An Exploration of Etch Step Interactions in the Dual Patterning Process for Process Modeling

Lawrence S. Melvin III[a], Brain Ward, Hua Song
Synopsys, Inc. 2025 NW Cornelius Pass Road, Hillsboro, OR 97124

Dual patterning is a potential process for the 22 nm half pitch manufacturing node that harbors strong potential for reaching high volume manufacturing. Dual patterning effectively splits a process layer into two almost distinct layers, taking advantage of the Rayleigh limit on pitch to image dramatically sub wavelength features. The dual patterning process requires twice as many manufacturing steps for a device layer as are required for a traditional single reticle device layer. However, the dual patterning process does have a direct interaction between the individually processed layers at the final etch processing step. In one incarnation of double patterning, at this final etch step the first half of the double patterning features are patterned in a hard mask, while the second set of features is patterned in photoresist, then both patterns are etched into the substrate simultaneously.

This double patterning methodology leads to different sidewall passivation characteristics between the first and second patterns at pattern transfer time. In addition, the use of the hardmask for half the pattern leads to a step change in height across the substrate. These issues lead to differences in sidewall angles and CDs across the two sets of features after etch, as may be observed in Figure 1. Process efforts are ongoing to reduce these differences. However, it is not certain these efforts will be completely successful. It is quite possible that residual differences will be left between the two patterns after substrate etch. It is also know that etch microloading effects lead to CD differences based on feature size and 'line of sight' proximity.

Current process modeling capabilities can be designed to account for these potential differences observed between the two patterns. However, it is unclear at this time whether or not real differences are present between the two patterns in double patterning. It is also not certain if proximity effects play a role in the process. This study will use currently available data from the IMEC double patterning process to determine if there is a significant interaction between the photoresist and hardmask patterns during substrate etch, and if there is a significant interaction, how a process model should be constructed to capture this effect.

[a] email: lmelvin@synopsys.com

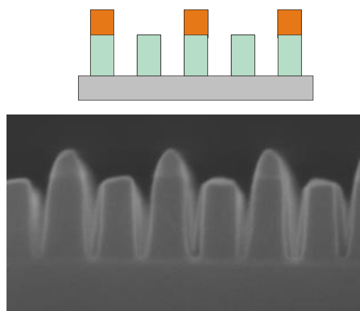

Figure 1. SEM cross section of a dual patterning process from IMEC after Etch. The remaining hardmask is visible in the image. Clear slide wall differences can be observed between features with a hard mask and features without a hard mask.

[a] email: lmelvin@synopsys.com