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Application Note 111202v1

Trench Etch Qualification Using Deep UV

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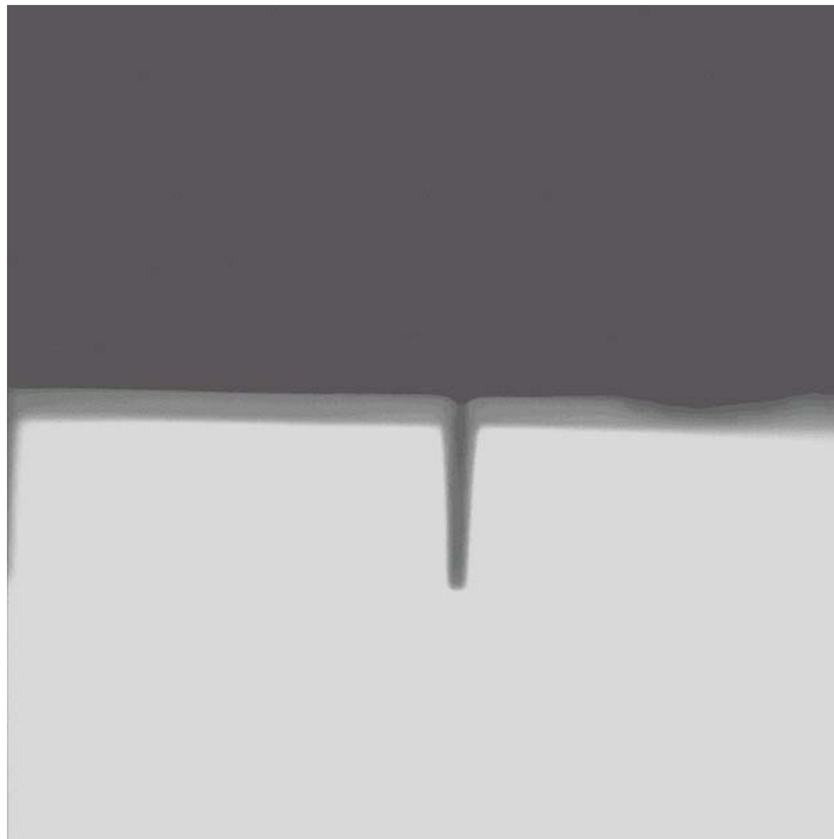
Abstract:
The standard methodology for trench depth qualification requires the sectioning of a wafer to measure under a SEM. This methodology requires a significant amount of time and trained manpower. The time lag (3-48 hours) for final data is extremely critical when using the trench etch measurement to qualify a production tool that has been undergoing maintenance or monitoring process control.

Utilizing DUV imaging on the Olympus MX80 DUV has significantly impacted the procedure and the time to solution for trench etch qualification. Using the MX80 DUV provides clear and precise measurements in 10 minutes as opposed to the 3 to 48 hours it takes to receive results from the SEM. In addition the MX80 DUV has allowed the critical trench etch qualification process to be performed inside the fab. Performing this critical step in the fab has provided equipment and etch engineers greater flexibility and speed in qualifying and controlling the etch process



