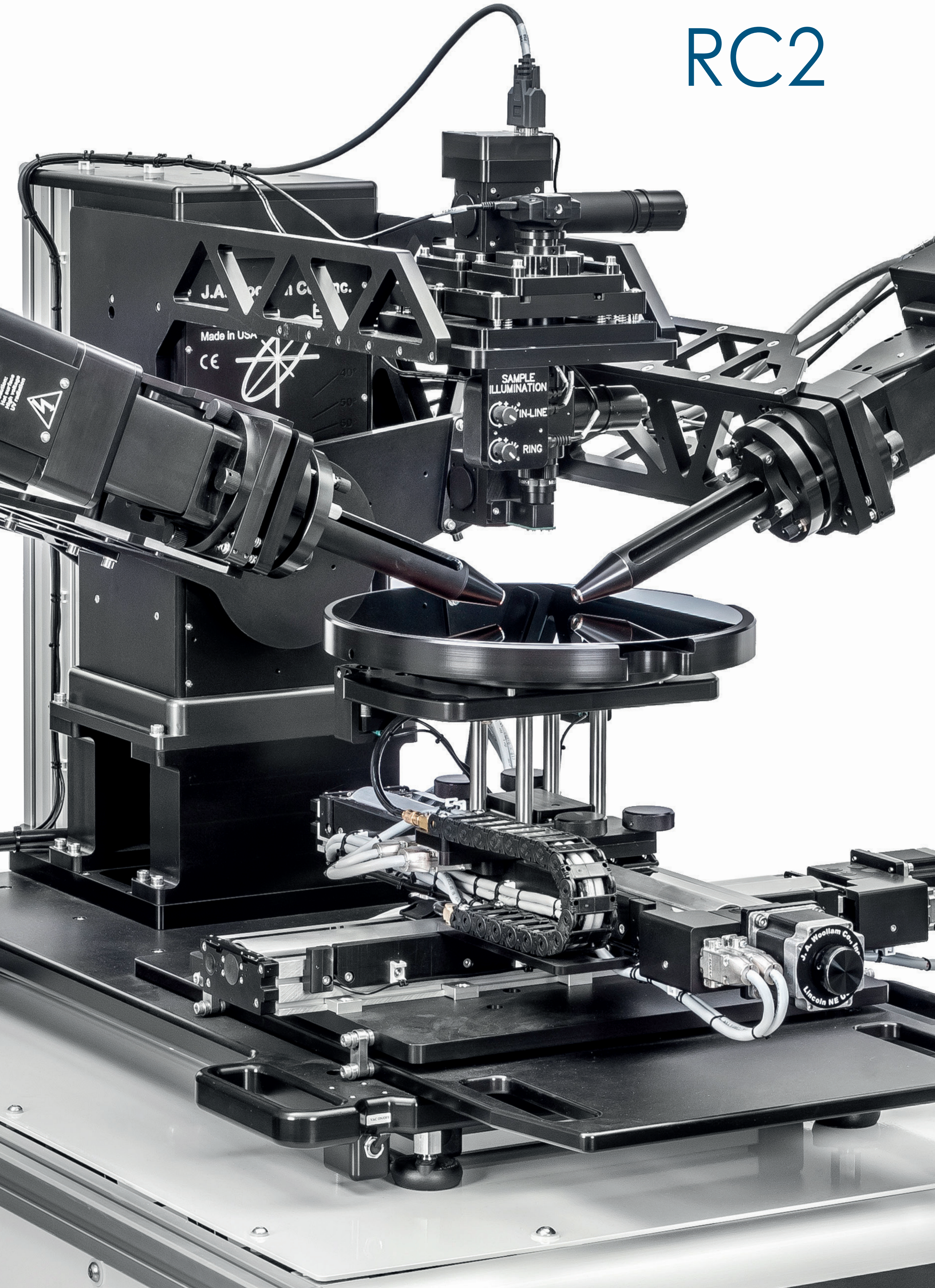
RC2



Innovative

Capabilities

The RC2® builds on 25 years of ellipsometry experience. It combines the best features of previous instruments with innovative new technology: dual rotating compensators, achromatic compensator design, advanced light source and next-generation spectrometer design. The RC2 is a near-universal solution for the diverse applications of spectroscopic ellipsometry and Mueller matrix ellipsometry.

Why an RC2?

Advanced Measurement Capabilities

The RC2 is the first commercial spectroscopic ellipsometer to collect all 16 elements of the Mueller matrix. Mueller matrix SE allows characterization of the most advanced samples and nanostructures.

Unparalleled Accuracy

An innovative optical design allows superior data accuracy for standard spectroscopic ellipsometry measurements (SE), generalized ellipsometry measurements (g-SE), and the entire Mueller matrix (MM-SE).

Wide Spectral Range

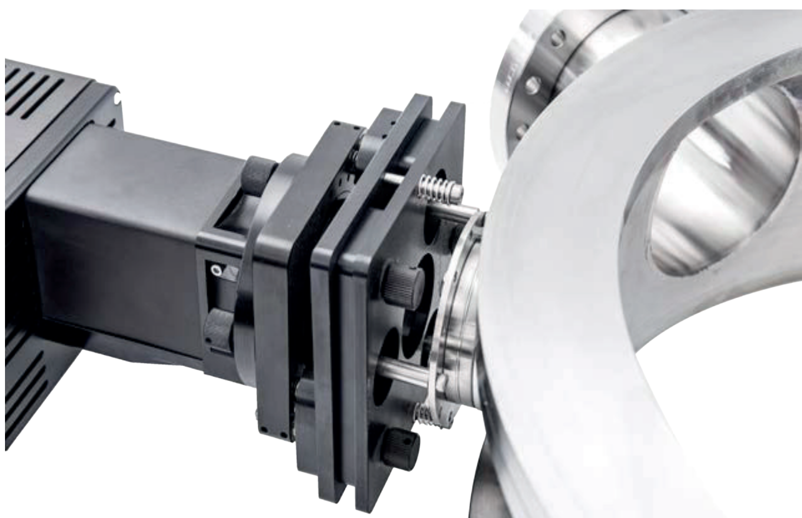
The RC2 is the first CCD-based spectroscopic ellipsometer to cover wavelengths from the ultraviolet (down to 193 nm) to the extended near infrared (up to 2500 nm)

Fast Measurement Speed

Synchronous operation of both compensators allows highly accurate data without waiting to "zone-average" over optical elements. Collect the entire spectrum (over 1000 wavelengths) simultaneously in a fraction of a second.

Flexible Configurations

The RC2 is perfect for any application. Choose automated angle of incidence, highly focused spot size, or even mount the system directly to your process chamber.



Advanced Technology

Dual Rotating Compensators

The RC2 uses synchronous rotation of two compensators (both before and after the sample) to provide high accuracy, fast measurement speed, and advanced measurements including the complete Mueller matrix.

