APP NOTE

Advanced Photonics Thin Film Measurement Applications

Advanced photonic devices require precise optical characterization to optimize light propagation, reduce losses, and improve device performance. Optical coatings, waveguides, photonic integrated circuits (PICs), and laser components all depend on accurate measurement to support development and manufacturing.

StellarNet photonic device measurement systems combine reflectance and transmission spectroscopy with modular optical measurement platforms to characterize advanced photonic structures, optical filters, and laser components through fast, non-contact optical measurements.

Key Photonic Device Measurement Parameters

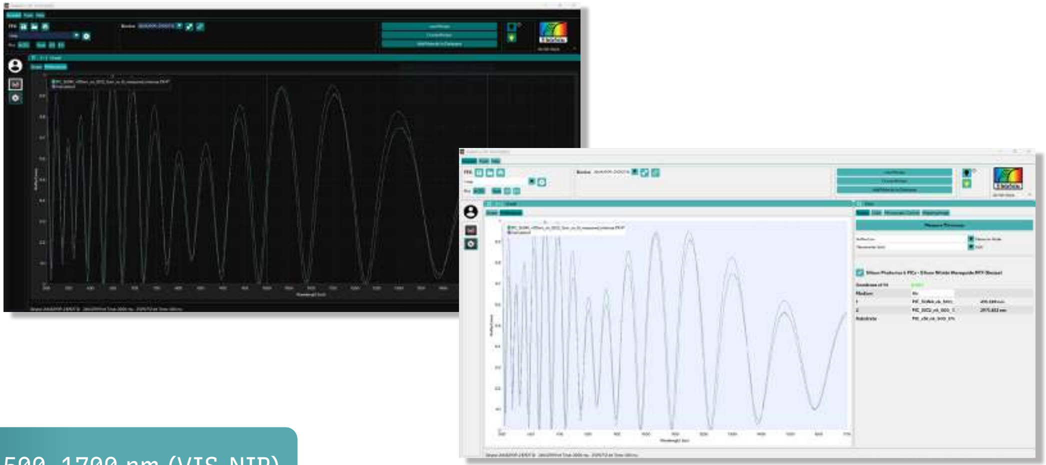
- Thin Film Thickness – Verify layer dimensions and deposition accuracy.
- Reflectance & Transmission – Evaluate optical efficiency and light propagation.
- Optical Loss – Minimize signal attenuation in photonic devices.
- Wavelength Response – Characterize spectral performance across the operating range.
- Optical Constants (n & k) – Measure refractive index and extinction coefficient.
- Optical Filter Characterization – Validate filter performance and spectral selectivity.
- Waveguide & Device Characterization – Assess light confinement and device behavior.
- Process Monitoring & Quality Control – Ensure repeatable manufacturing and consistent device performance.

Together, these measurements help optimize photonic device performance, improve manufacturing consistency, and accelerate the development of advanced optical technologies.

APP #1

Silicon Nitride Waveguide Thickness

Silicon nitride (Si_3N_4) waveguides are a foundational technology for silicon photonic integrated circuits (PICs), enabling low-loss optical routing for telecommunications, LiDAR, biosensing, quantum photonics, and integrated optical sensors. The waveguide thickness directly influences optical confinement, propagation loss, coupling efficiency, and overall device performance. Spectroscopic reflectometry provides fast, non-contact thickness measurement of silicon nitride waveguide layers deposited on silicon dioxide and silicon substrates, supporting process development, wafer qualification, and high-volume PIC manufacturing.



Typical Recipe:

- Air
- Si_3N_4 (400 nm)
- SiO_2 BOX/Cladding (3000 nm)
- Silicon (Bulk)

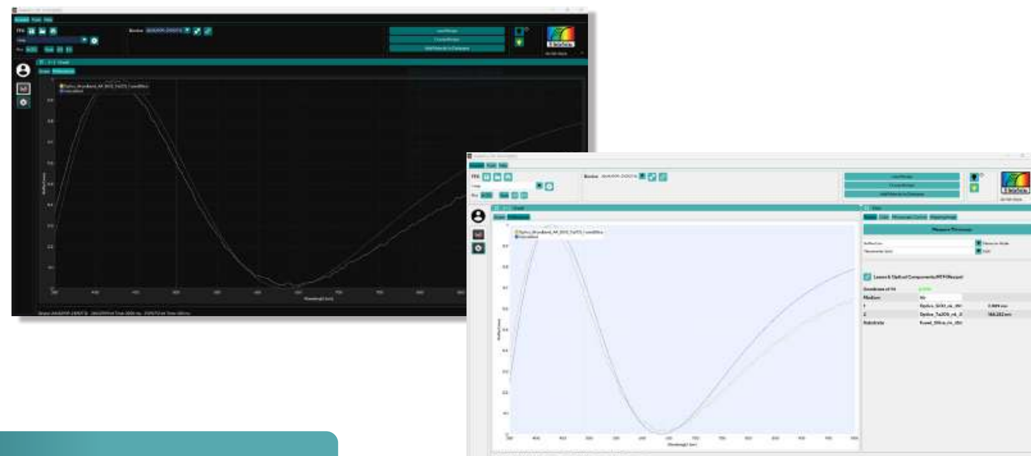
Recommended Spectrometer: 500–1700 nm (VIS-NIR)

Why it's Important: Waveguide thickness directly influences propagation loss, effective refractive index, and wavelength response in silicon photonic devices. Thin-film metrology verifies deposited Si_3N_4 layers before fabrication, ensuring consistent device performance and improved process repeatability.

