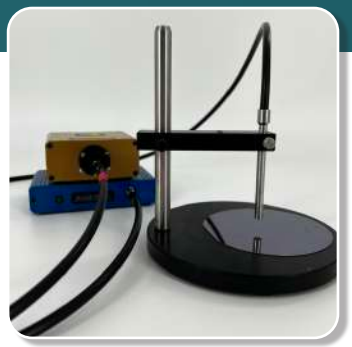
APP NOTE

# Semiconductor Thin Film Thickness Measurement



Accurate thin film thickness measurement is essential in semiconductor manufacturing for process control, device performance, and manufacturing yield. Thin dielectric, conductive, and photoresist films directly affect transistor performance, gate insulation, lithography, MEMS devices, and advanced packaging.

StellarNet's spectroscopic reflectometry solutions use Transfer Matrix Method (TMM) modeling to accurately measure single-layer and multilayer films through non-contact, nondestructive optical measurements.

## Semiconductor Measurement Applications

StellarNet solutions support thickness measurements for:

- Thermal oxide ($SiO_2$/Si)
- Silicon nitride on oxide ($Si_3N_4$/$SiO_2$/Si)
- Photoresist coatings
- Thick photoresist
- Polysilicon
- Silicon-on-insulator (SOI)
- High-k dielectric materials

Applications include front-end wafer fabrication, MEMS manufacturing, advanced packaging, research and development, and quality control.

## Broad Spectral Coverage for Diverse Film Thicknesses

StellarNet offers UV, VIS, NIR, and UV-VIS-NIR spectrometer configurations for measuring films from a few nanometers to tens of micrometers.

- Shorter wavelengths provide excellent sensitivity for ultra-thin oxide and dielectric films.
- Extended near-infrared coverage enables accurate measurement of thicker photoresist, polysilicon, polymer, and multilayer semiconductor structures.

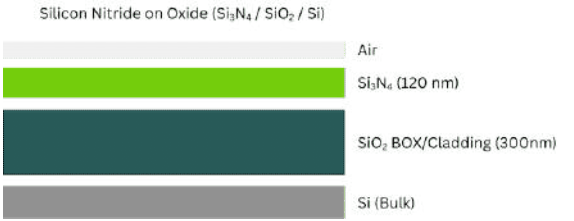
A single platform delivers fast, repeatable, and reliable semiconductor thin film characterization across a broad range of applications.

# APP #1

## Silicon Nitride on Oxide

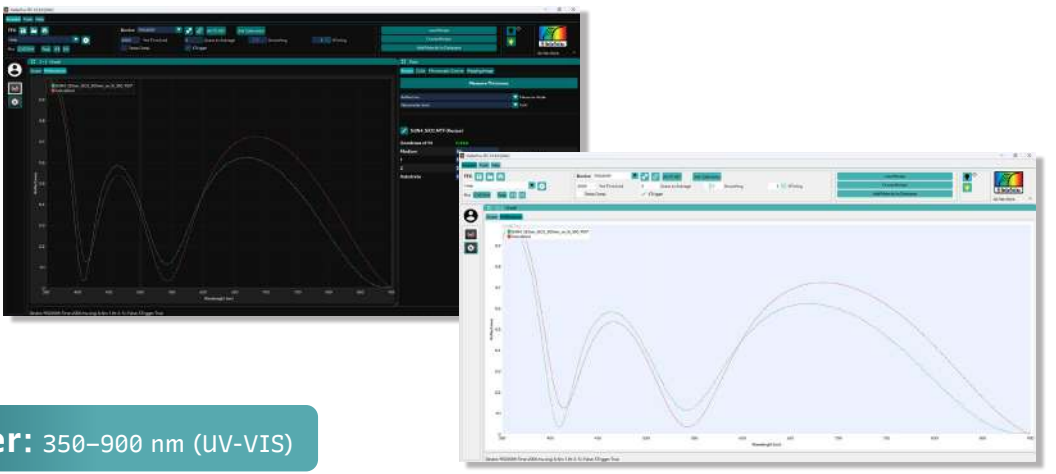
($Si_3N_4$ / $SiO_2$ / Si)

Silicon nitride ($Si_3N_4$) deposited on thermal oxide is commonly used for passivation, stress engineering, masking, diffusion barriers, and MEMS fabrication. Simultaneous measurement of silicon nitride and underlying oxide thickness enables accurate multilayer process control throughout semiconductor production. Using Transfer Matrix Method (TMM) modeling, multilayer dielectric stacks can be characterized quickly and nondestructively for improved manufacturing consistency and yield.




## Typical Recipe:

- Air
- $Si_3N_4$ (120 nm)
- $SiO_2$ BOX/Cladding (300 nm)
- Si (Bulk)



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

**Why it's Important:** Silicon nitride on thermal oxide is a foundational film stack in photonic integrated circuits, waveguides, and semiconductor devices. Accurate, non-contact thickness measurements verify deposition quality, optimize optical performance, and help manufacturers maintain consistent, high-yield production.

