

Integrated 3D scatterometry as enabler for Recess uniformity control

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To meet the needs of current semiconductor node we have to produce more complex features in more structuring steps than before. Beside wafer to wafer mean deviations product also is influenced by fingerprints of a longer chain of production steps, causing within wafer non-uniformity. The higher density of features causes local variations which also consume a considerable part of process window.

The control task is to improve upon the results of structuring the buried strap. To do this we need to meet a tight product specification for Recess 2 and Recess 3. Both results depend on Recess 1 CD. Therefore the accurate measurement of Recess 1 would help to control Recess 2 and Recess 3. (Figure 1).

To control product at critical structuring processes we have process knobs available which are addressing mean and radial deviations of incoming product.

The metrology concept has to account for variations in product as well as in process.

For considered etch operations the metrology should:

- be accurate, precise, reliable and non-destructive
- deliver the parameters of interest (critical dimension, taper, film thicknesses) in a single operation
- average a high number of features to provide trend at the measurement site
- measure in structured areas at features of interest, not on test structures
- allow extensive sampling plans
- have a low CoO

Having in mind the control task, the project team worked with integrated Optical Digital Profilometry (ODP) to address these aforementioned challenges of metrology for several tasks in deep trench module.

The recess application consists of deep holes in silicon below a mask [Step 4, (Figure 2)]. Previous applications in the chain open the masks for deep trench structure [Step 1 thru (Figure 2)].

Recess 1 Top CD – the Feed Forward information for Recess 2 and Recess 3 – is checked against CD SEM reference. Figure 3.

The ODP performance gives us confidence to improve buried strap control by within wafer uniformity correction.

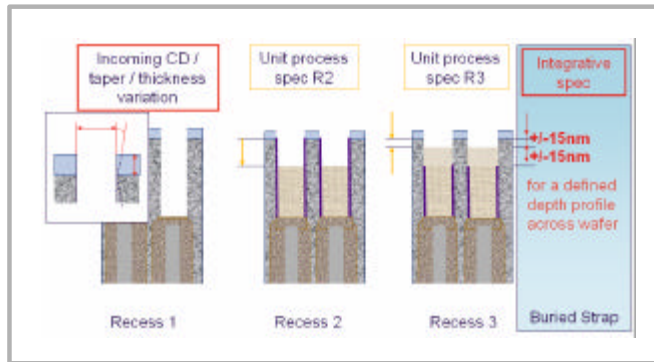


Figure 1. Control task description

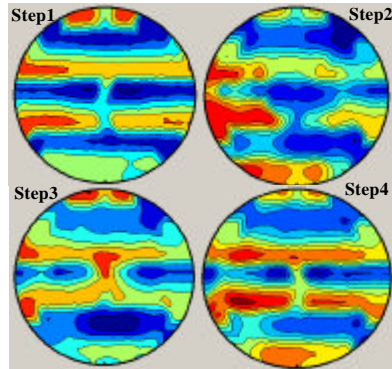


Figure 2. Good ODP data integrity demonstrated by consistent detection of intentional introduced process variation on all studied structures

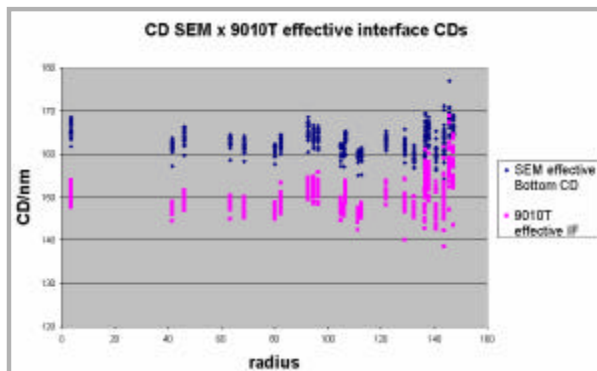


Figure 3. Good matching between ODP (magenta) and SEM (blue) results on critical dimensions for Recess1

