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Spectroscopic ellipsometry characterization of multilayer optical coatings

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Abstract

The performance of an optical coating stack depends on thickness and refractive index of each layer. In situ spectroscopic ellipsometry (SE) can track coating properties in real-time, but ex situ SE characterization is limited by the large number of unknown sample properties. We review various SE characterization strategies for multilayer structures using 37-layer alternating high-low index stacks of Ta_2O_5 and SiO_2. A "tooling factor" for each coating material is developed to inform how the actual layer thicknesses compare to nominal specifications.

We also introduce tests for sources of error that can occur during multilayer processing. Process drift may produce a gradual change in film properties, such as a slight increase or decrease in coating thickness or optical constants. This is modeled by adding a gradient to each tooling factor. User-error is also considered, where incorrect parameter entry produces an unintentional stack design. An erroneous layer is identified by systematically testing each layer. A "blind" test was performed to determine SE sensitivity to such errors, where a single layer was intentionally altered within a 37-layer stack, and systematic testing was able to resolve the altered layer thickness and position in the stack.

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