Referenced Spectral Ellipsometry for process control applications

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Ellipsometry is a very sensitive optical method which has been used for about a hundred years to derive information about surfaces. It allows to deduce information about the film properties, especially the film thickness.
The Referenced Spectral Ellipsometer (RSE) is a new type of ellipsometer, whereby the sample is compared to a specifically chosen reference. By that, the ellipsometric difference between sample and reference can be measured. Due to the special optical arrangement, none of the optical components need to be moved or modulated during measurement and the full, high resolution spectrum can be obtained in a single-shot measurement. The device settings are optimized for a specific goal parameter like a small variation of a film thickness prior to a measurement. Due to the differential measurement in combination with this optimization the signal-to-noise ratio is that high, that no averaging is necessary and the full spectral ellipsometric information is acquired within an integration time of 10ms.
In combination with a synchronized x-y-stage a large-field film-thickness-map of the sample can be measured within a few minutes. Thereby the measurement is done during the movement of the stage. Including acceleration and deceleration times an effective mapping speed of 2mm²/sec at 200µm lateral resolution can be achieved.

The pictures show measurements of a 2”-silicon-wafer partly spin-coated with tin oxide (SnO). The left image shows an intensity-map of the entire wafer at a wavelength of λ = 500nm. The lower half and the seven squares in the upper half are coated with SnO. Besides these a contamination becomes obvious which forms a concentric shape on the wafer. It is caused by residues of the used photoresist. This effect wasn’t visible with other common methods.
In the lower right of the wafer a defect in the coating is visible. The right picture shows the calculated SnO-film-thickness-map at this position. The mean SnO-thickness is 9nm. At the defect the coating is completely removed.
With only a few representing single-point measurements none of these defects would have been detected. Only the ellipsometric mapping of the entire wafer gave all information about the wafer in this case.

Figures

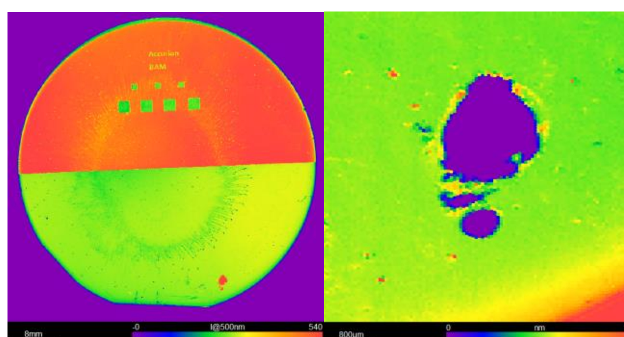

Figure 1: The left picture shows an intensity-map of a SnO-coated silicon-wafer at a wavelength of = 500nm. The right image shows a fitted SnO-film-thickness-map of the lower right of the wafer.