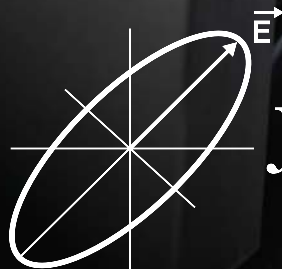
M-2000®



J.A. Woollam Co., Inc.

Ellipsometry Solutions

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Speed

Discover the Difference

Auto Alignment

The M-2000® line of spectroscopic ellipsometers is engineered to meet the diverse demands of thin film characterization. An advanced optical design, wide spectral range, and fast data acquisition make it an extremely powerful and versatile tool.

The M-2000 delivers both speed and accuracy. Our patented RCE technology combines Rotating Compensator Ellipsometry with high-speed CCD detection to collect the entire spectrum (hundreds of wavelengths) in a fraction of a second with a wide array of configurations. The M-2000 is the first ellipsometer to truly excel at everything from in-situ monitoring and process control to large-area uniformity mapping and general purpose thin film characterization.

300 mm Mapping

Why an M-2000?

Advanced Ellipsometer Technology

The M-2000 utilizes our patented RCE (rotating compensator ellipsometer) technology to achieve high accuracy and precision.

Fast Spectral Detection

The RCE design is compatible with advanced CCD detection to measure ALL wavelengths simultaneously.

Wide Spectral Range

Collect over 700 wavelengths from the ultraviolet to the near infrared – all simultaneously.

Flexible System Integration

With modular optical design, the M-2000 is suited for direct attachment to your process chamber or configured on any of our table-top bases (page 7).

Accuracy

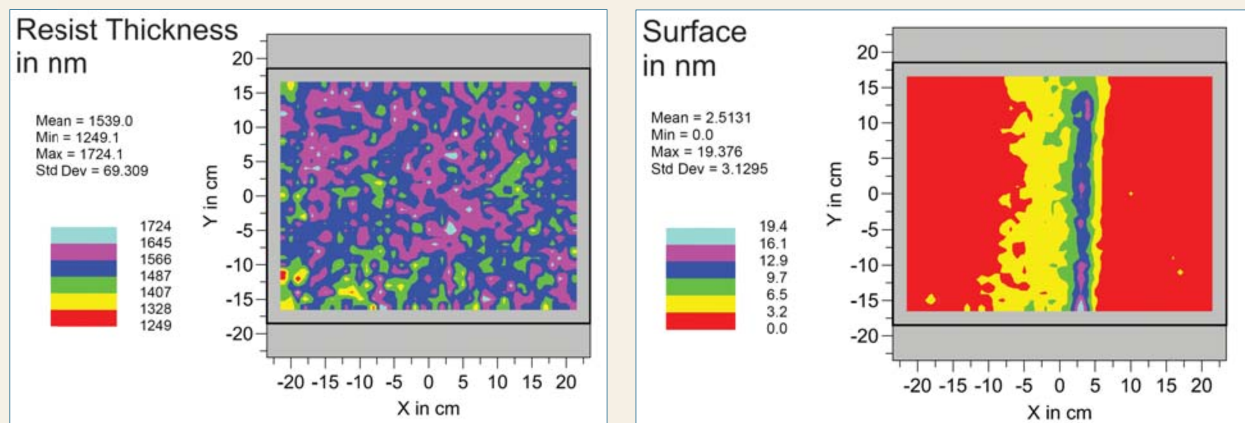
Advanced design ensures accurate ellipsometry measurements for any sample.

Applications

The speed, accuracy, and wide spectral range of the M-2000® make it ideal for a diverse range of measurements. The primary application of ellipsometry is to characterize film thickness and optical constants. The M-2000 excels for both. It measures films from sub-nanometer thickness up to tens of microns and the optical properties from transparent to absorbing materials. It is a flexible instrument and can characterize any type of thin film: dielectrics, organics, semiconductors, metals, and more. Wide spectral range and variable angle allow the M-2000 to diagnose many multi-layered structures.

Flat Panel Displays

The M-2000 is commonly used to map thin film uniformity. In the flat panel display industry, measurements of transparent conductive oxides such as ITO, amorphous and nanocrystalline silicon layers, oxide and nitride thin films, and photoresists insure final device quality.