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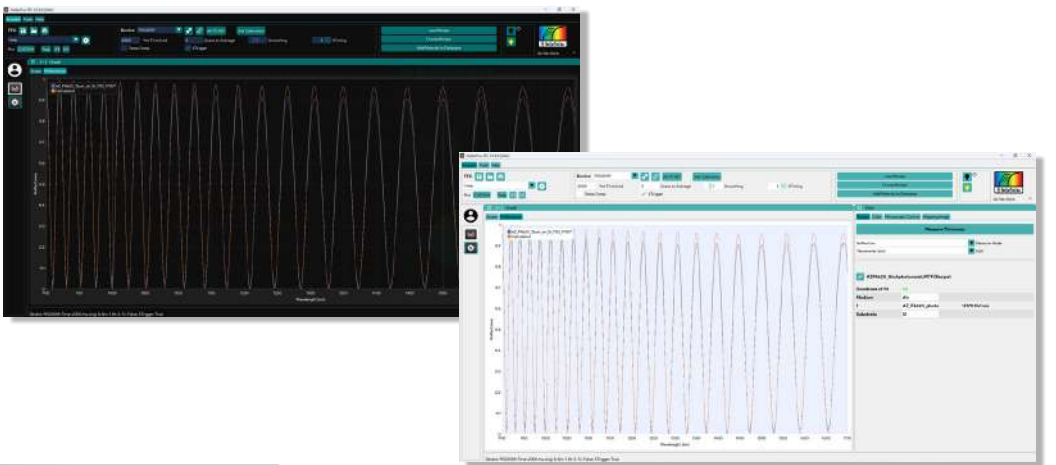
# APP #2

## Photoresist Thickness Measurement

Photoresist thickness plays a critical role in photolithography, directly affecting exposure, pattern transfer, etching, and device fabrication. Spectroscopic reflectometry provides rapid, non-contact measurement of positive and negative photoresists across a wide range of thicknesses, from thin imaging resists to thick MEMS process resists. This enables reliable process control, spin coating optimization, and production quality assurance while eliminating the need for destructive measurements.



## Typical Recipe:

- Air
- AZ P4620 Photoresist (12000 nm)
- Si (Bulk)

## Recommended Spectrometer: 900–1700 nm (NIR)

**Why its Important:** Photoresist thickness measurement is a critical quality control step in semiconductor, MEMS, display, and photonic device manufacturing. Non-destructive optical metrology verifies resist thickness and uniformity, supporting accurate photolithography, improved process control, and higher manufacturing yield.

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# APP #3

## Thermal Oxide

(SiO2)

Thermal silicon dioxide ($SiO_2$) is one of the most widely used dielectric materials in semiconductor manufacturing, serving as a gate oxide, isolation layer, masking layer, and surface passivation. Accurate oxide thickness measurement is critical for maintaining electrical performance and process consistency. Spectroscopic reflectometry provides fast, non-contact measurement of thermal oxide films from only a few nanometers to several micrometers with excellent repeatability, making it ideal for wafer process monitoring, quality control, and research applications.

## Typical Recipe:

- Air
- $SiO_2$
- Si (Bulk)

## Recommended Spectrometer: 350–900 nm (TF-UVVIS)

**Why is it important:** Thermal oxide thickness directly influences electrical insulation, optical performance, and process repeatability. Non-contact optical metrology provides rapid verification of oxide growth and etch processes, helping manufacturers maintain tight process control, improve yield, and ensure consistent device performance.

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# APP #4

## Polysilicon Thickness Measurement

Polysilicon thin films are widely used in transistor gates, MEMS structures, sensors, and advanced semiconductor devices. Accurate polysilicon thickness measurement is essential for maintaining device performance and process repeatability. Near-infrared spectroscopic reflectometry provides excellent sensitivity for measuring micron-scale polysilicon films deposited on oxide or silicon substrates, enabling fast, non-contact thickness measurement for wafer inspection, process development, and production monitoring.

## **Summary**: Broad Semiconductor Measurement Capability

StellarNet thin film measurement systems provide a versatile platform for semiconductor thin film metrology by supporting UV, VIS, NIR, and UV-VIS-NIR spectrometer configurations. This broad spectral coverage enables accurate measurement of a wide range of semiconductor materials and film thicknesses using fast, non-contact spectroscopic reflectometry with Transfer Matrix Method (TMM) analysis.

From thermal oxide and silicon nitride to photoresist, polysilicon, silicon-on-insulator (SOI), high-k dielectrics, multilayer dielectric stacks, MEMS structures, and advanced semiconductor coatings, a single StellarNet platform supports diverse semiconductor manufacturing and research applications.

Depending on the spectrometer configuration, film thicknesses ranging from just a few nanometers to tens of micrometers can be measured with the speed, accuracy, and repeatability required for process development, quality control, and advanced semiconductor manufacturing.

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