MX80 DUV Trench Etch Image

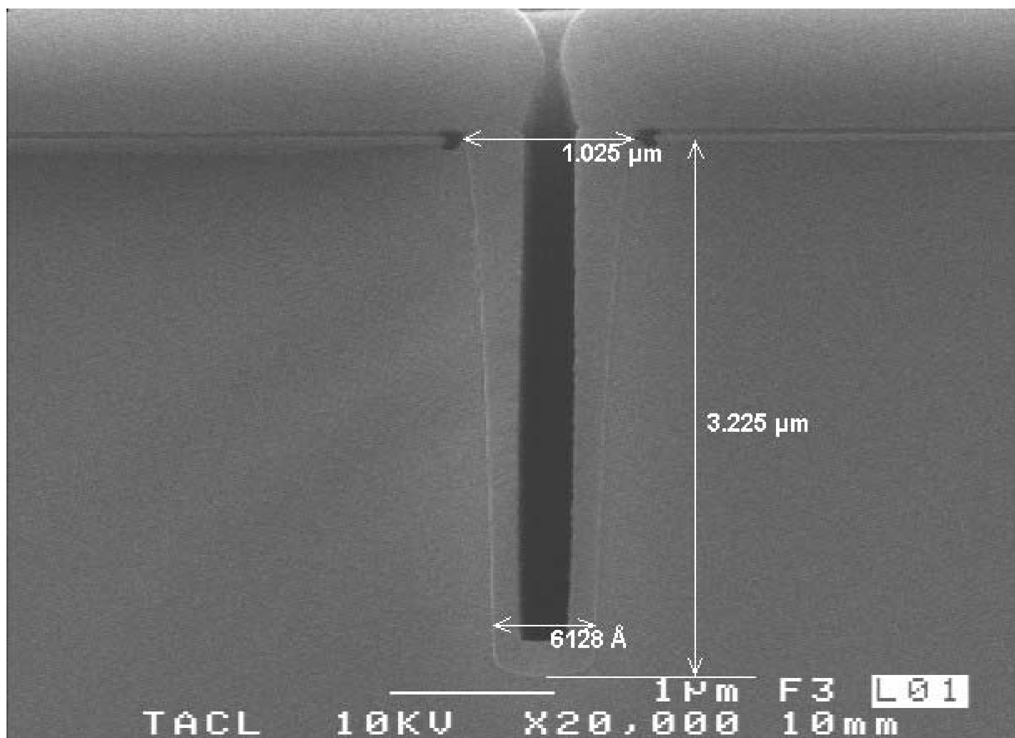
SEM Technique

The trench etch qualification process is most often required after periodic maintenance of the etcher. In addition this measurement is performed as a critical component of the weekly process control monitoring of the etch process.

The measurement itself is simple in concept:

1. Section sample
2. Polish sample
3. Decorate (plate) the sample
4. Mount in the SEM
5. Measure

Unfortunately the majority of this work must take place outside of the FAB. The use of specialized polishing and SEM sample preparation equipment is limited to the outside support laboratories. The SEM lab provides the required measurement in 3 hours if there is no queue and up to 48 hours during the weekend.



SEM Image

DUV Technique

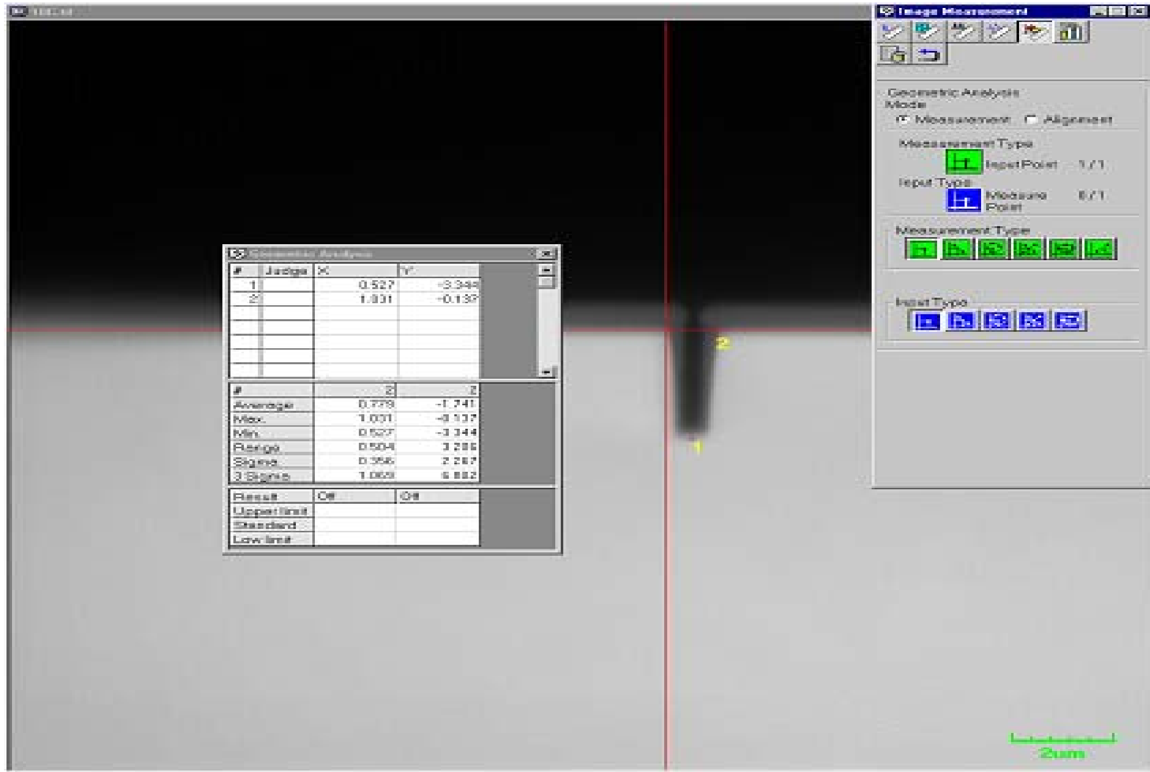
The MX80 DUV provides a faster more accessible alternative. The use of DUV imaging technology allows the high contrast resolution of features down to 0.08μm. This new technology coupled with a simple and efficient tool, located in FAB, is the basis for a new solution.

