Error correction in different material step height measurement using Coherence Correlation Interferometry

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This Technical note shows how CCI can resolve issues with 'different material step height measurement errors' explained in Technical note 'T153'.

Both thin film steps and dissimilar material steps give rise to a phase-change on reflection (PCOR). This inevitably distorts the interference series and result in the presence of a DC-shift in the measured topographical surface, leading to an error in step height measurement. CCI will resolve these issues.

1 PCOR induced error correction – 'Films and Materials' technique

'Films and Materials' technique

Through the knowledge of thin film structure and 'Films and Materials' technique, the DC shift (shift of the fringe envelope) due to the phase-change on reflection (PCOR) for both dissimilar material step and thin film step can be compensated so that the 'true' step-heights are determined.

Error correction

A pair of HCF [1,2] functions are directly determined from the CCI interference series corresponding to the top surface and the bottom surface of the step.

A corresponding pair of synthetic functions is then optimised to match this function pair. These synthetic functions take account of the spectral n and k values of the substrate (bottom of step) and likewise of any thin film or dissimilar material present (top of step); Accurate step height is then possible through taking advantage of the topographical terms embedded within these synthetic functions.

2 Measurement range and accuracy

Accuracy – ~2%

'Films and Materials' technique can be used for the step height measurement of dissimilar material step and thin film step with an accuracy of ~2% accuracy