Achromatic Compensator Design

Patented achromatic compensators provide optimized performance over a wide spectral range from the ultraviolet to the near infrared.

Advanced Light Source

Next-generation light source includes computer-controlled beam intensity to automatically optimize the signal on any sample (low or high reflection).

Innovative Spectrometer

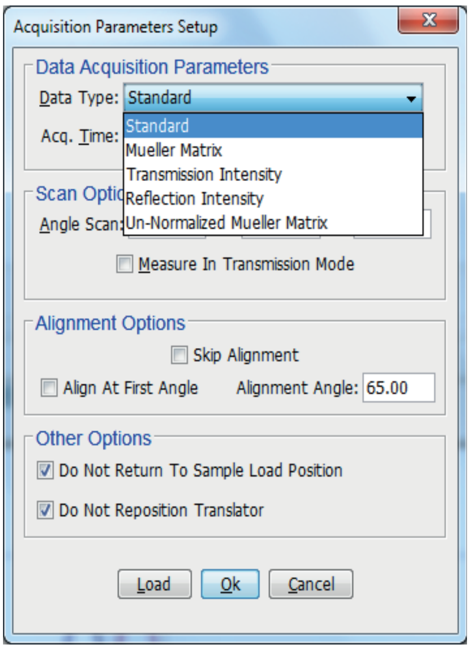
Next-generation spectrometer collects over 1000 wavelengths simultaneously. Advanced silicon CCD is combined with an InGaAs diode array - both designed to reduce bandwidth which improves measurement of sharp data features.

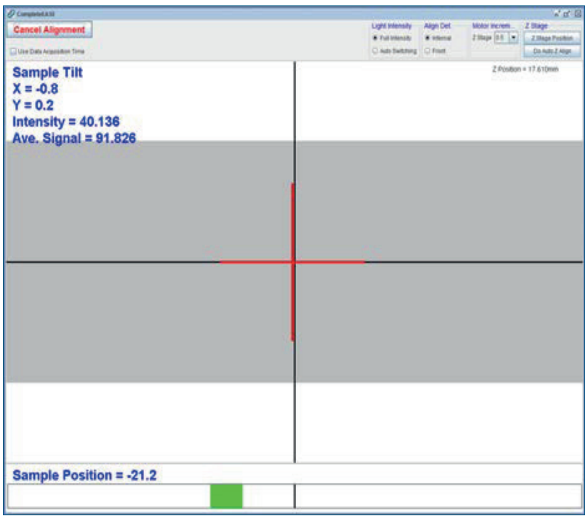
Novel Beam Alignment

With the RC2, we have “re-thought” how beam alignment should be achieved. Multiple position-sensitive detectors along the beam path help ensure the system (and sample) are always well-aligned for highest data accuracy.

New Extended NIR Spectrometer

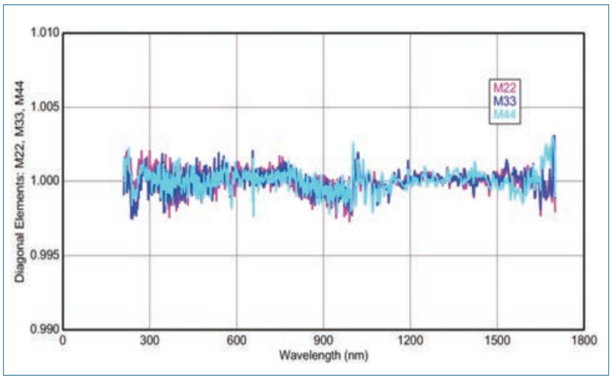
The RC2 is the first commercial ellipsometer to use the latest thermoelectric (TE) cooled, strained InGaAs array to collect hundreds of wavelengths in the infrared out to 2500 nm.

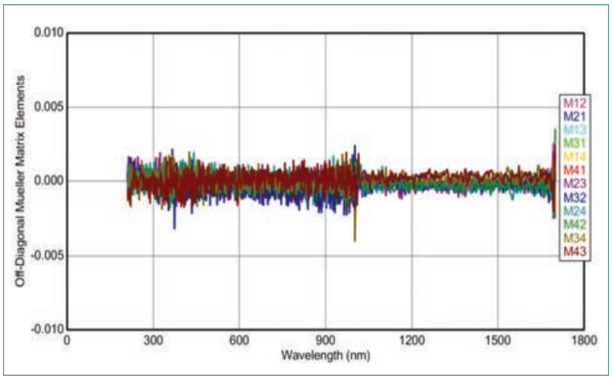




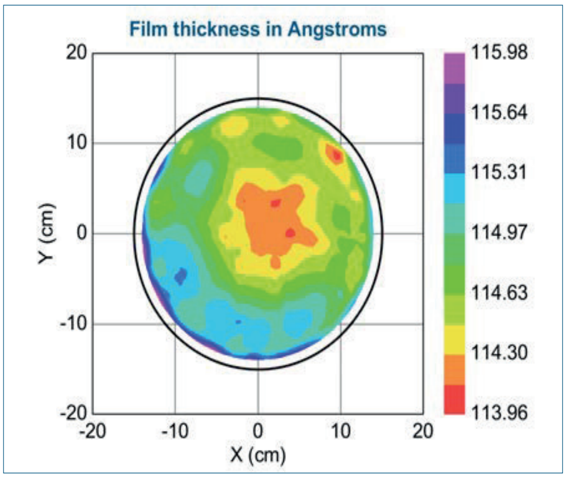
Excellent Data Quality

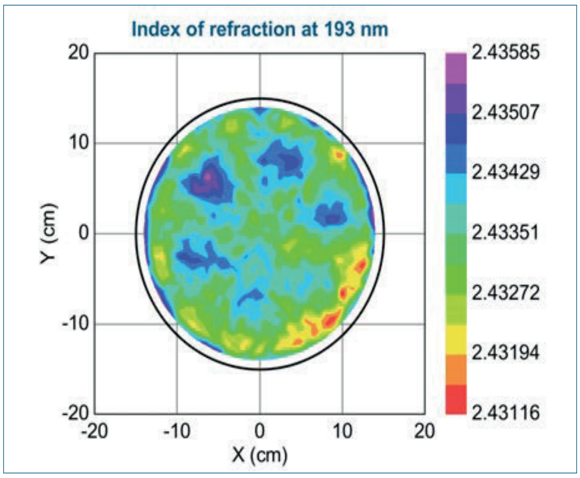
The advanced RC2 technology provides very high data accuracy. A test measurement of air (straight-through) produces diagonal Mueller matrix values = 1 ± .002 and off-diagonal Mueller matrix values = 0 ± .002.

