



Characterization of optical/physical properties of anisotropic thin films with rough surfaces by Stokes-Mueller ellipsometry

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Research focus

A decomposition model with depolarization matrix is proposed to extract the refractive indices, thickness and surface roughness of (HfO₂ thin film)/(Silicon substrate) sample with three different surface roughness from fine to coarse, namely $Ra = 0.6$ nm, 19.7nm, and 200nm. The validity of the proposed method is demonstrated by comparing the experimental results for the refractive index and thickness of a thin film with known value. The results show that the proposed method is enables to determine the coarse surface roughness of thin-film samples in a non-contact optical manner first time in literature.

Research results

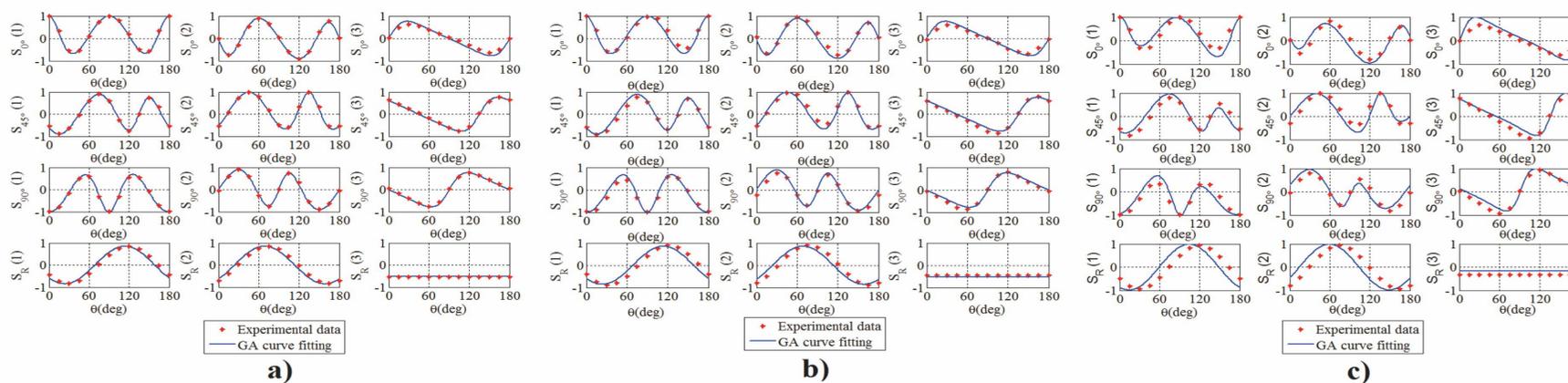


Fig. 1. Experimental and GA curve-fitting results for normalized Stokes vectors (in four input polarized states of 0°, 90°, +45° and R-) of 215-nm thickness anisotropic thin film as function of scanning angle θ given surface roughness values of: (a) $Ra = 6$ nm and (b) $Ra = 19.7$ nm, and (c) $Ra=200$ nm.

The extracted results for ordinary refractive index (n_o), extraordinary refractive index (n_e), thickness of thin film (d) and thickness of surface roughness (d_s) of Ra 6nm sample (fig.1a) are 2.14, 2.07, 215.38nm and 0.8nm, respectively. The corresponding deviation from the known values by just 0.03, 0.01 and 0.26 nm, respectively. The corresponding extracted results of Ra 200nm sample (fig.1c) are 2.16, 2.08, 215.97nm and 218nm, respectively. The corresponding deviation from the known values by 0.05, 0.02 and 0.54 nm, respectively.

Research experience

Research process is a learning process in which experienced supervisor and Ph.D student collaborate to achieve the research goal. Many obstacles and difficulties will be encountered during the research journey. An enthusiasm, passionate behavior and optimistic thinking will help. Don't rush to solve a problem, lets it flows as the way as it is, someday you will cry out loud "Eureka" as Archimedes did when he found out the method to determine the volume of object with an irregular shape.