APP #2

Broadband Anti-Reflection Coating Thickness

Broadband anti-reflection (AR) coatings reduce optical losses by minimizing surface reflections over a wide wavelength range. These multilayer dielectric coatings are widely used on laser optics, imaging lenses, optical windows, fiber optic components, spectrometers, microscopes, and scientific instruments. Precise control of each coating layer is essential for achieving high transmission and low reflectance. Spectroscopic reflectometry combined with Transfer Matrix Method (TMM) analysis provides accurate, nondestructive thickness measurement of multilayer optical coatings throughout manufacturing and quality control.



Typical Recipe:

- Air
- SiO_2 (110 nm)
- Ta_2O_5 (72 nm)
- Fused Silica (Bulk)

Recommended Spectrometer: 350–1000 nm (UV-VIS-NIR)

APP #3

ITO Current Spreading Layer Thickness

Indium Tin Oxide (ITO) current spreading layers are commonly used in GaN-based LEDs to distribute electrical current uniformly across the active device area while maintaining high optical transparency. Uniform ITO thickness is critical for improving light output, electrical efficiency, brightness uniformity, and device reliability. Spectroscopic reflectometry enables fast, nondestructive measurement of transparent conductive coatings deposited on GaN and sapphire substrates, making it an ideal metrology solution for LED process monitoring and production quality control.

Typical Recipe:

- Air
- ITO (150 nm)
- GaN (2000 nm)
- Sapphire (Bulk)

Recommended Spectrometer: 400–1000 nm (VIS-NIR)

Why it's Important: ITO thin films are widely used in photonic devices, optical modulators, and integrated optics. Precise thickness measurements help maintain optical transmission, electrical performance, and device consistency throughout fabrication.

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APP #4

MEMS Optical Mirror Thickness

Optical MEMS mirrors are widely used in LiDAR systems, optical switching, barcode scanners, pico projectors, biomedical imaging, and adaptive optics. These devices typically incorporate reflective aluminum coatings deposited over dielectric layers to maximize reflectivity while maintaining precise mechanical performance. Accurate thin film thickness measurement ensures consistent optical reflectance, mirror flatness, and device reliability. Spectroscopic reflectometry offers a rapid, non-contact solution for characterizing reflective and dielectric layers used in MEMS and MOEMS manufacturing.

Typical Recipe:

- Air
- Aluminum (80 nm)
- Si_3N_4 (250 nm)
- Silicon (Bulk)

Recommended Spectrometer: 350–900 nm (UV-VIS)

APP #5

DWDM Thin Film Filter Thickness

Dense Wavelength Division Multiplexing (DWDM) filters are precision multilayer dielectric optical filters used in fiber optic communication systems to separate and combine closely spaced optical wavelengths around the telecom bands. The optical performance of these filters depends on precise control of each dielectric layer thickness, often to sub-nanometer accuracy. Spectroscopic reflectometry combined with TMM modeling provides rapid, non-contact measurement of multilayer optical filter stacks, supporting manufacturing of DWDM, CWDM, optical transceivers, and high-speed communication components.

Typical Recipe:

- Air
- Multilayer Dielectric Stack (Ta_2O_5 / SiO_2)
- Optical Glass (Bulk)

Recommended Spectrometer: 1200–1700 nm (NIR)

