Abstract—The silicon wafer manufacturing process relies heavily on precision polished wafers that have uniform thickness and, depending on the application, also control parallelism to a secondary wafer after bonding. Lumetrics’ low coherence interferometer, commercially marketed as OptiGauge II, is a device capable of measuring the simultaneous wafer thickness, adhesive thickness, and parallelism between surfaces to sub-micron precision. Combined with custom software and a precision XY raster scanner, a wafer or wafer assembly can be fully characterized with respect to layer thicknesses and surface parallelism.

Index Terms—adhesive, flatness, interferometry, metrology, optical thickness measurement, parallelism, silicon, wafer

I. INTRODUCTION

LUMETRICS is the market leader in providing high-precision, non-contact optical thickness measurements to medical, scientific, and ophthalmic industries.

A unique capability of our flagship thickness measurement device, OptiGauge II, is its ability to measure the individual layer thickness of a multi-layer sample.

The OptiGauge II measures using a 1310nm wavelength. This is an ideal wavelength for measuring through nearly all visually transparent and semi-transparent objects.

A visually opaque material that is highly-transmissive at 1310nm is silicon. This makes silicon an ideal sample for optical thickness measurement.

When combined with a precision XY scanner or robotic system, the entire wafer can be profiled to provide the user with thickness and parallelism measurements. Based on these measurements, the user may implement process changes to correct for uneven thickness by repolishing the wafers or correcting the parallelism to a secondary surface before its adhesive has cured.

This capability makes the OptiGauge II an ideal measurement tool for numerous silicon, glass, sapphire, or many other wafer applications.

II. SINGLE LAYER SILICON WAFER MEASUREMENT

Measuring a silicon wafer’s thickness is one of the most straightforward applications for the OptiGauge II. A simple motorized scanner that moves the measurement probe above the sample while traversing the wafer’s width can quickly generate a thickness profile (Figure 3).
III. MULTI-LAYER WAFER ASSEMBLY

The OptiGauge II can also be used to simultaneously measure thicknesses of multiple layers in a bonded wafer stack. A simulated bonded wafer stack (using two glass microscope slides and an adhesive) is plotted (Figure 4). The transverse scan immediately shows variations in the thickness of the adhesive, as well as thickness variation in the wafers themselves. This information could benefit from better polishing methods to achieve more uniform thickness.

IV. WAFER ASSEMBLY SURFACE FLATNESS

In addition to thickness, surface flatness can also be quantified using OptiGauge II in combination with a scanning fixture and a flat reference surface. The scanning probe measures the relative displacement between the reference plane and the top surface of the object under test. After mathematically removing the tilt of the scanner relative to the sample, an accurate surface flatness can be calculated (Figure 5).

V. REAL-WORLD APPLICATIONS

The data gathered by the OptiGauge II has several practical applications.

Inspection of silicon wafers or other optical wafers made from quartz or sapphire may be checked during an incoming inspection process upon receipt from a supplier.

Technicians are able to manually inspect before and after a polishing process in a quality lab to verify they are removing the proper amount of material.

The thickness measurement system may also be combined with an automated scanning system to quickly profile the sample.

With proper mounting and software, the OptiGauge II can be integrated directly into a polishing machine and able to provide real-time feedback.

VI. CONCLUSION

The OptiGauge II is a powerful non-contact optical measurement instrument. It can precisely measure flatness, thickness, and parallelism of transparent and even visually opaque materials, like a silicon wafer. This instrument can be integrated onto robotic or other automated stations for fast inspection of wafers during the polishing and chemical etching processes for instant feedback.

Lumetrics’ engineers can quickly answer any questions pertaining to software communication with the OptiGauge II, mechanical mounting options of the optical head (which is less than 1” diameter), or any other technical question to help you evaluate your metrology options.

Contact Lumetrics for additional information

Email: sales@lumetrics.com or engineering@lumetrics.com