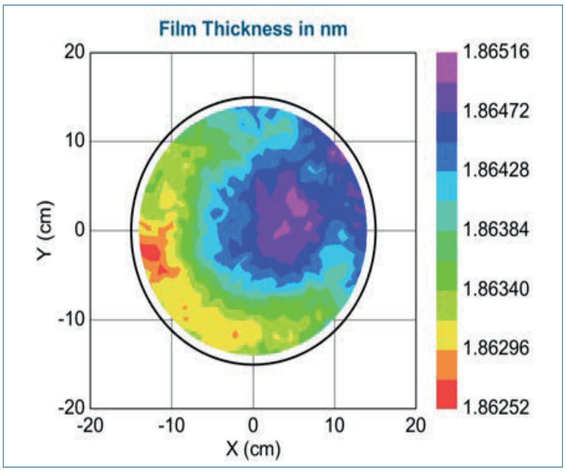




Ultimately, superior Mueller matrix performance translates to high-precision thickness and refractive index measurements. Thickness repeatability for a thin oxide film is < 0.005 nm. The phase information from Ellipsometry is also very sensitive to thicknesses down to a monolayer of material, as witnessed in the map of native oxide thickness.

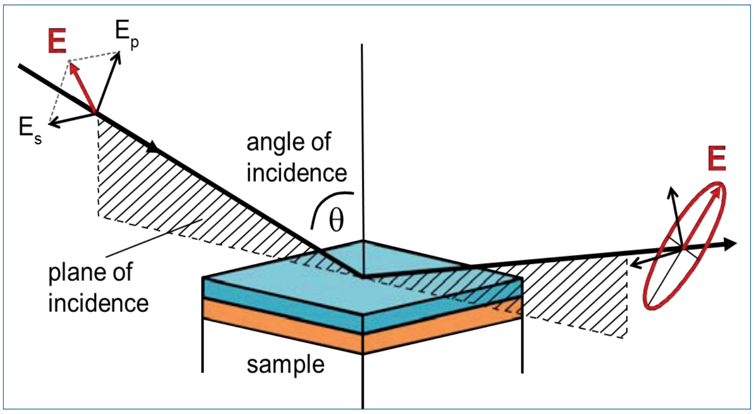


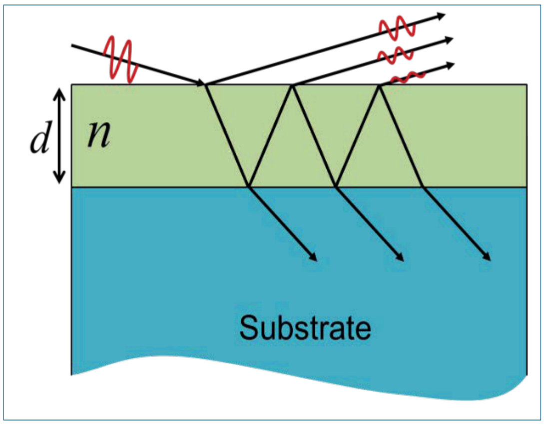




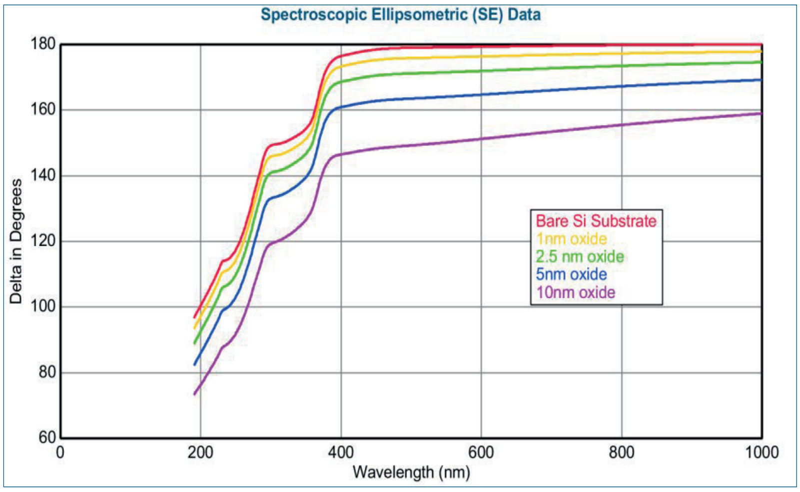
Thin Film Characterization

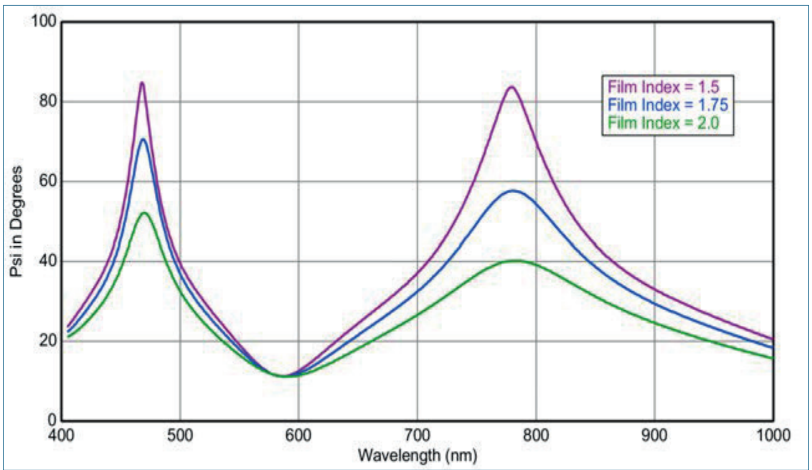
Ellipsometry uses polarized light to characterize thin film and bulk materials. A change in polarization is measured after reflecting light from the surface. Thin film thickness (*d*) and optical constants (*n, k*) are derived from the measurement.





Spectroscopic ellipsometry is very sensitive to the presence of surface layers on the order of just a fraction of a nanometer. Primary sensitivity comes from changes in phase (Delta), as is shown in the graph to the right for a series of thin oxides on silicon substrate.

