Novel Double Sided Stitching Interferometer Concept for 450 mm Wafers

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Abstract

The silicon wafer industry is currently preparing to make a transition from 300 to 450 mm wafers. Equipment manufacturers are investigating how to re-use and scale up their 300 mm platforms as much as possible. However, for the wafer shape and thickness variation measurement equipment up-scaling may not be the best solution. Currently wafer geometry characterization is typically done using double sided full aperture Fizeau interferometer systems. The price of Fizeau interferometer systems tends to increase exponentially with aperture size and at the same time the spatial resolution of interferometer systems tends to be decreased by up-scaling.

We propose a compact and scalable stitching interferometer concept that uses two opposing dynamic interferometers to perform fast "on-the-fly" measurements as an alternative to expensive and bulky full aperture interferometer systems for measuring the shape and thickness variation of 450 mm silicon wafers.

1 Dynamic Interferometer concept

The developed instantaneous phase shifting Fizeau interferometers are true common path homodyne interferometers where the polarized reference beams are formed by normal incidence wiregrid polarizing reference flats (*Figure 1*). The wiregrid polarizers [1] consist of conducting parallel MicroWires®. The shape of the MicroWires® causes birefringence, splitting one ray of light into two rays. Light that is oriented parallel to the MircroWires® is reflected (s-plane). Light that is perpendicular to the wires is transmitted (p-plane). The relatively thin commercially available wiregrid polarizers have been cemented against rigid optical flats to ensure shape stability.

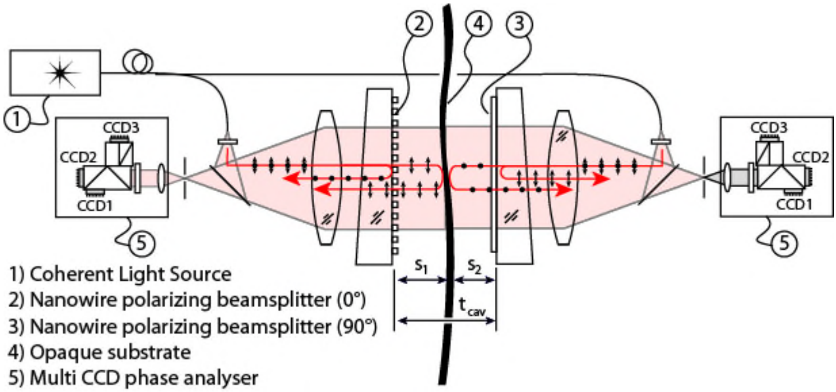

Figure 1: Schematic layout of the double sided stitching interferometer.

Compact multi-CCD phase analysers are developed to reconstruct the wavefronts from the orthogonally polarized reference waves and test waves (*Figure 2*). The CCDs are aligned with pixel level accuracy and the monolithic design guarantees life time stability without the need for alignment recalibration.

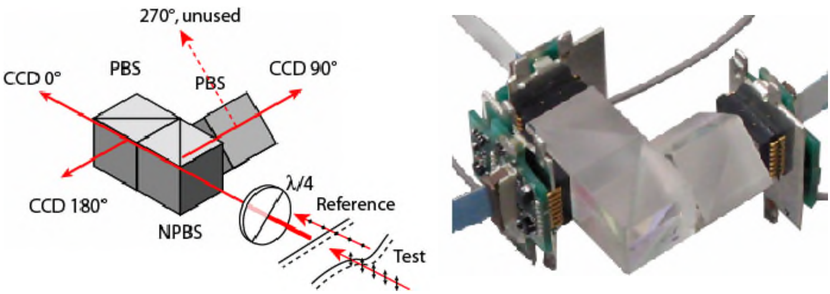

Figure 2: Phase analyser module based on a high resolution 3-CCD camera.

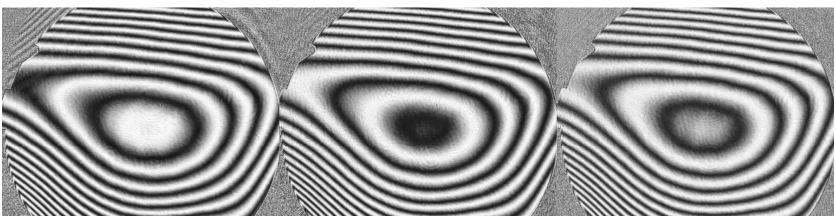

Figure 3: Three simultaneously phase shifted interferograms as obtained with the multi-CCD analyser from an orthogonally polarized reference wave and test wave.

