

POD018

Securing in-line layer thickness measurements by using spectroscopic plasma monitoring for real-time control and adjustment of refractive indices in production processes

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While specifications in thin film industry are getting more and more demanding, high production yields and cost effective production becomes a major factor in this competitive market. Quality control of the final product does ensure the specifications of the shipped product but is of limited use for real-time process control due to the indirect feedback loop. Smart and combined in-line or even in-situ control techniques will fill this gap in production lines by monitoring process and product simultaneously with real-time production feedback. Spectroscopic measurements of the reflectivity and/or transmissivity of the deposited layer is a well-known technique to determine the thicknesses of the individual layers of a coating. The underlying calculation depends critically on the knowledge of the refractive indices of the coated layer, which in general are fixed input parameters. It is also known that these material parameters depend on conditions of the coating process, i.e. the plasma parameters. However, plasma parameters will change over production time, e.g. due to parasitic coating of the vacuum vessel in PECVD applications or due target erosion in sputtering applications, and thus the refractive indices must be adjusted for reliable layer thickness calculation.

By measuring continuously the plasma parameters, especially the relative content of certain plasma species, via spectroscopic plasma monitoring changes in the refractive indices can be deduced and provided as input parameters for the layer thickness calculation in real time. This combined measurement technique results in more reliable thickness values of the coated layer.

Setups for in-line and in-situ applications are presented and results from PECVD process producing e.g. silicon nitride and a-C:H layers as well as from sputtered Al₂O₃ layers are discussed.

Keywords

spectroscopic plasma monitoring
thickness measurement
real-time control