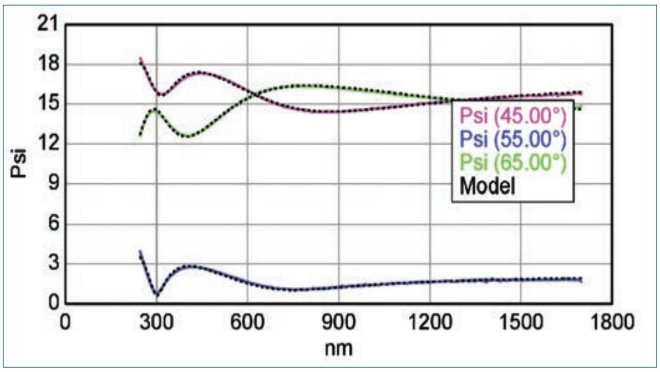


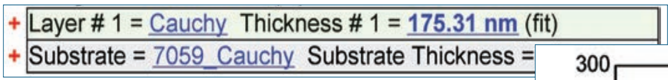


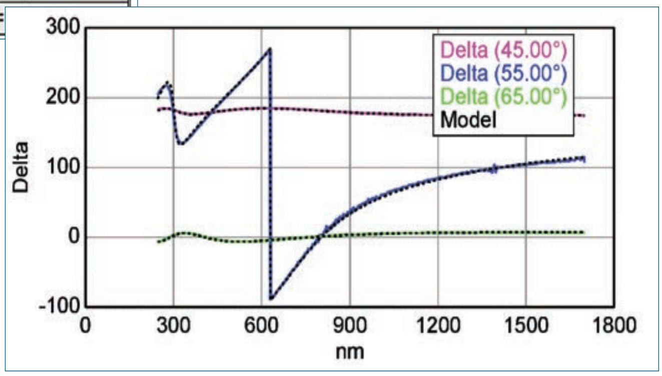
In addition to thickness measurements, spectroscopic ellipsometry is also able to measure the optical properties of thin films. The refractive index of a transparent film will affect the Psi measurement amplitude, as shown in the graph to left.

SiO_2 on Glass

Adjustable light output optimizes measurements for low-reflection coatings such as index matched films on glass.

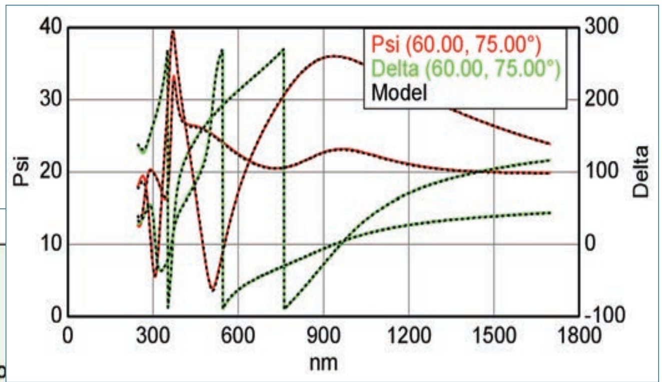


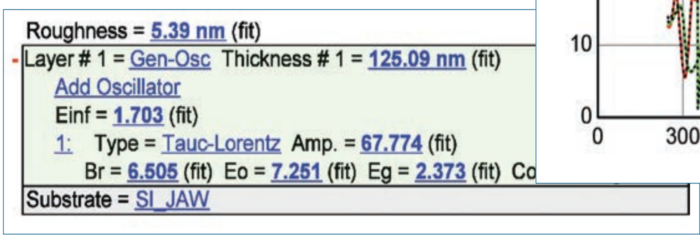


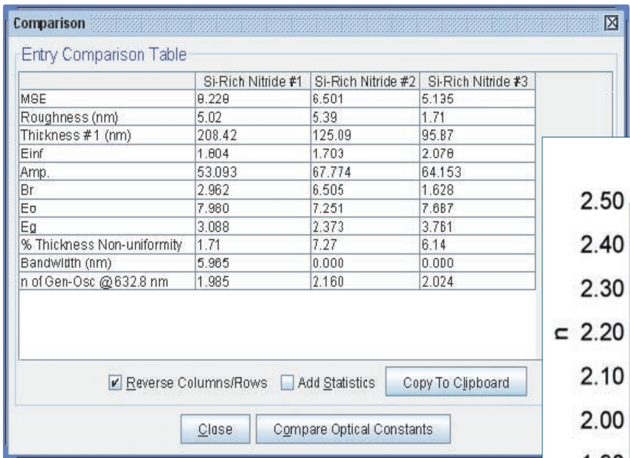


Si-rich Nitride

Get quick results for any thin film - dielectrics, organics, semiconductors, metals...and more.





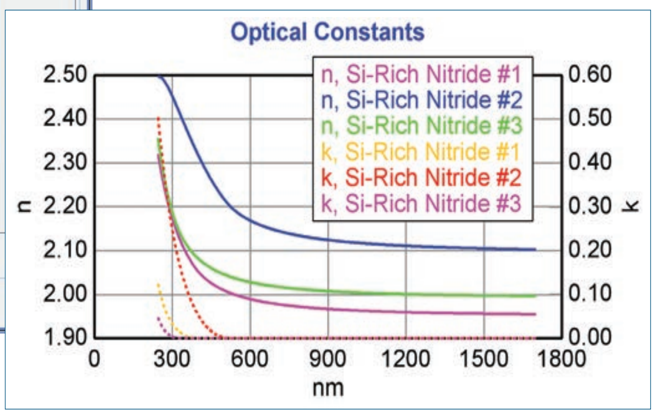

Comparison

Entry Comparison Table

	Si-Rich Nitride #1	Si-Rich Nitride #2	Si-Rich Nitride #3
MSE	8.228	6.501	5.135
Roughness (nm)	5.02	5.39	1.71
Thickness # 1 (nm)	208.42	125.09	95.87
Einf	1.604	1.703	2.078
Amp.	53.093	67.774	64.153
Br	2.962	6.505	1.628
Eo	7.980	7.251	7.687
Eg	3.088	2.373	3.761
% Thickness Non-uniformity	1.71	7.27	6.14
Bandwidth (nm)	5.965	0.000	0.000
n of Gen-Osc @632.8 nm	1.985	2.160	2.024

Reverse Columns/Rows Add Statistics Copy To Clipboard

Close Compare Optical Constants

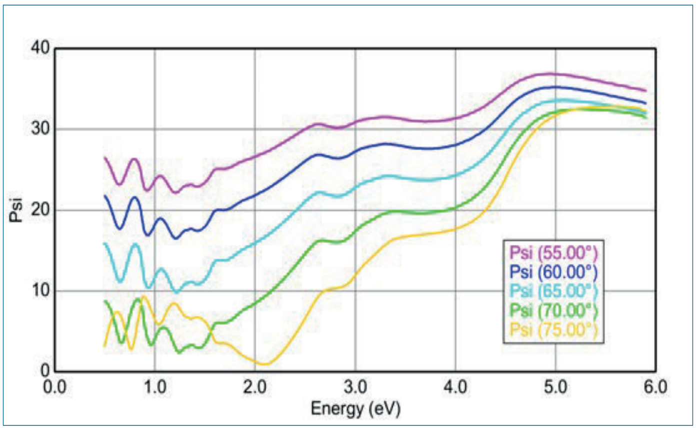


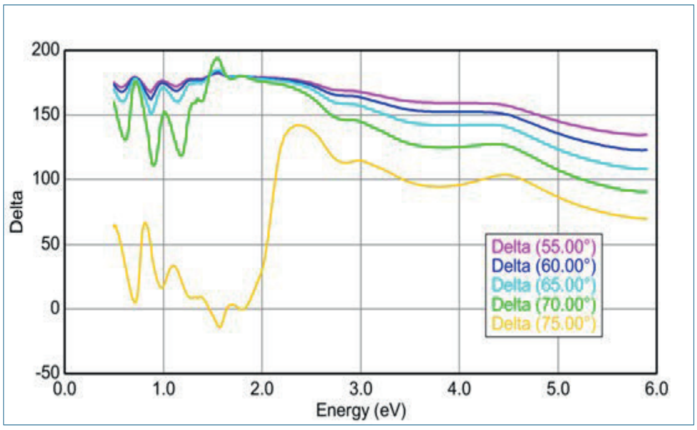
Compare optical constants measured from a series of silicon-rich nitrides to study changes with process conditions.

