

Thin Film Metrology

Optical thickness of a coating is determined by white light interference and the pattern is translated into optical thickness through mathematical calculations.

Thin film metrology involves the use of these mathematical calculations to the presence and thickness of coatings which have been deposited on a substrate material using a variety of processes. The techniques available for this measurement range from profilometry to ellipsometry, spectroscopic reflectometry and x-ray analysis. Avantes instruments and fiber-optic sampling tools enable spectroscopic reflectometry measurements to support applications in a variety of industries from semiconductor to solar and optical coating measurements. Avantes thin film solutions provide low cost measurement systems for single and multi-layer thin films on a number of substrates.

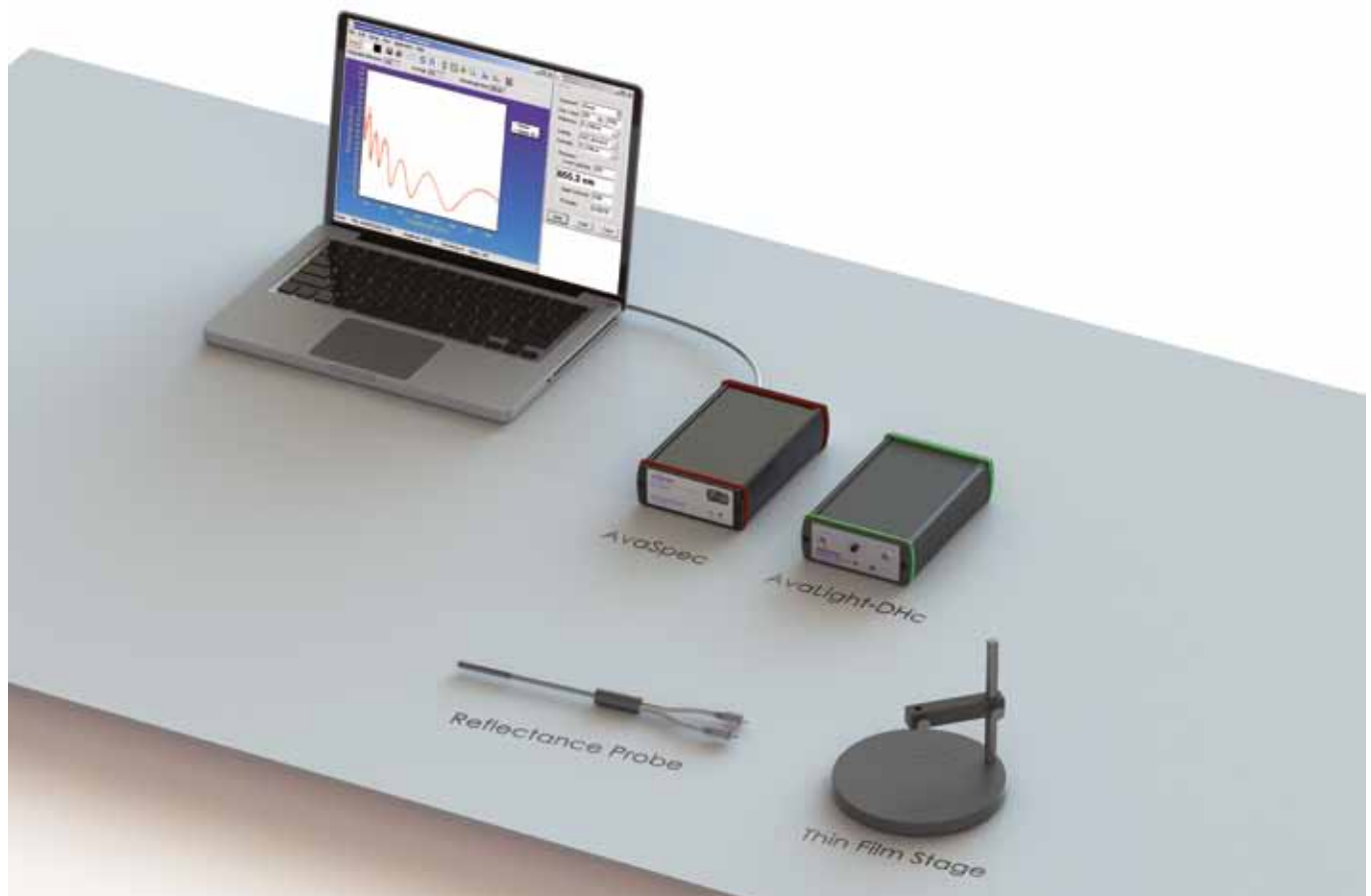
Thin Film Quality Control

Thin film deposition processes require regular monitoring and quality control particularly as new recipes are implemented and optimized in a coating facility. Typical applications require regular quality control

inspection during the initial phases requiring a high-speed offline measurement system to validate film thickness. Avantes thin film solutions enable high-speed spot measurements which can facilitate thin film presence and thickness validation.