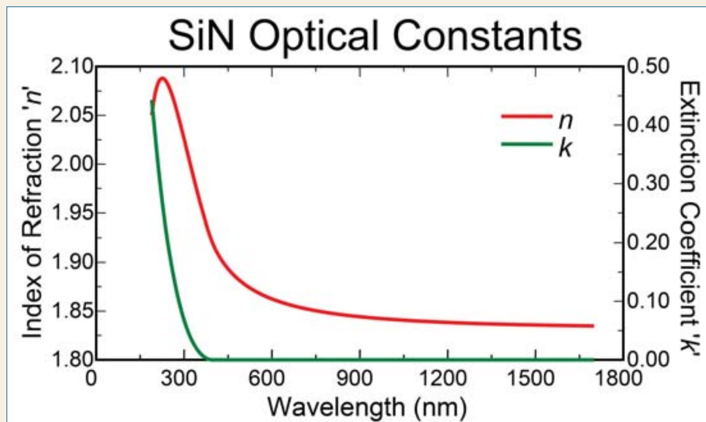


Measurement of a resist coated panel provides film thickness and optical constants as well as a measure of surface damage caused by a processing problem that occurred midway through the panel.

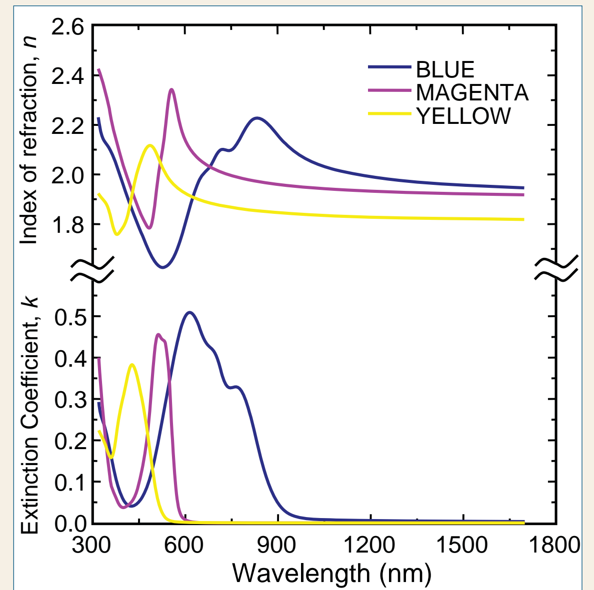
M-2000 Flat Panel

Materials Research

Many industries and researchers benefit from the M-2000® flexibility to study different materials. The photovoltaic industry benefits from high optical throughput of the M-2000 to measure in-situ during processing and to qualify coating uniformity on rough polycrystalline substrates. Color filter layers are measured by combining NIR data to get thickness with UV-VIS data to study the absorbing regions.



SiNx optical constants measured from rough solar cell.