Applications

Low bandgap semiconductors

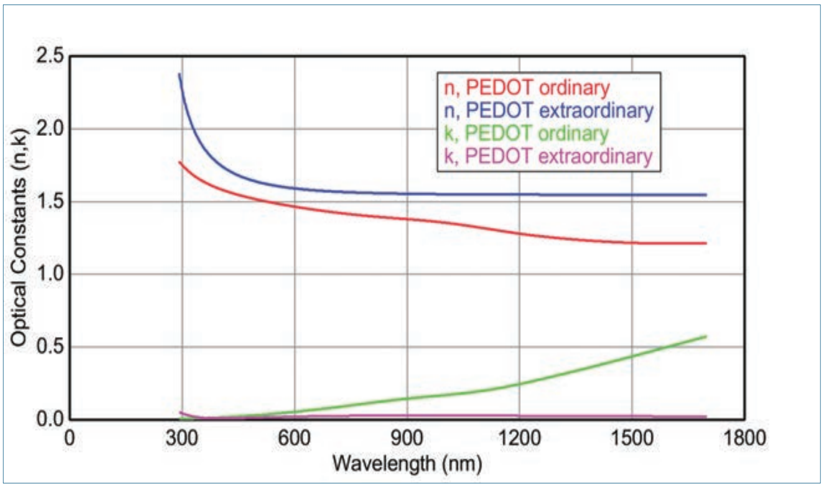
The RC2 can cover wavelengths from the ultraviolet to the near infrared. For compound semiconductor thin films, this allows coverage of photon energies down to 0.5 eV and up to 6 eV. The low-energy region can show the bandgap of the material, while the high energy shows the absorptions caused by other electronic transitions.

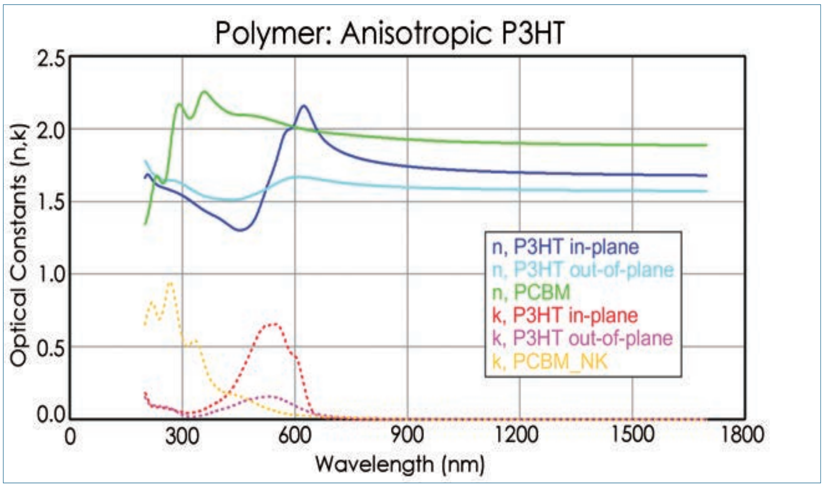




Conductive Organics

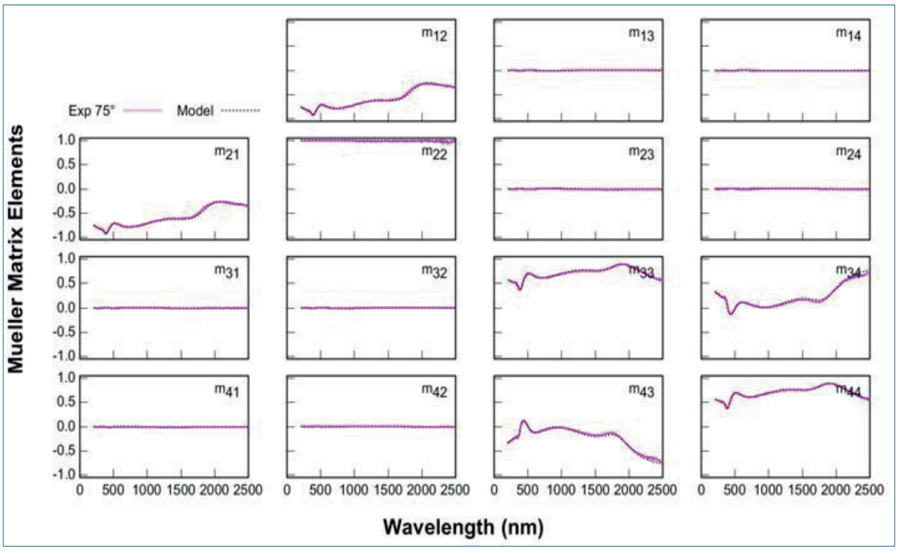
Great progress has occurred in the area of organic layers and stacks used for display (OLED) or photovoltaic applications. There are many different materials being studied, from small molecules such as Alq3 to conjugated polymers such as P3HT. Often multiple materials are blended together – which requires the wide spectral range of the RC2 – to probe different wavelengths where the organics are optically different. Long-chain molecules may also have significant anisotropy, where orientational stacking of the polymer chains produces different optical constants in different directions.