Much like the SEM procedure the DUV method requires some basic sample preparation. The sample preparation is limited to sectioning the wafer and placing it in a measurement fixture. After this easy and fast preparation the measurement can be performed. All of this is done in the FAB in close proximity to the etch tools.

To achieve a useful measurement a custom measurement fixture was required. Working with the engineering and applications team at Olympus ITA a special stage mounting and test fixture was designed and delivered in less than two weeks. The measuring fixture was unique and mated well to the standard MX80DUV.

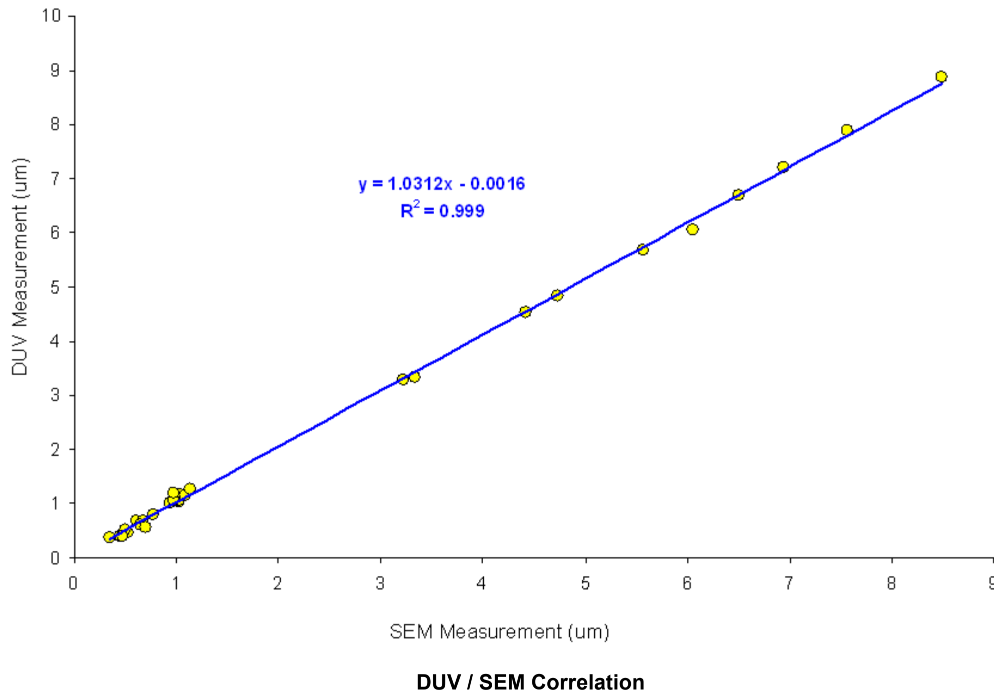
Custom sample fixture solution provided by Olympus - ITA

The measurement data was then captured using the MX80 DUV Olympus application software, specifically the geometric analysis technique. To validate this technique a correlation to the established SEM measurement was required.



Sample MX80 DUV Image and Measurement Result

Correlation to SEM



DUV / SEM Correlation

To validate the new procedure a NIST traceable standard was used to calibrate the MX80 DUV. To provide a complete understanding of the measuring characteristics of the MX80 DUV both axis of measurement were calibrated.

This makes the tool even more forgiving since exact orientation under the imaging path is not required.

After the initial calibration steps 5 test wafers were run through the production SEM qualified etcher. A direct data set of 30 points (2 measuring sites per wafer with 3 measurements per site) was produced on both the SEM and the MX80 DUV. As you can see the correlation between the MX80 DUV and the previously qualified SEM was near unity with R^2 = 0.999 and a negligible offset of 16 Å.

As a final step, a Gage Repeatability and Reproducibility (GRR) study was performed to determine how much of the observed process variation is due to measurement system variation. A contribution of less than 10% would be an acceptable result in order to put DUV measurement of trench etches qualification into production. The results of this study, using the ANOVA method; showed a contribution due to measurement system variation close to zero (0.029%) and a repeatability and reproducibility error contribution of 1.7%, both excellent results.

Conclusion

The DUV measurement method for trench etch qualification has provided a faster solution when performing this important test. The MX80 DUV with its custom fixture provided results in 10 minutes as opposed to 3 - 48 hours with the SEM. The correlation of the measurement results between the MX80 DUV and the SEM near unity (R^2 = 0.999) with a negligible offset of 16 Å, after calibration to in house NIST standards, with a GR&R result of less than 2% total contribution due to measurement system variations.

This solution provides a fast solution that saves both time and money. The excellent correlation results coupled with the time and cost savings have now allowed this technique to be fully implemented into production for weekly etch tool qualifications.