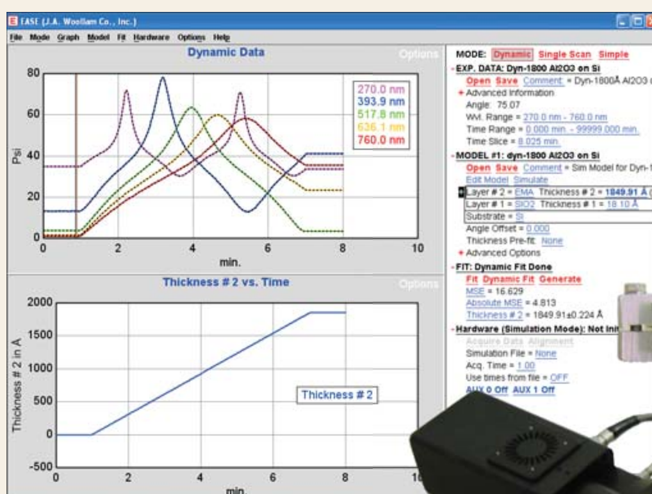


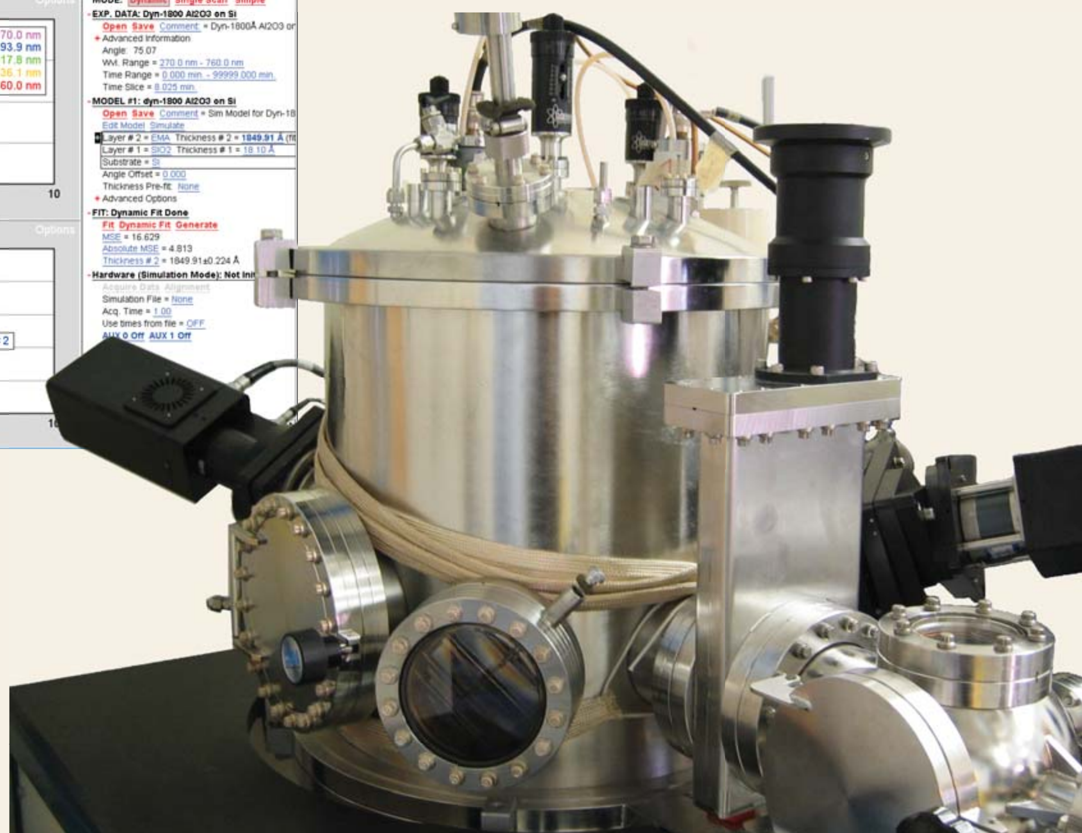
Color filter optical constants measured with M-2000.

In-Situ

The M-2000 is ideal for in-situ monitoring and process control. It is used successfully with many different processes to provide real-time results:

- MBE
- MOCVD
- Liquid Cell
- Sputter
- PECVD
- Heat Stages
- ALD
- Plasma etch
- Cryostat
- E-beam evaporators
- ECR