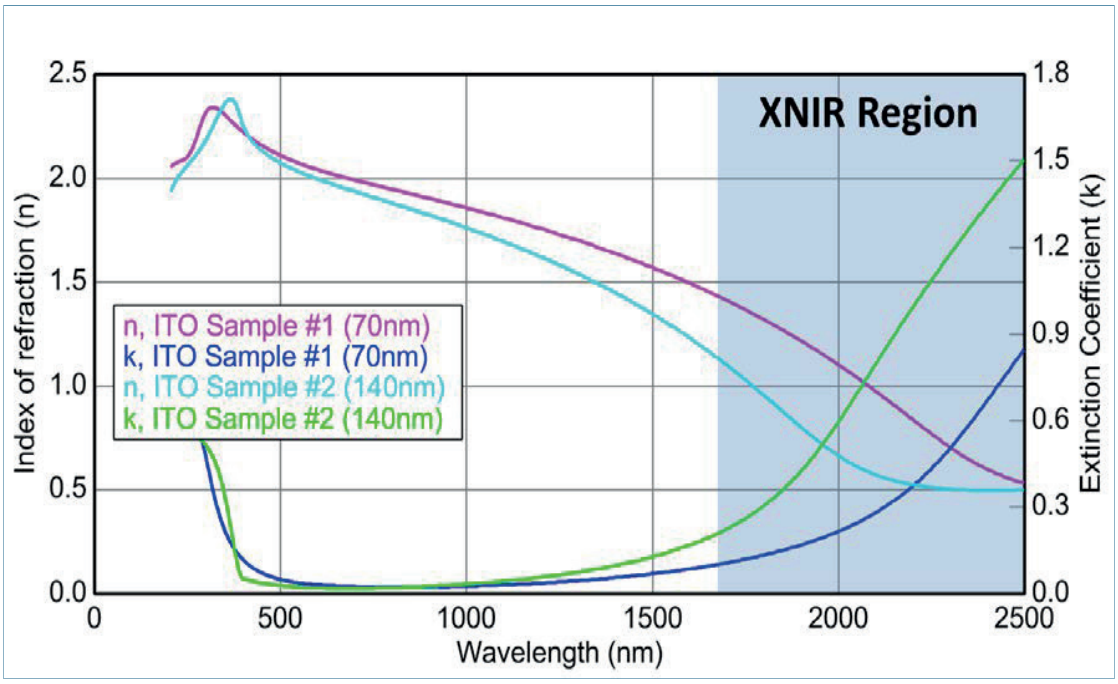


Display Applications

Measurements of a-Si, poly-Si, microcrystalline-Si, OLED layers, color filters, ITO, MgO, polyimide, and liquid crystals are beneficial during display R&D and production.



MM data from an ITO layer on flexible PET substrate



ITO conductivity is related to NIR absorption, which the RC2 is perfectly suited to measure with the NIR or XNIR wavelength extensions.

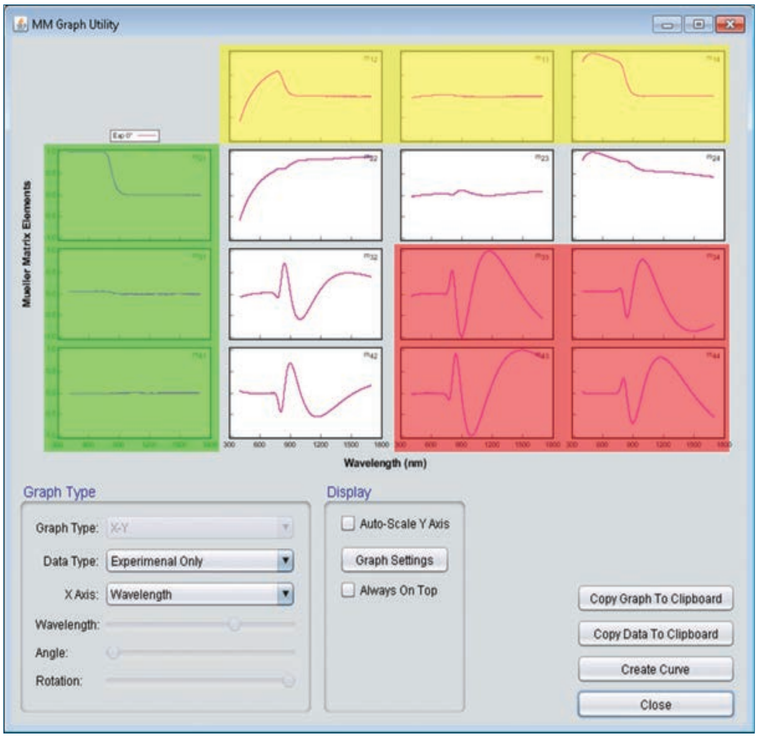
Anisotropic Applications

Complete Mueller Matrix

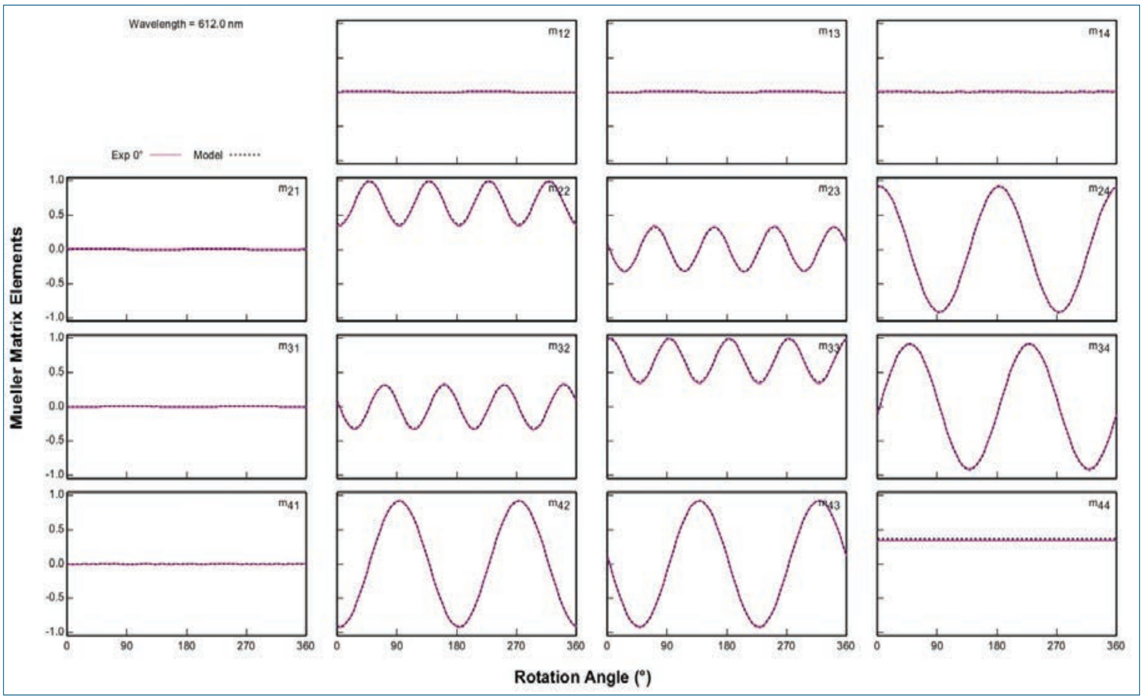
The RC2® can characterize the full Mueller matrix of a sample. This advanced data type ensures appropriate characterization of complex samples that are both anisotropic and depolarizing.

$$M_{11}\begin{bmatrix} 1 & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \\ m_{41} & m_{42} & m_{43} & m_{44} \end{bmatrix}$$

Mueller matrix ellipsometry for an anisotropic, depolarizing samples can contain information in every element of the normalized Mueller matrix.