2 Double sided stitching interferometer setup

To demonstrate the potential of a dynamic interferometer we created a double sided setup where a silicon wafer is scanned in between two opposing interferometers at high speed (*Figure 4*). The metrology frame holds both reference flats and is fully decoupled from the scanning mechanism to ensure a good measurement stability. To be able to measure wafers with large bow, the tip and tilt of the wafer is continuously adjusted for optimal alignment.

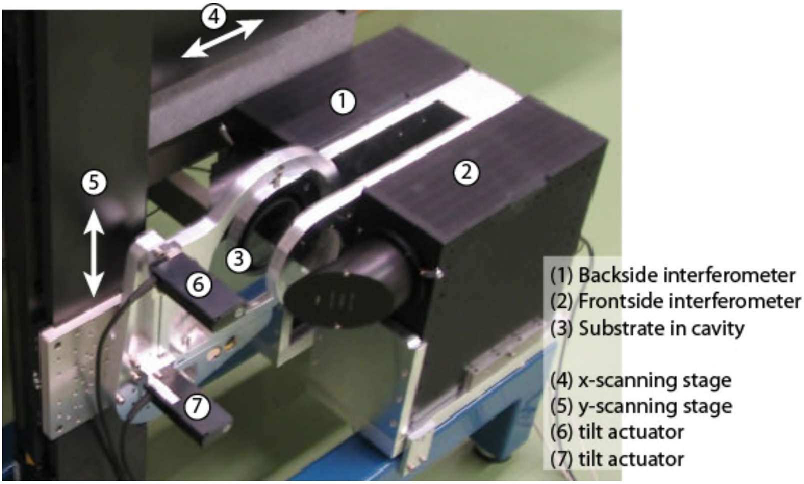

Figure 4: Double sided dynamic interferometer configuration and a mechanism for lateral scanning and tip/tilt adjustment of the substrate.

In our prototype a full wafer scan typically requires 10 seconds, which is limited only by the used scanning stages and not by the interferometer system. Current testing is done with 200 mm wafers, but the setup is prepared for measuring 450 mm wafers as well.

3 Measurement result

In *Figure 5* subaperture interferogram measurements are presented from which the shape of the full wafer is derived by means of stitching. For the thickness measurement no stitching is required as the calculated thickness phasemaps should principally already connect seemlessly.

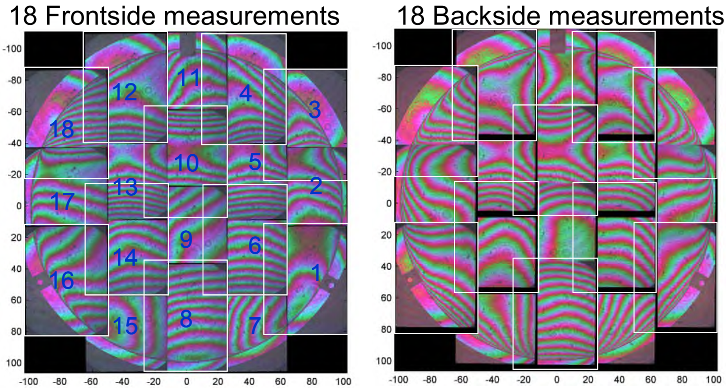

Figure 5: Typical result of an on-the-fly wafer measurement consisting of 18 partially overlapping subapertures. The interferograms are presented in "false-color", where each color channel (RGB) represents a phase shifted interferogram.

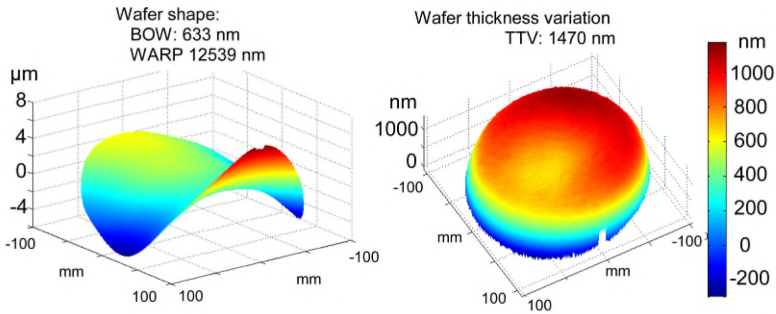

Figure 6: Stitched wafer shape and derived wafer thickness variation.

By measuring the empty reference cavity as well, the setup is made completely self calibrating for the measurement of thickness variation. For accurate shape measurements the reference flats have been calibrated against a reference artifact.

References:

[1] Moxtek, ProFlux™ polarizers, http://www.moxtek.com/

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[3] M. Jansen, "Dual polarization interferometers for measuring opposite sides of a workpiece", US Pat. 7471396 - Filed Mar 23, 2007 - Mitutoyo Corporation