OptiPrime-CD

Ultra-High Resolution &
Ultra-High Sensitivity Scatterometer
with Thin Film Measurement Capabilities

FULLY AUTOMATED, HIGH THROUGHPUT OPTICAL METROLOGY SYSTEM FOR SEMICONDUCTOR APPLICATIONS.

n&k® the true measure

OptiPrime-CD

METHOD OF ANALYSIS

The OptiPrime-CD is an Ultra-High Resolution and Ultra-High Sensitivity Scatterometer with Thin Film Measurement Capabilites. The system utilizes Polarized Reflectance (*Rs, Rp*) data to determine the optical properties (*n* and *k*), and thicknesses of thin films and critical dimensions (depth, CDs, and profiles) of the structures being analyzed. This fully-automated system can be configured for various size wafers (300 mm (12”), 200 mm (8”), 150 mm (6”)) for a large variety of semiconductor applications. Raw reflectance data is acquired over a wide wavelength range (190 – 1000 nm) with optimized signal-to-noise ratio, resulting in the capability of the OptiPrime-CD to characterize increasingly smaller features of current and next generation products.

The n&k software combines the Forouhi-Bloomer (FB) equations and Rigorous Coupled Wave Analysis (RCWA) to analyze the raw data. The Forouhi-Bloomer (FB) equations, derived from first principles of quantum physics, are universal equations describing the Refractive Index, *n*, and Extinction Coefficient, *k*, as functions of wavelength, λ, whereas RCWA determines optical critical dimensions. By combining FB and RCWA, very complex and complicated structures can be readily analyzed.

Also available is the manual-load, and cost-effective counterpart of the OptiPrime-CD, the n&k OptiPrime-CD-M, utilizing the same optical configurations and analysis capabilities, but without the automatic loading system.

KEY QUALITIES OF OPTIPRIME-CD

- *Optimized Polarized Reflectance (Rs and Rp) Data*
  - *Wavelength Range: 190 – 1000 nm*
  - *Micro-Spot Technology*
- *Can be Configured for 300 mm (12”), 200 mm (8”), and 150 mm (6”) Wafers*
- *Fully Automated*
- *Based on Patented Reflective Optics that Optimizes the Signal-to-Noise Ratio*
- *Strong Sensitivity to Sub-Nanometer Structural and Material Variations*
  - *Thickness, n and k (from 190 — 1000 nm)*
- *OCD Metrology for 2-D and 3 -D Structures (Trenches and Contact Holes)*
  - *Depth, CD, Profile*
- *Cognex Pattern Recognition Software*
- *No Re-Alignment Issues Upon Light Bulb Replacement*
- *Modular design — Easy to Maintain and Service*
- *GEM/SECS Communication Interface*
- *SEMI Standard and Third Party Certifications*

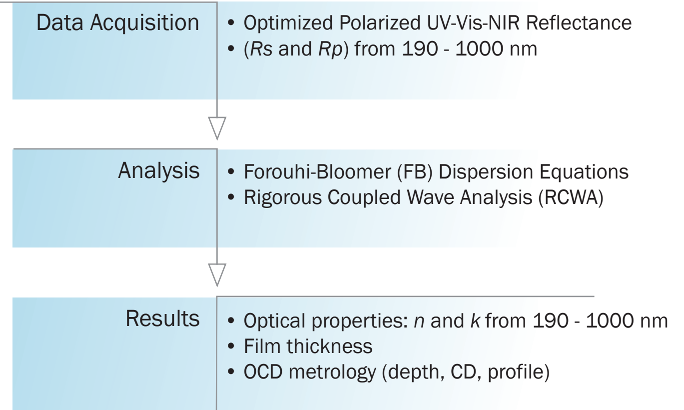
METROLOGY PREREQUISTES FULLFILLED BY OPTIPRIME-CD

- *Optimized Signal-to-Noise Ratio & Large Dynamic Range of Detection*
- *Wide Wavelength Range (190 – 1000 nm) & Ultra-High Resolution*
- *Physically Valid Model (FB & RCWA)*
- *User-Friendly, Proprietary Software*