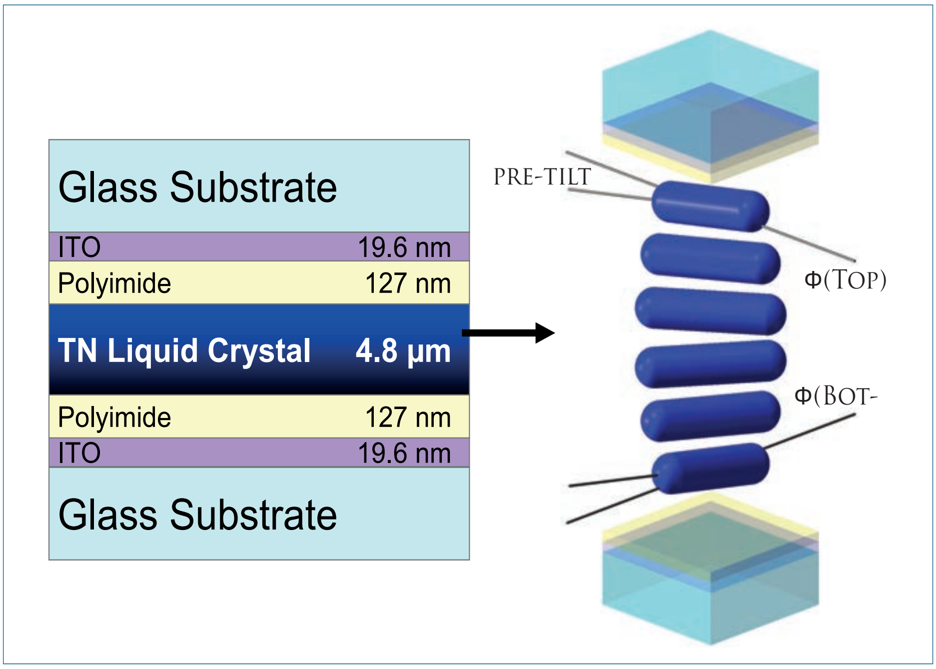
Viewing the entire Mueller matrix allows access to different polarization effects in advanced samples. The yellow and green sections are related to Diattenuation and Polarizance, respectively. The red section shows unrotated Retardance. Further rotating the sample will shift this information into different regions of the Mueller matrix.



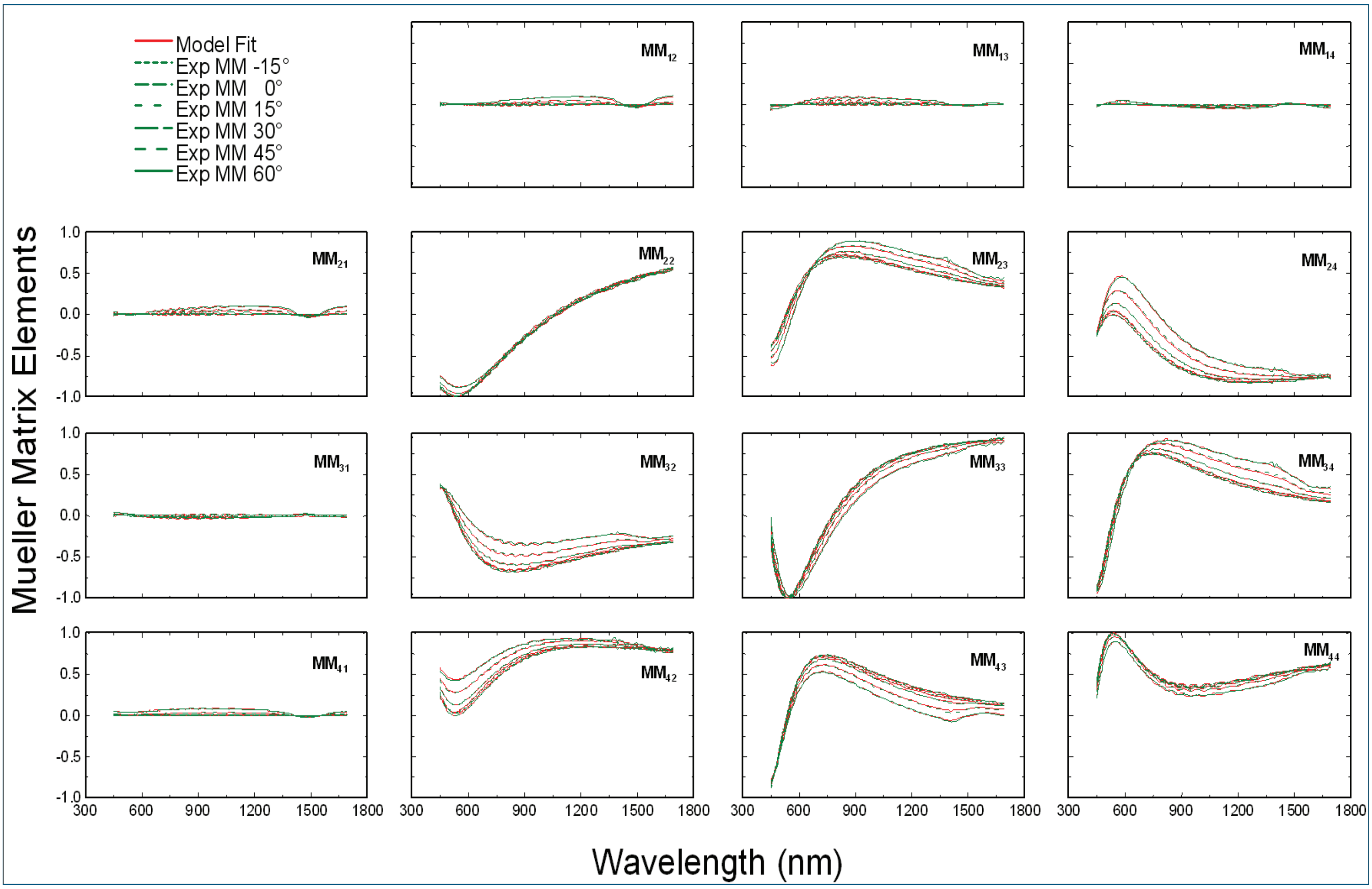
Rotation MM-SE scan shows the retardation signature from an anisotropic sample in the bottom-right nine elements.