Thin Film Reflectometry

Spectroscopic reflectometry involves illuminating samples with a white light (typically tungsten halogen or deuterium-halogen) at an incident angle which is normal to the sample and then measuring the reflectance and interference from the same geometry. Depending upon the nature of the coating ultra-violet, visible or near infrared wavelength measurements may be necessary to obtain an optimum fitting of the measured curve relative to the theoretical reflectance curve. The theoretical curve is developed from a database of optical constants (n and k). The "n" value is the refractive index and "k" is the extinction coefficient. The sampling process initially involves measuring a reference uncoated substrate followed by the sample measurement using the same conditions. Characteristics about the substrate (thickness and material) are inputs



for the software along with characteristics of the thin film layers (material, thickness). Reflectance spectra are captured and analyzed by software algorithms which compare the measured data to theoretical calculated values derived from the database of optical constants. The software provides a calculated thickness value along with a measure of goodness of fit relative to the theoretical curve.

Single-layer Thin Film Metrology

Avantes' single-layer thin film metrology system consists of our AvaSpec-ULS2048-USB2 fiber-optic spectrometer, AvaLight-DHc/AvaLight-DH-S deuterium-halogen light source or AvaLight-HAL tungsten halogen light source, the FCR-7UV200-2-ME (optional FCR-7UV400-2-ME for higher throughput) fiber-optic reflection probe and our Thin Film Stage. The software that drives the single layer system is Avantes' AvaSoft-ThinFilm which is a 32 or 64-bit application which supports single layer measurements of thin films ranging from 10 nm-50 µm with 1 nm resolution. AvaSoft-ThinFilm supports UV/VIS and NIR wavelength measurements from 200-1100 nm. The system is available with an optional thin film standard which provides samples of uncoated and coated substrates for validation purposes. For most specular surface UV measurements, the AvaLight-DHc compact deuterium halogen source is adequate, but for more diffuse coated surfaces, the higher power AvaLight-DH-S is recommended.

Multi-layer Thin Film Metrology

Avantes' multi-layer thin film metrology system consists of our AvaSpec-ULS2048-USB2 fiber-optic spectrometer, AvaLight-DHc/AvaLight-DH-S deuterium halogen light source or AvaLight-HAL tungsten halogen light source, the FCR-7UV200-2-ME (optional FCR-7UV400-2-ME for higher throughput) fiber-optic reflection probe and our Thin Film Stage. The software which drives the multi-layer system is TFProbe 2.0 which is developed by Angstrom Sun Technologies and is fully compatible with Avantes spectrometers. This sophisticated application supports up to five layer measurements and supports a variety of methods including nk constants, dispersion, and effective media approximation (EMA). TFProbe provides a user-friendly graphical user interface to input layer structure parameters. The system can include an optional thin-film standard which provides sample uncoated and coated substrates for validation purposes. TFProbe supports UV/VIS and NIR wavelengths from 200-1700 nm and enables the connection of multiple spectrometers to support this broadband wavelength measurement capability. For most specular surface UV measurements, the AvaLight-DHc compact deuterium halogen source is adequate, but for more diffuse coated surfaces, the higher power AvaLight-DH-S is recommended.

Components used in the thin film measurement setup

Spectrometer	AvaSpec- ULS2048-USB2 Grating UA (200-1100 nm), DCL-UV/VIS, 100 µm slit , DUV coating, OSC-UA
Layer thickness	10 nm- 50 µm, 1 nm resolution
Software	AvaSoft-ThinFilm or TFProbe®
Lightsources	AvaLight-DHc Compact deuterium-halogen light source
Fiber-optics	FCR-7UV200-2-ME reflection probe UV/VIS, 2 m, SMA ThinFilm stage to hold reflection probe
Accessories	ThinFilm-standard Tile with 2 calibrated different thickness layers of SiO ₂ and a reference layer ThinFilm-standard-multilayer Thin Film Reference, Box With Reference sample, a 2-layer sample and a 5-layer sample