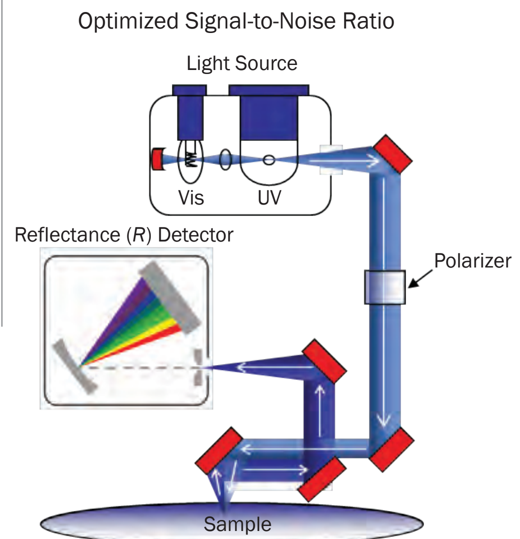
PHYSICAL CHARACTERISTICS

Dimensions (W x D x H):	*112 cm x 202 cm x 189 cm*
Weight (unpacked):	*770 Kg*
Facility Requirements:	*100 - 240 V, 50/60 Hz, 1Φ* *Vacuum, CDA (for FOUP Load Port)*

SYSTEM OPERATION FLOW



PATENTED REFLECTIVE OPTICS

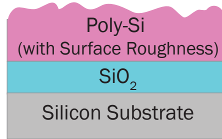


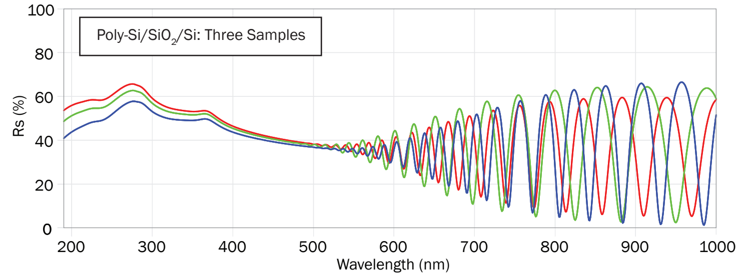
Thin Film Application Examples

The n&k OptiPrime-CD's thin film applications cover both current and next generation thin film measurement demands for R&D and production: Ultra Thin Films and Residual Layers, Multi-Layer Stacks, Inhomogeneous Films, 193 nm and 248 nm ARCs and Resists, Low-κ Films, High-κ Films, and films deposited on practically any substrate.

ROUGH POLY-Si ON SiO_2

- The wide wavelength range (190 - 1000 nm) of the OptiPrime-CD is needed in order to simultaneously measure the surface roughness and film thickness values
- The data is sensitive to the *n* and *k* values of the Poly-Si layer, which can be measured to determine the silicon properties (from amorphous to crystalline)

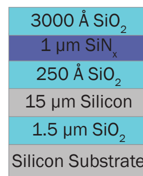


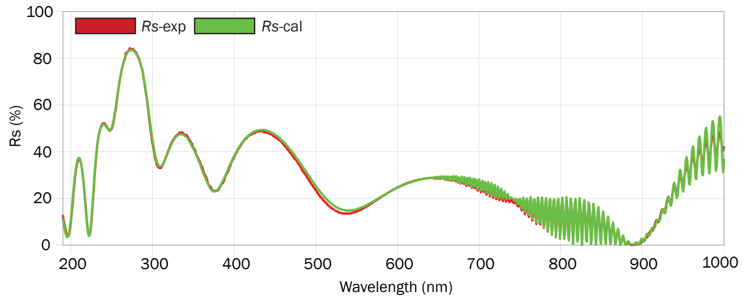


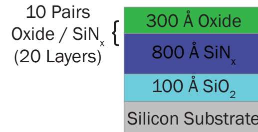
Spectra	Surface Roughness (Å)	Poly-Si Thickness (Å)	SiO_2 Thickness (Å)
Red	32	18245	505
Green	57	15078	622
Blue	85	21330	765

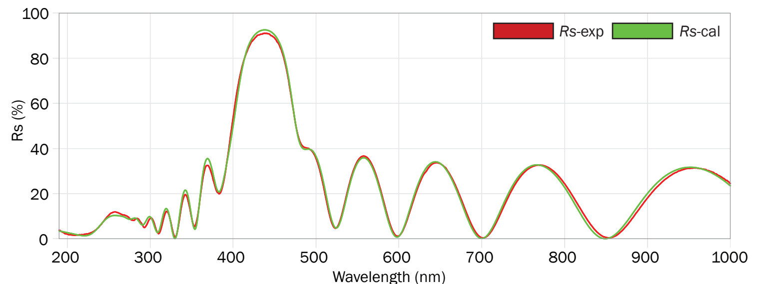
COMPLEX MULTI-LAYER FILM STRUCTURE

- Complex multilayer film stacks can be measured with the OptiPrime-CD
- Super structures, with sets of repeating layers, can be fully modeled in the analysis software
- Film stacks containing over 80 layers have been successfully measured