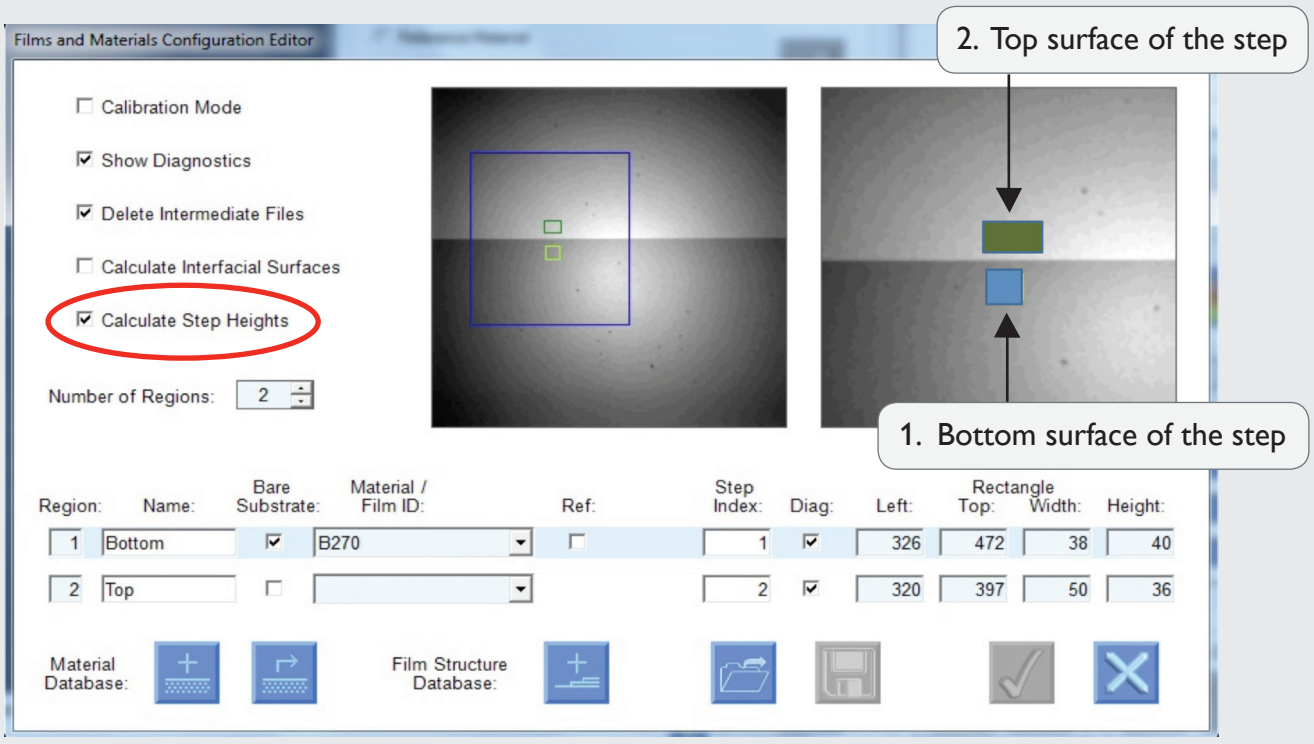
Measurement range

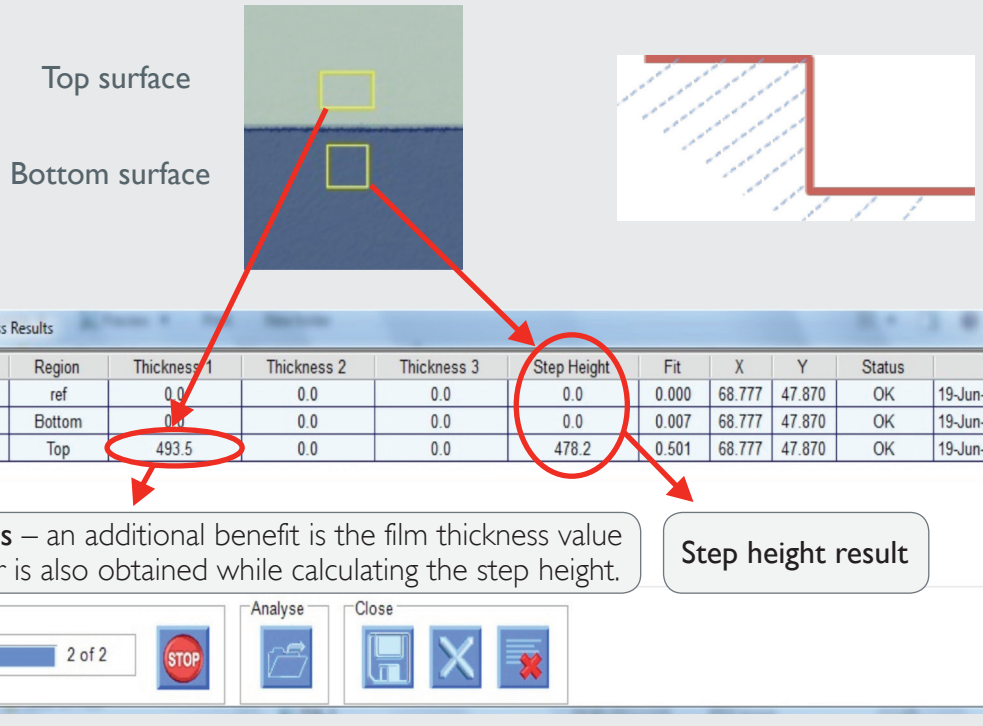
Dissimilar material step	0 to ~130 um (latest software)
Thin film step	~25 nm to 5 µm

The measurement can be made within the measurement range of ~25 nm to 5 µm for a step with a semi-transparent thin film coated surface, and ~ 0 to scan range limited step height value for a dissimilar material step.

3 How it works on CCI HD?

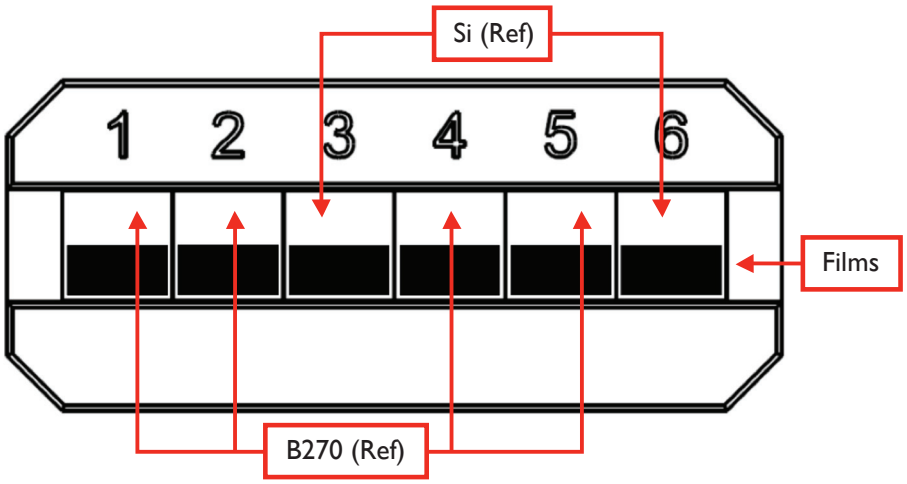
Figure 2(a) An example of a single layer thin film step height measurement use CCI HD





