

# Wafer Thickness, Precision Step Height & Sheet Resistance

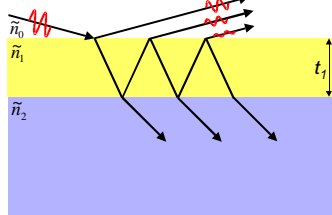
## Measurement Analysis

SIMCO Electronics performs accredited measurement analysis for Wafer Thickness, Precision Step Height, and Sheet Resistance for the Semiconductor Market.

Quality ISO 9001:2000 Registered  
ISO/IEC 17025-1999 Accredited by A2LA

**Ellipsometry** uses polarized light to characterize thin film and bulk materials. A change in polarization is measured after reflecting light from the surface. Thin film thickness ( $t$ ) and optical constants ( $n, k$ ) are derived from the measurement.

Information is obtained from each layer interacting with the measurement. Light returning from the film-substrate interface interferes with the surface reflection to provide layer information.

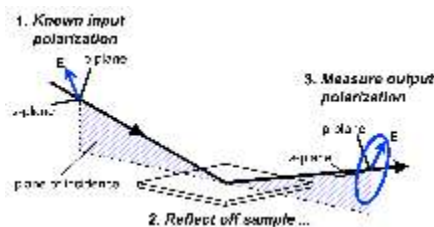


### Three Main advantages over simple Intensity-Based Reflection or Transmission Measurements:

1. Measurement is defined by ratio, thus ellipsometry is not sensitive to changes in absolute intensity of measurement beam (i.e. the sample becomes the 'reference' for the measurement)
2. Phase information (from  $\Delta$ ) provides enhanced sensitivity to ultra-thin films, even down to the sub-nm level
3. Ellipsometry measures 2 values ( $\Psi$  and  $\Delta$ ) at each wavelength, doubling the information content compared to an intensity reflection or transmission measurement.

### Ellipsometry measures $\Psi$ and $\Delta$ used to characterize:

- ? investigate surface and interfacial roughness
- ? alloy and doping concentration
- ? thin film thickness
- ? refractive index
- ? Degree of crystallinity



An ellipsometry measurement is a description of the change in polarization (see figure) as polarized light is reflected from a sample surface. It is expressed as two parameters for each wavelength-angle combination:  $\Psi$  and  $\Delta$ . These values can be related to the ratio of complex Fresnel reflection coefficients and polarized light.

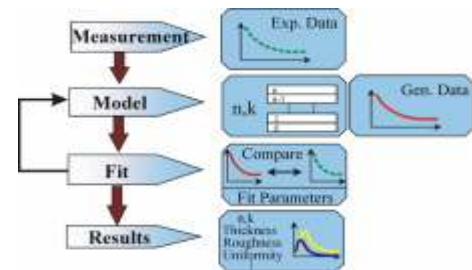


VASE®  
Variable Angle  
Spectroscopic  
Ellipsometer

### VASE® Measurements of SiC Films

- ? Thick and thin film characterization
- ? Determine film thickness and refractive index using spectroscopic ellipsometry (SE)
- ? Computer controlled wavelength and angle of incidence selection
- ? Xenon lamp supplies light from the ultraviolet (UV) to the near infrared (NIR)
- ? Stacked Si/InGaAs detector is used from 193nm to 1700nm
- ? Extended InGaAs detector allows measurement to 2500nm
- ? VASE uses a rotating analyzer ellipsometer (RAE)
- ? Advanced measurements of depolarization, Mueller-matrix elements, and generalized ellipsometry (for anisotropic materials)
- ? Ellipsometric  $\psi$  and  $\Delta$  data acquired at a single wavelength of 632.8nm
- ? Data acquired from 65° to 80° angles of incidence in steps of 0.1°
- ? Angles of incidence range ensures passage through Brewster's angle for maximum sensitivity to film thickness and index
- ? The back side of each wafer is roughened to suppress unwanted back-surface reflections
- ? All work performed with WVASE32 software version 3.466

**Data Analysis** is a very important part of spectroscopic ellipsometry (SE): without data analysis SE only measures the ellipsometry parameters  $\Psi$  and  $\Delta$  versus wavelength.



