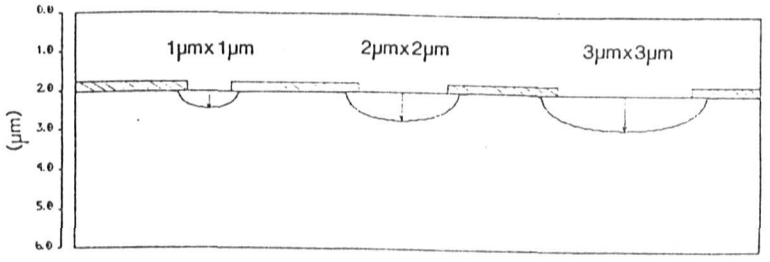

Fig. 3 Effect of mask width (Cross sectional view)

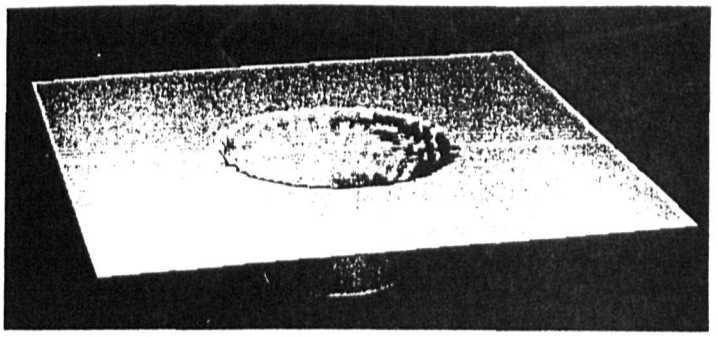

Fig. 4 Simulation of contact hole (Bird's-eye view)