The choice of optimal conditions of ellipsometric measurements for accurate determination of parameters of investigated systems.

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Ellipsometry is indirect method, which measures ellipsometric angles and not optical parameters of the investigated systems. By definition the change of any measured value $\delta\mathbf{m}$ at small change of a parameter of an investigated system $\delta\mathbf{p}$ is determined by the sensitivity of the measured parameter **m** to the system parameter **p** – $\partial\mathbf{m}/\partial\mathbf{p}$ via the expression $\delta\mathbf{m} = (\partial\mathbf{m}/\partial\mathbf{p})\,\delta\mathbf{p}$. So higher sensitivity should allow to feel smaller changes of the system parameters. It results in standard hint to make measurements at the conditions of higher sensitivity. However a simple example of a thin film on a transparent substrate demonstrates the problem of such an approach, as errors of measurements at Brewster angle make such measurements useless.

This example indicates the second element, which should be taken into account in the determination of the optimal conditions – errors of measurements. If the average magnitude of errors of measurements is $\sigma\mathbf{m}$, the minimal registered change of the system parameter **p** will be $\sigma\mathbf{p} = \sigma\mathbf{m} / (\partial\mathbf{m}/\partial\mathbf{p})$. Its inverted value $1/\sigma\mathbf{p}$ may be called “precision” of the determination of the parameter **p** and has simple interpretation, namely it is defined by the ratio of signal to noise, as the measured signal is proportional to the sensitivity.

The necessity to take into account errors at the choice of the conditions for the precise determination of parameters of the investigated system is noticed in the literature but for the analysis the constant level of errors is assumed. It turns us back to the situation with seeking for the maximal sensitivity. As the result suggestions to measure thin films on transparent substrate at angles slightly bigger than the Brewster one where the sensitivity is still high but errors are decreased may be found without any determination of the value of such angles.

At the same time expressions for the error level depending on the measurement conditions exist for long time. Those expressions with the ones for the sensitivity should be used to find the optimal condition of measurements for the accurate determination of the parameters of interest. In contrary to the qualitative hints this approach allows to determine optimal conditions of measurements quantitatively what is demonstrated in this presentation for different kinds of ellipsometers.

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