4 Comparison results

The 6 reference thin films were used in this study, the dissimilar material step height results were compared with other techniques include spectrophotometry and film thickness measurement



Step height comparison results

Thin film step (reference films)

	Film 1	Film 2	Film 3	Film 4	Film 5	Film 6
Film/substrate	Ta205/ B270	Ta205/ B270	Si02/Si	Ta205/ B270	Ta205/ B270	Si02/ Si
Film thickness (spectrophotometer) (nm)	48.8	98.5	311.1	504.6	1002.2	994.5
Mean film thickness (film thickness measurement) (nm)	52.5 ± 0.6	99.1 ± 0.3	312.8 ± 0.3	505.1 ± 0.6	1003.4 ± 1.2	996.9 ± 1.2
Mean step height (dissimilar material step measurement) (nm)	**56.1 ± 0.7**	**97.3 ± 0.3**	**315.9 ± 2.1**	**514.1 ± 1.1**	**994.8 ± 1.6**	**1014.6 ± 1.6**

The standard deviation (σ) for all the analysis was calculated by means of 20 measurements

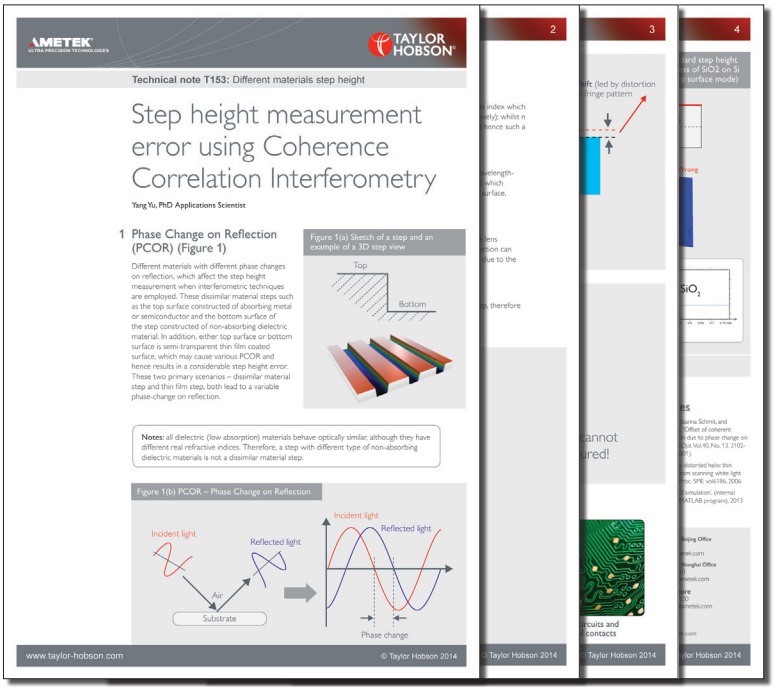
Good agreement!

4 Summary

Through the development of 'Films and Materials' technique, coherence correlation interferometry (CCI) has become the ideal method to obtain not only film thicknesses and interface information but also true step heights for dissimilar material steps and thin film steps.

'Films and Materials' technique can eliminate the step height measurement errors caused by the distortion of the fringe series due to PCOR from both thin film steps and dissimilar material steps.

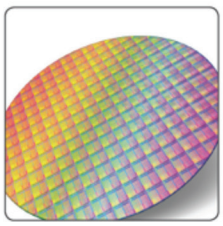
Following up technical note T153

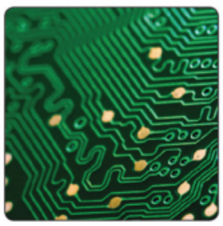


Some example applications


Mems devices


Solar PV


Semiconductors


Hybrid circuits and electrical contacts

References

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2. Mansfield, D., US7755768, 'Apparatus for and a method of determining a characteristic of a layer or layers', 2010

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