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Look but don't touch: Spectroscopic ellipsometry advances materials research and process monitoring

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Spectroscopic ellipsometry is a non-contact, non-destructive optical technique that can measure film thickness with a sub-nanometer precision, as well as the complex refractive index/dielectric function of films and substrates. Ellipsometers measure the change in polarization of light as it reflects from (or transmits through) a sample. Sample properties are determined by fitting the polarization information to models that are based on well-established scattering matrix theory and the Fresnel equations. Modern ellipsometers operate at ultraviolet, visible IR and THz spectral ranges. Some instruments measure hundreds or even thousands of wavelengths simultaneously. Such instruments can rapidly map film thickness and properties on wafers, photovoltaics and flat panel displays; as well as roll-to-roll coatings on metals, plastics and glass. They can also monitor deposition, etching, annealing, electrochemistry, biomolecule adsorption/desorption in liquid environments and other dynamic processes. In recent years, spectroscopic ellipsometers have been developed to measure all sixteen Mueller matrix elements, thus providing a complete description of a sample's polarization properties. Mueller matrix ellipsometry is used to characterize highly anisotropic samples, including gratings, nanopillars, and plasmonic structures; and is also used routinely to measure critical dimensions on semiconductor devices. Examples of some these applications will be presented during the talk.