Flexible Spectral Range

M-2000V

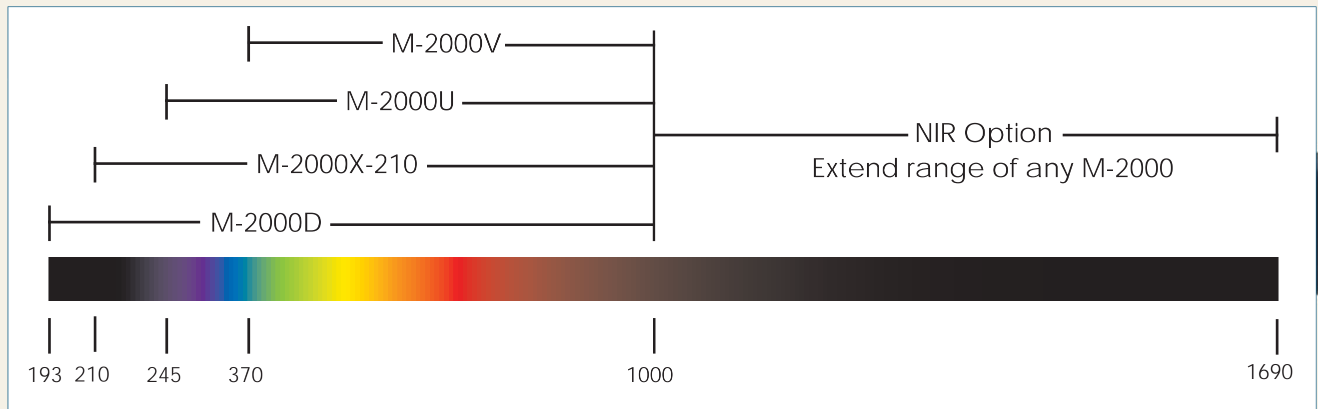
370-1000nm, 390 wavelengths

Spectral coverage is ideal for dielectrics, organics, and amorphous semiconductors. Speed, accuracy, and compact optics combine in an affordable design.

M-2000U

245-1000nm, 470 wavelengths

Ideal for many thin films: dielectrics, organics, semiconductors, metals, and more. Measure optical constants and thickness for coatings from sub-nanometer to tens of microns.



M-2000X-210

210-1000nm, 490 wavelengths

Enhanced UV coverage down to 210nm from a special design that provides smaller focused spot and higher intensity for in-situ applications.

NIR Extension

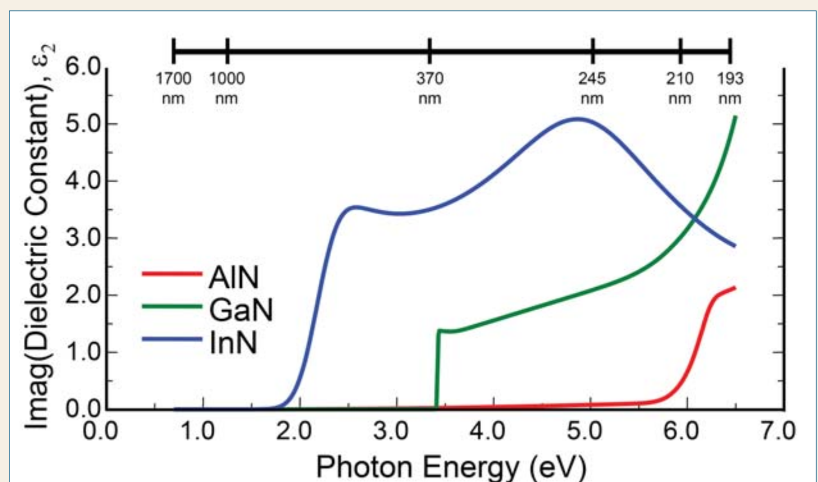
1000-1690nm, 200 wavelengths

Extend any M-2000 into the near infrared. Long wavelengths enable characterization of transparent conductive oxides like ITO, telecommunications films, and semiconductors like Si_xGe_{1-x} that are absorbing at shorter wavelengths. The NIR is also preferred for thick films and complicated multi-layers.

