USE OF THE EXACT APPROACH OF THE RAYLEIGH–RICE THEORY FOR CALCULATING ELLIPSOMETRIC PARAMETERS AND REFLECTANCE OF MULTILAYER SYSTEMS WITH RANDOMLY ROUGH BOUNDARIES

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Theoretical results concerning the optical quantities of multi-layer systems with randomly rough boundaries are presented. The exact approach of the Rayleigh–Rice theory is used to express the formulae describing optical quantities such as the ellipsometric parameters or reflectance. This approach is exact in the sense that it takes into account the propagation of perturbed electromagnetic waves among randomly rough boundaries including all cross-correlation and auto-correlation effects. The restriction to the second order of perturbation, which is the lowest order that gives nonzero corrections to coherent waves (obeying the Snell's law), represents the only approximation used in our calculations.

The presented approach represents the generalization of the exact approach for single layers and the improvement of the approximate approach for multi-layer systems published earlier [1,2].

As an example it is assumed that the layers and the substrate are formed by optically homogeneous and isotropic materials. The layered system consists of $SiO_2/HfO_2/SiO_2$ placed on Si substrate. The numerical calculations are performed for several examples differing in the total thicknesses of the layered systems.

The numerical results based on the exact approach of the Rayleigh–Rice theory are compared with those obtained by the approximate approach.

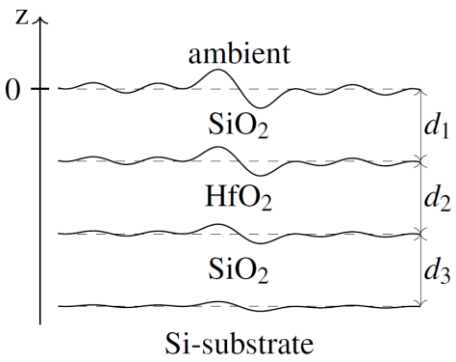

Fig.1. Schematic diagram of three-layer system with four slightly rough boundaries. The dashed lines represent the mean planes of the boundaries. The symbols d_i denote the mean thicknesses of the layers.

Keywords: multilayer systems; rough boundaries; ellipsometric parameters; reflectance

[1] D. Franta, I. Ohlídal, J. Mod. Opt. 45 (1998) 903–934.
[2] D. Franta, I. Ohlídal, D. Nečas, Opt. Express 16 (2008) 7789–7803.