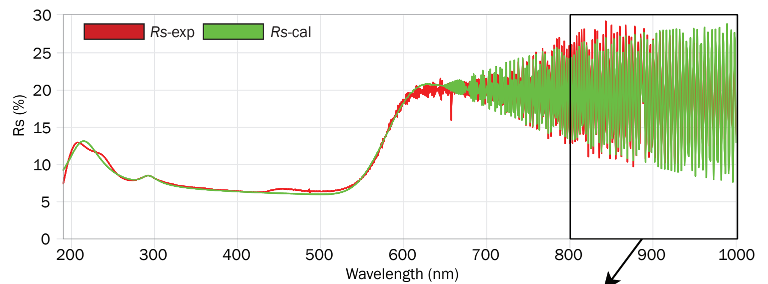


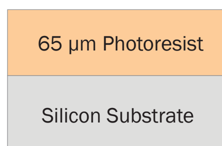


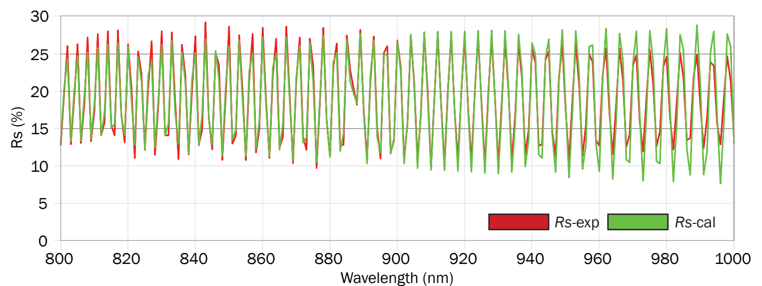


ULTRA THICK PHOTORESIST

- The 1 nm wavelength resolution of the OptiPrime-CD captures all interference fringes for the 65 µm Photoresist, enabling measurement of the film thickness
- Films up to 75 µm thick have been measured using the OptiPrime-CD



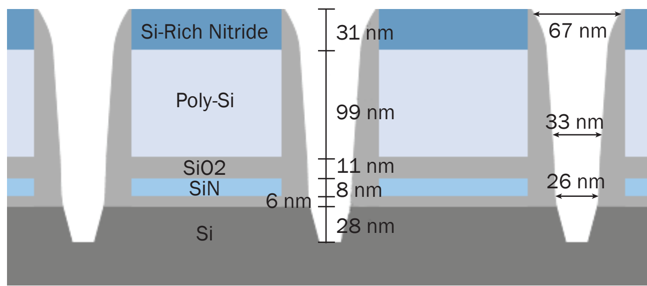




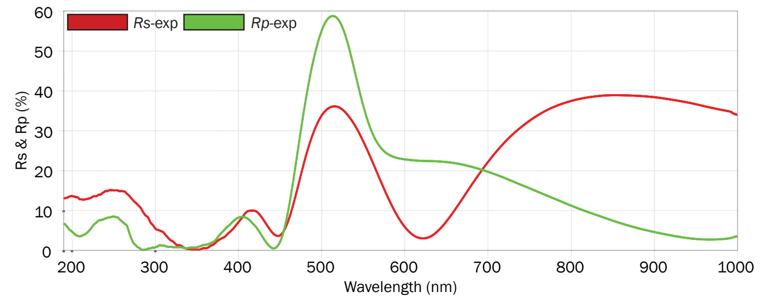
OCD Scatterometry Application Examples

The n&k OptiPrime-CD's OCD scatterometry applications cover structures with very large pitches and very small pitches, 2-D and 3-D complex structures including films inside and outside of shallow and deep trenches and contact holes. Because of our patented and unique optical design, n&k Technology offers the highest signal-to-noise ratio and lowest cost of ownership to support your OCD requirement.