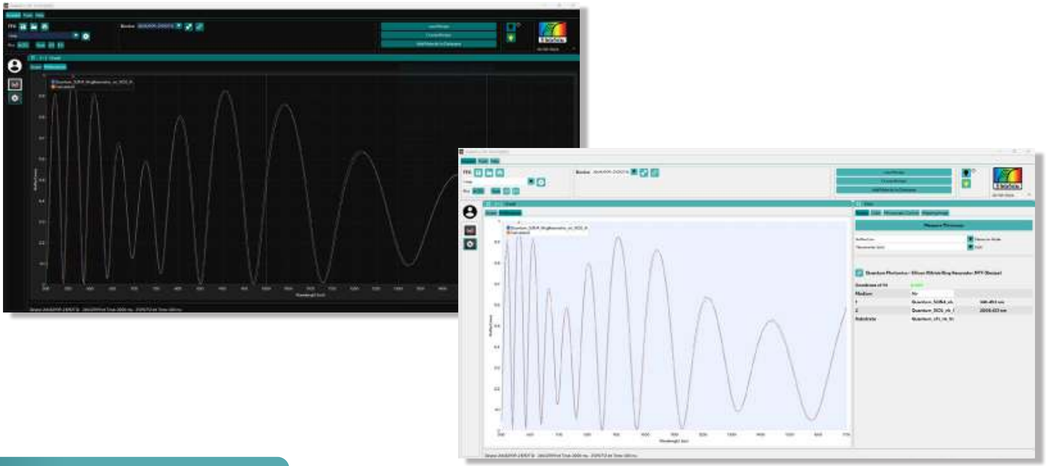
APP #6

Silicon Nitride Ring Resonator Thickness

Silicon nitride ring resonators are fundamental building blocks for quantum photonic integrated circuits, optical frequency combs, quantum sensing, nonlinear optics, and precision metrology. Waveguide thickness directly affects resonance wavelength, quality factor (Q), optical confinement, and device performance. Spectroscopic reflectometry provides accurate, nondestructive thickness measurement of silicon nitride resonator structures deposited on silicon dioxide and silicon substrates, enabling precise fabrication control for research and commercial quantum photonic devices.

Typical Recipe:

- Air
- Si_3N_4 (350 nm)
- SiO_2 (2000 nm)
- Silicon (Bulk)



Recommended Spectrometer: 500–1700 nm (VIS-NIR)

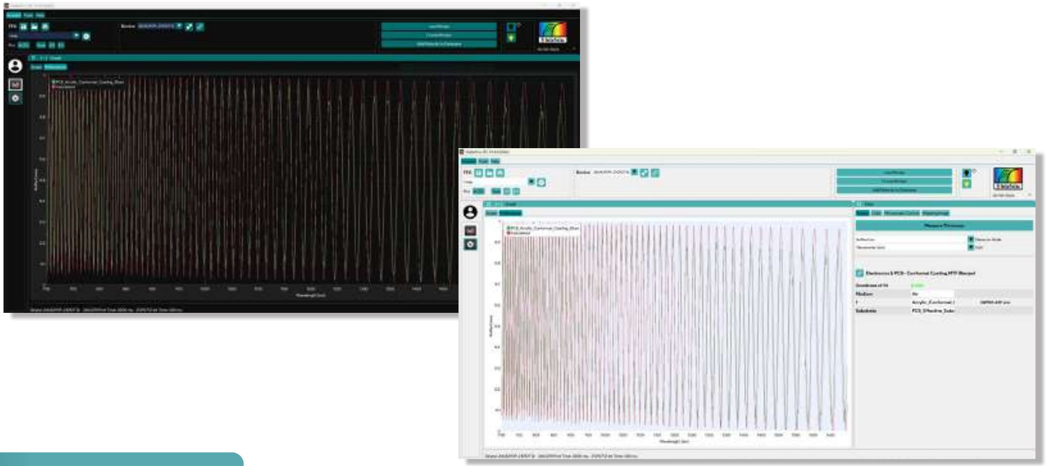
APP #7

Conformal Coating Thickness

Conformal coatings protect printed circuit boards (PCBs) and electronic assemblies from moisture, dust, chemicals, corrosion, and harsh operating environments. Acrylic, silicone, urethane, and other polymer coatings are commonly applied in automotive, aerospace, medical, industrial, and defense electronics. Accurate coating thickness is essential to ensure adequate environmental protection without affecting connectors, thermal performance, or component reliability. Spectroscopic reflectometry provides rapid, non-contact measurement of transparent conformal coatings, enabling consistent process control and quality assurance during electronics manufacturing.

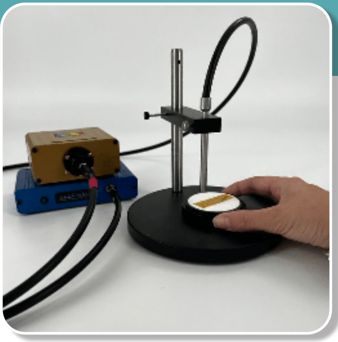
Typical Recipe:

- Air
- Acrylic Conformal Coating (25000 nm)
- PCB Substrate (Bulk)



Recommended Spectrometer: 700–1700 nm (NIR)

Summary: Broad Advanced Photonics Thin Film Measurement Capability



Across the advanced photonics industry, precise thin film thickness measurement is essential for optimizing optical performance, improving manufacturing consistency, and ensuring device reliability. StellarNet spectroscopic reflectometry systems provide a flexible, nondestructive solution for characterizing thin-film materials and multilayer structures used in a wide range of photonic applications.

Applications include photonic integrated circuits (PICs), optical coatings, MEMS devices, LEDs, optical communications, quantum photonics, and advanced electronics.

With broad spectral coverage, advanced Transfer Matrix Method (TMM) analysis, and support for both nanometer-scale and micron-scale films, StellarNet helps engineers accelerate process development, improve quality control, and confidently verify critical thin-film structures throughout the product lifecycle.

Why Engineers Choose StellarNet

For more than three decades, StellarNet has helped researchers, engineers, and manufacturers transform light into actionable engineering intelligence. Our modular thin film metrology systems combine high-performance optical measurement, flexible system configurations, rapid customization, and US-based engineering support to help solve complex measurement challenges across the global photonics industry.