DIFFERENT PARAMETERIZATION OF THE TIN OPTICAL PROPERTIES FOR SPECTROSCOPIC ELLIPSOMETRY–X-RAY REFLECTOMETRY COMPARISON

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Typical dispersion model used for description of the titanium nitride (TiN) dielectric function in the optical range is a combination of the Drude model (free electrons at energy up to the plasma energy) with a dual Lorentz oscillator model (bound electrons at higher energy), sometimes called a "D2L model" [1,2]. Also, some researchers describe the TiN dielectric function using, say, D1L model with single Lorentz oscillator [3] or D*n*L model with the number of Lorentz oscillators $n > 2$ to cover a very broad spectral range [4,5]. There are also other physics-based optical dispersion parameterizations which can be applied to describe the TiN dielectric function.

In this study, the thickness-dependent TiN optical properties were represented by the multiple-oscillator Drude–Lorentz (DL), Forouhi–Bloomer (FB) and Lorentz optical dispersions with different numbers of parameters. The dielectric function of thin TiN films with intermediate behavior can be appropriately expressed in terms of 9 to 13 model parameters.

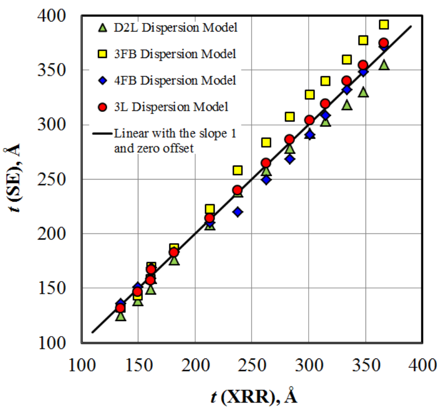

Fig. 1. Comparisons of film thickness using SE and XRR measurements

Using X-ray reflectometry (XRR) as a reference technique and taking into account surface roughness on the TiN films, it has been shown that three-term Lorentz (3L) model provides not only the best fit quality for the nominal thicknesses ranging from 125 Å to 350 Å but also an extremely good correlation between the thickness values obtained by spectroscopic ellipsometry (SE) and XRR and the following linear equation was established between the thickness measurements: $t_{SE}(\text{Å}) = 1.038 \times t_{XRR}(\text{Å}) - 7.532$ Å with $R^2 = 0.9994$ (see Fig. 1). Use of other models results in the worst correlation between XRR and SE measurements.

Thus, an appropriate modeling of the film's optical properties is one of the factors needed to be taken into account to establish well-grounded and credible SE and XRR correlation.

Keywords: Titanium nitride; Thin films; Optical modeling; Dielectric function; Spectroscopic ellipsometry; X-ray reflectometry

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