M-2000D

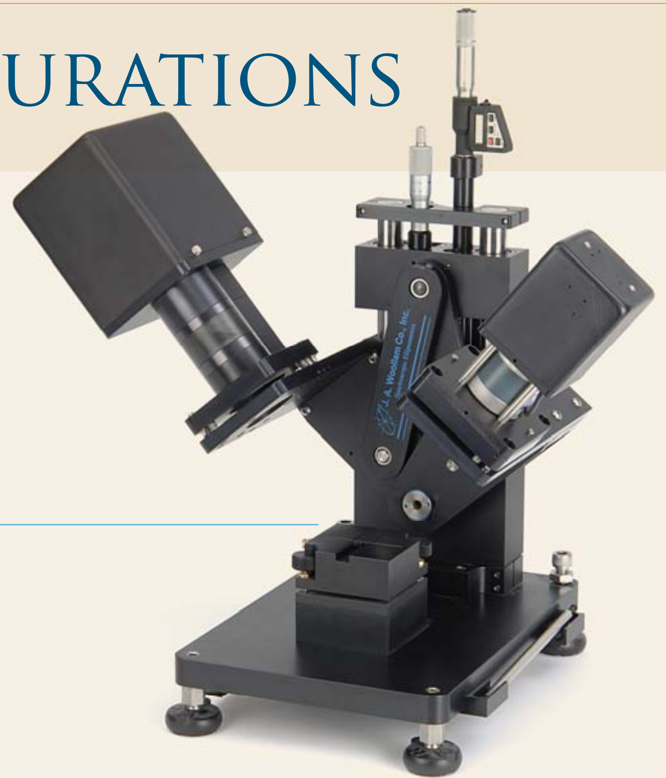
193-1000nm, 500 wavelengths

Perfect for semiconductor industry requirements. Measure at each lithography line – 193nm, 248nm, and 365nm. Short wavelengths can increase sensitivity to ultra-thin films, while simultaneous collection at longer wavelengths insures accurate thickness of transparent films.



Extending UV spectrum opens up higher eV range for semiconductor characterization.

Flexible Configurations



Fixed Angle

For many applications, the simplicity and affordability of a fixed angle systems offers great value.

Manual Angle

A flexible system covering the same applications (and options) as more automated systems.

Automated Angle

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

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

Vertical system offers wide angle range and flexibility. Independent control of sample and detector angle for diverse reflection or transmission measurements.

MASE®

Offers multi-angle and/or focusing spectroscopic ellipsometry in a small instrument footprint. Focusing or multi-angle optics automatically slide into place.

Focusing

The smallest M-2000 spot size available (25 by 60 microns) for demanding feature sizes.

Accessories

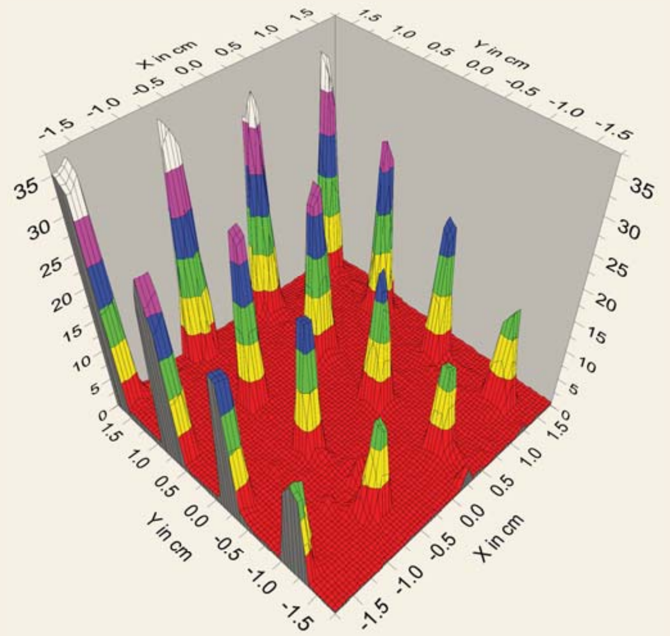
The diverse applications covered by spectroscopic ellipsometry are enabled by the large variety of M-2000® accessories.

Automated Alignment

Computer-controlled tip-tilt and Z-height options provide quick, effortless sample alignment.

Automated Sample Translation

Conveniently map thin film uniformity – available in sizes from small samples requiring focused measurements up to large flat panel display glass.



