Rapid ellipsometric imaging characterization of alloy and nanocomposite films with an artificial neural network

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Spectroscopic ellipsometry (SE) is one of the most powerful techniques for investigating the opto-geometrical properties of materials. SE is based on the measurement of the change of polarization state of light reflected from a sample. However, the trends of device miniaturization require the development of an ellipsometric setup with microscopic scaled resolution. Imaging ellipsometry was recently introduced to address this issue. Two images representing the ellipsometric angles are recorded for each wavelength. As SE is an indirect characterization tool, the extraction of physical parameters of the sample from the recorded spectra requires a modeling step. However, the analysis of this huge data-cube remains challenging. To reduce the data size, pixels can be gathered into a region of interest (ROI) by using the binning process. However, this approach assumes that opto-geometrical properties are homogeneous inside a ROI. On the other end, the fitting of the full ellipsometric map by using a classical optimization algorithm such as the Levenberg–Marquardt algorithm (LM) is often time-consuming. Even the interpolation of the Ψ and Δ values limits the power of the analysis to one-parameter optical models. In this context, we have introduced an original imaging ellipsometric characterization tool based on the used of an artificial neural network (ANN). Our technic is used to characterized plasmonic films . We demonstrate that imaging ellispometry can be use to determine the spatial variation of film thickness, NP volume fraction, NP shape distribution, dielectric function and plasmonic properties of nanocomposite films. The computing time required for the analysis of the 842460 spectra of Ψ and Δ which composed the ellipsometric map decreases from 15 days for the LM to 1 s for the ANN.is about 1 s by using ANN. This can be considered as a real drastic improvement for in-line SE imaging characterization.

Keywords: Imaging ellipsometry, neural network, plasmon

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