2-D COMPLEX STRUCTURE

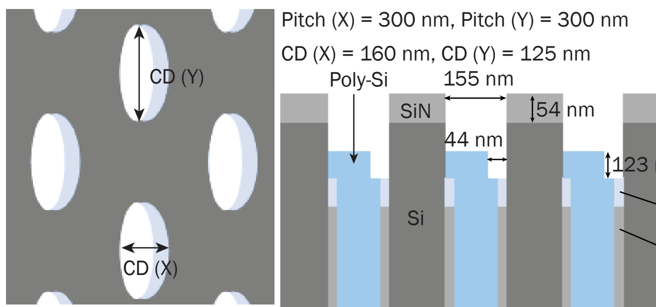


n&k Results - Cross Sectional View



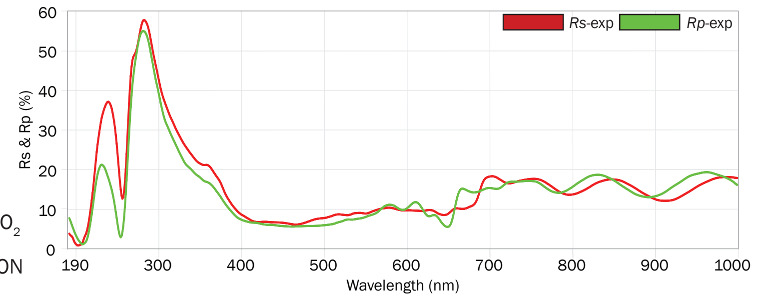
Experimental Spectra Showing Distinct *Rs* and *Rp* Polarized Spectra

3-D ASYMMETRIC ELLIPTICAL HOLES



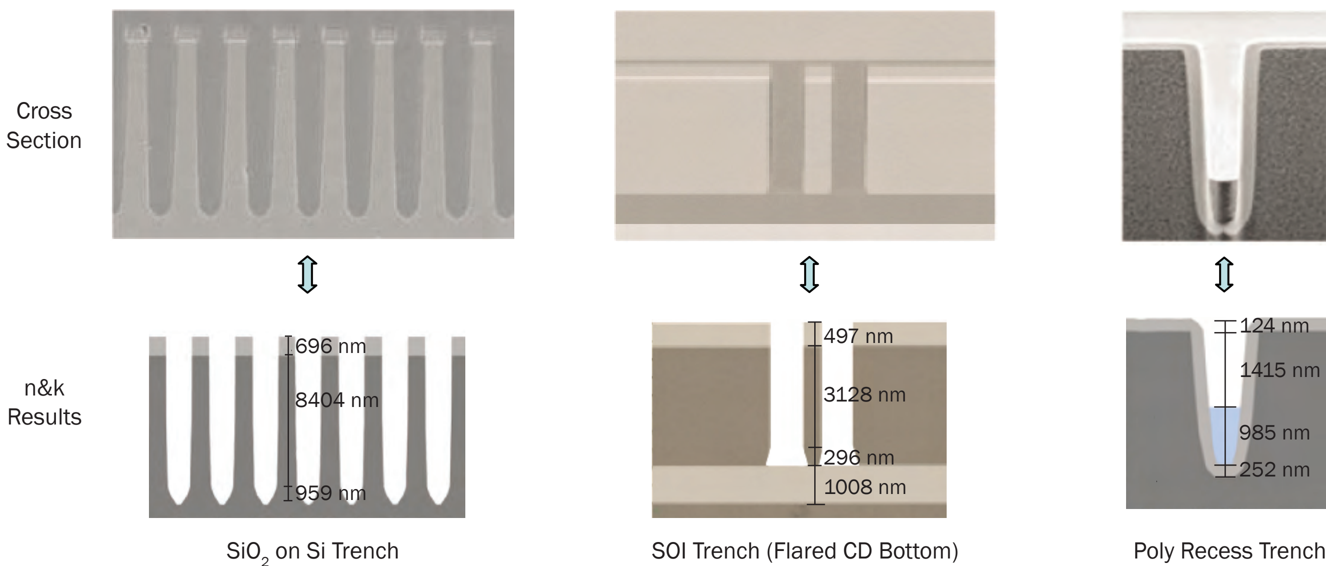
n&k Results - Top View

Cross Sectional View



Experimental Spectra Showing Distinct *Rs* and *Rp* Polarized Spectra

PROFILE COMPARISON WITH FIB AND X-SEM



SiO_2 on Si Trench

SOI Trench (Flared CD Bottom)

Poly Recess Trench

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