Liquid Crystals

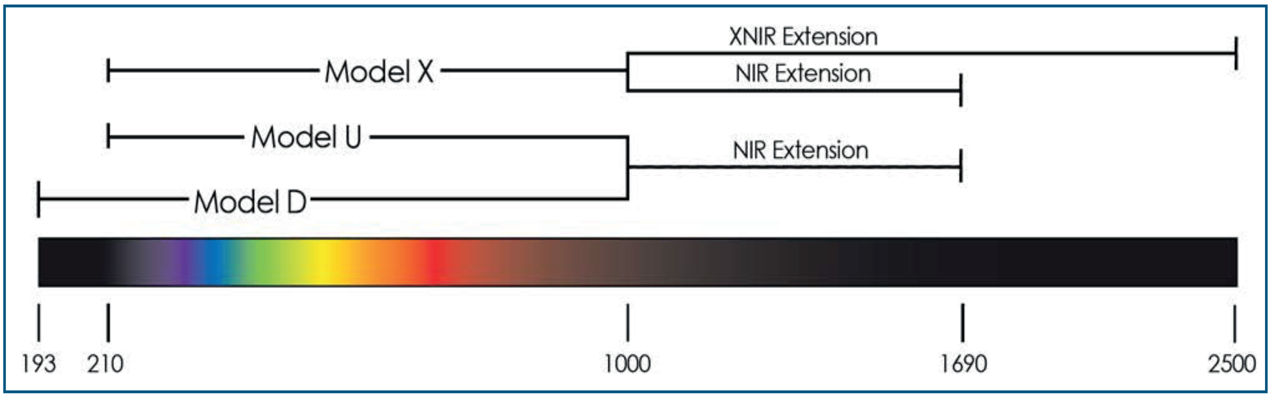
Twisted nematic liquid crystal films introduce the complexity of an anisotropic film with a smoothly varying optical axis orientation. MM-SE is the best choice for thick liquid crystal layers sandwiched between glass substrates - as depolarization and anisotropy effects will both exist.



The complete Mueller matrix was measured for a twisted liquid crystal. This enabled characterization of the optical axis twist and pre-tilt, and liquid crystal anisotropic refractive index.



Configurations/Wavelengths

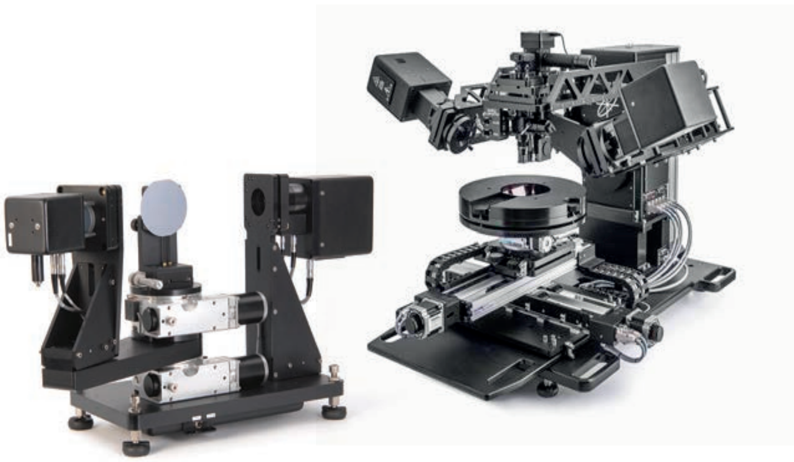


Automated Angle

Combine flexibility with convenient automation. Available in horizontal or vertical configuration.

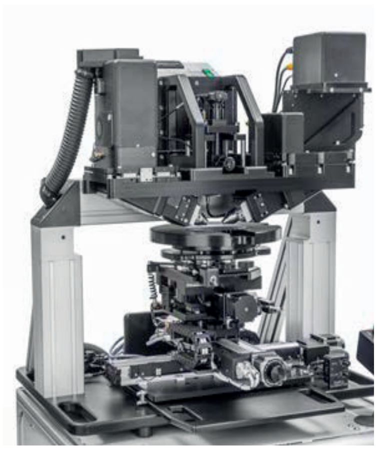
Vertical system offers wide range range and independent control of sample and detector angle for flexible reflection or transmission measurements

Horizontal system offers wide range of options like large area mapping, liquid cells, and heat stages.



Focused

The smallest RC2 spot size available (25 by 60 microns) for demanding feature sizes.



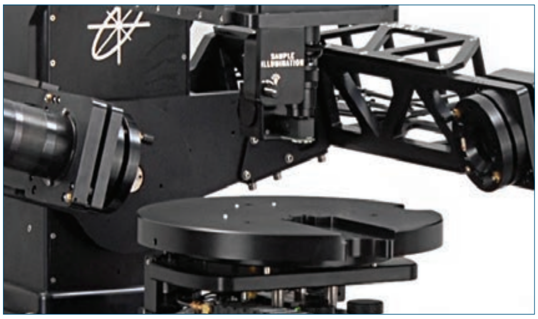
In-Situ

Mount the RC2 directly to a process chamber for real-time monitoring and control

Accessories

Mapping & Rotation

Fully automated sample translation or rotation. Map thin film uniformity of wafers or glass panels. Rotator useful for anisotropic material characterization.



Automated 300 x 300 mm XY mapping.

Sample Rotator

Auto-Align, Camera & Focused Spot

Fully automated sample alignment to adjust tip-tilt-z. Focused spot size with camera for patterned features.

RC2 with automated sample alignment and detachable focusing probes.

Liquid & Temperature Studies

Study your thin films in a liquid environment or with adjustable temperature in one of our many cells.

5mL Heated Liquid Cell
(Room Temp. to 50°C)

Linkam Temperature Stage

Environmental Studies

Control the sample environment to study porous materials.

Environment Cell and Control Setup

Specifications

System Overview

Patented dual rotating compensator ellipsometer with simultaneous CCD detection of all wavelengths, flexible system configuration.

Measurement Capabilities

- Spectroscopic Ellipsometry (SE): Psi and Delta over their full range.
- Generalized SE: Complete 2x2 Jones matrix for anisotropic samples.
- Mueller Matrix SE: All 16 elements of the 4x4 Mueller matrix.
- Depolarization: Measure and model the non-ideal nature of your sample.
- Intensity: Both reflectance and transmittance, including anisotropic terms such as like- and cross-polarized intensities.

Wavelength Range

U, X:	210-1000 nm	790 wvls.
D:	193-1000 nm	800 wvls.
UI, XI:	210-1690 nm	1065 wvls.
DI:	193-1690nm	1075 wvls.
XI+:	210-2500 nm	1065 wvls.

Data Acquisition Rate

Measure complete spectrum in 1/3 of a second - even for advanced data types!

Angle Range

Fixed Angle	65°
Horz. Auto Angle	45° - 90°
Vert. Auto Angle	20° - 90°

Advanced

Quantum Design
1 avenue de l'Atlantique
Bâtiment Fuji-Yama
91940 Les Ulis - France

Tél. : +33 1 69 19 49 49
france@qd-europe.com
www.qd-europe.com