Focusing/Camera

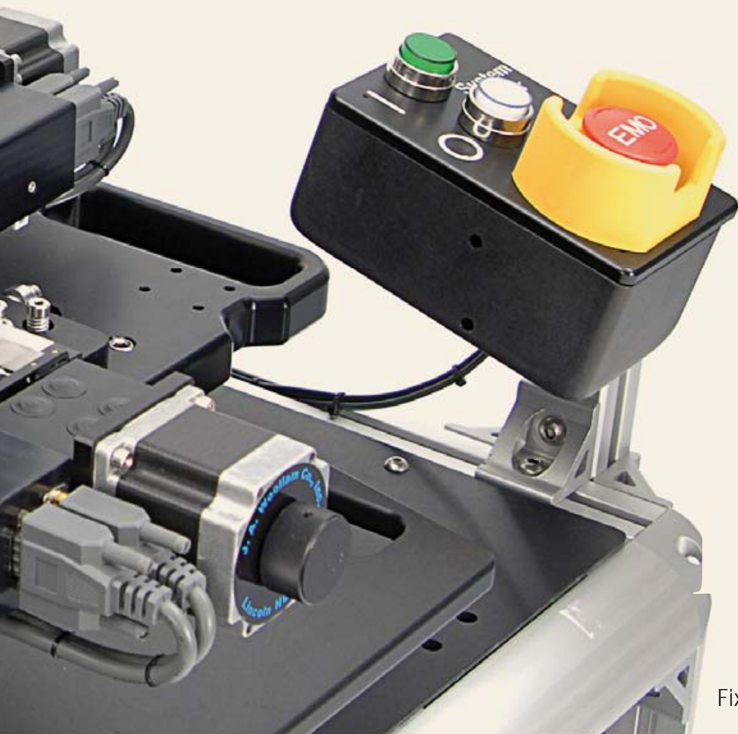
Ideal for applications where the measurement area is sub-mm.

Temperature Control Stages

Study how film properties change with temperature. Various heat stage and cryostat options control temperatures from 4.2K to 600°C.

Liquid Studies

Monitor the liquid-solid interface in real-time. Options available for small liquid volumes, electrochemical processes, and in conjunction with QCM (Quartz Crystal Monitoring) measurements.



In-situ

The M-2000 is ideal for in-situ monitoring and process control. It is used with many different process chambers including MBE, sputter, ALD, E-beam evaporator, MOCVD, PECVD, plasma etch, ECR, and more.

Fixed Angle M-2000 with 300mm mapping.

Advanced Measurements

In addition to highly accurate ellipsometry measurements, the M-2000® offers advanced measurements of complex samples.

Polarized R/T

Measure Reflectance and Transmittance at multiple angles and wavelengths. Collect data for different polarizations, including cross-polarization for anisotropic materials.

Mueller-Matrix

For complicated samples with both anisotropy and depolarization, the most complete measurement involves the Mueller-matrix. The M-2000 measures 11 Mueller-matrix elements – enough to characterize highly complex samples.

Anisotropy

The M-2000 offers complete measurement description for anisotropic samples – Generalized Ellipsometry. Data include both standard ellipsometry measurement and additional terms to describe cross-polarization from the sample. Anisotropic materials include plastic substrates, liquid crystals layers, and non-cubic crystals.

Depolarization

Depolarization measurements quantify effects due to thickness nonuniformity, patterned layers, and incoherent backside reflections.

Specifications

Wavelength Range:

M2000V	370-1000nm, 390 wavelengths
M2000VI	370-1690nm, 590 wavelengths
M2000U	245-1000nm, 470 wavelengths
M2000UI	245-1690nm, 670 wavelengths
M2000X-210	210-1000nm, 490 wavelengths
M2000XI-210	210-1690nm, 690 wavelengths
M2000D	193-1000nm, 500 wavelengths
M2000DI	193-1690nm, 700 wavelengths

Angle Range:

Fixed Angle	65°
Manual Angle	45° - 90°
Horz. Auto Angle	45° - 90°
Vert. Auto Angle	20° - 90°
MASE	45°, 60°, 75°
Focusing	65°

System Overview:

Patented rotating compensator ellipsometry, simultaneous CCD detection of all wavelengths, flexible system integration

Data Acquisition Rate:

Data collected 20 times per second. For optimal signal-to-noise, typical measurement times for full spectrum is between 0.5 and 5 seconds.

PRECISION

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J.A. Woollam Co., Inc.

645 M Street, Suite 102 • Lincoln, NE 68508 • USA
Ph. 402-477-7501 • Fx. 402-477-8214
www.jawoollam.com

LOT Oriel Gruppe Europa

eMail: info@lot-oriel.com
Click here for your local contact: www.lot-oriel.com