# Wafer Thickness, Precision Step Height & Sheet Resistance

SIMCO Electronics uses versatile stylus profilers to perform accredited surface profiling measurement analysis including precision step height, roughness and planarity.

## Step Height Repeatability

- ? Low Inertia Sensor provides unparalleled step height repeatability
- ? Program leveling functions and software ensure consistent, accurate measurement with minimal uncertainty
- ? Advanced technology developed especially for shrinking geometrics
- ? NIST Referenced and Traceable Standards
- ? Excellent step height repeatability of 10 angstroms, 1 sigma
- ? Surface profiling of features for microelectronic applications such as:
  - » semiconductor wafers,
  - » micro-machined devices (MEMs)®
  - » hybrid circuits
  - » surface mount devices
  - » electrical contacts, as well as
  - » thickness of thin films, paints and coatings

Stylus profilers are versatile measurement tools for the study of surface topography. The profiler relies on a small-diameter metal stylus with a diamond or composite material tip that scans the surface of the sample. During the scan, the stylus makes direct contact with the surface to obtain data with very high precision and repeatability. The stylus profiler stage moves the sample linearly under the stylus to obtain measurements of the surface profile. As it encounters surface features, the stylus moves vertically to measure the various features.



Dektek 3® – A surface profiler used by SIMCO to measure roughness and topography on substrates, polymers, optical lenses, metallurgy and advanced materials.

## Features

- ? Analytical parameters such as Ra, Rt, Rq, TIR, and average step height.
- ? 6.5" sample vacuum stage
- ? 3"x6" XY sample translation
- ? manual stage
- ? 1A vertical resolution
- ? 131um maximum vertical range
- ? 50um to 50mm scan length
- ? maximum 8,000 points per scan
- ? 1mg-40mg programmable stylus force range

## Measurement Specifications

Ellipsometer			SRMs @ ? = 632.8 nm
	Parameters	Best Uncertainty	Comments
Psi (?)	44.38 deg.	0.04 deg.	NIST 2534
	21.86 deg.	0.04 deg.	NIST 2531
	13.73 deg.	0.04 deg.	NIST 2532
Delta (?)	90.1 deg.	0.04 deg.	NIST 2534
	89.9 deg.	0.04 deg.	NIST 2531
	89.8 deg.	0.04 deg.	NIST 2532
Wafer Thickness Standards			Woolam VASE with SRMs
	26.4 nm	0.68 nm	NIST 2534
	46.9 nm	2.0 nm	NIST 2531
	105.0 nm	3.8 nm	NIST 2532
Precision Step Height <sup>7</sup>			
	(200 to 1000) Å	4.2 %	Veeco Dektek 3 comparator with
	(1 to 100) kÅ	0.1 %	Veeco 138, VLSI SHS step height
	(10 to 25) µm	0.01 %	standards

## Sheet Resistance Wafer Calibration

Sheet Resistance Standards (SRS) accurately calibrate sheet resistance for both contact and non-contact instruments.

These products are created by sawing a doped single crystalline ingot into wafers and then lapping and chemically cleaning them to specifications.

Four point probe processes are used to measure the specification of sheet resistance per/cm of resistive reference wafers.

Each individual standard has a specific sheet resistance and thickness value to calibrate the appropriate measurement ranges of the instrument.

Calibrated sheet resistance values will be in the stated ranges. Stated values are nominal and calibrated values are traceable to NIST.

- ? 3-inch as-lapped silicon wafer
- ? All measurements compliant to ASTM F-84
- ? Measured at a single point in the center of the wafer (+/- 5mm)
- ? Temperature correction factor of 23°C