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Method for determining of the optical constants for films and materials inside the absorption bands region

Spectrophotometric methods are most commonly used for determining of the optical constants of films and materials are. These methods are based on measuring of the reflection R (λ), transmission T (λ) and absorption A (λ) spectra and make it possible to obtain the dispersion characteristics of the optical constants throughout the required range of the spectrum. The principal difficulties arise at the stage of analysis of the spectra, and obtaining from them the information about optical constants, particularly in the absorption bands regions. In terms of mathematical methods of spectra processing, methods of determining of the optical constants can be divided into two sets: analytical and numerical. The first set involves the search for suitable analytical expressions for the direct calculation of optical constants in various specific cases. The second one is based on numerical methods for finding the minimum of functional of quality. Currently there is no single universal method for determining the optical parameters of of real films and materials from the spectrophotometric data. It is caused by incorrectness and the ambiguity in determining the optical constants from the spectra. We propose a new method based on the correction of measured spectra taking into account the absorption. After this correction, the absorption becomes zero and one variable - the absorption coefficient is excluded from the calculation, which greatly simplifies finding of the optical constants. The main idea of the proposed method is based on the additivity of energy conservation law, which can be presented as $1=T(\lambda)+R(\lambda)+A(\lambda)$. Absorption may be divided into two parts: $A(\lambda)=A_T+A_R$, where A_T and A_R defines the absorption contribution to the transmission and reflection spectra. To find the $A_R(\lambda)$ and $A_T(\lambda)$, we use the correction functions fr and ft which define the contribution of total absorption $A(\lambda$ into $A_R(\lambda)$ and $A_T(\lambda)$. Correction functions fr and fl are calculated using the approximate absorption spectrum $A(\lambda)$ Spectra without absorption are defined as: $T_0(\lambda)=T(\lambda)+ftA(\lambda)$ $R_0(\lambda)=R(\lambda)+f_RA(\lambda)$ where all the values in the right-hand sides are known. It is important to note that the dispersion of the refractive index in the spectra of $T_0(\lambda)$ and $R_0(\lambda)$ remains unchanged. The absorption coefficient λ can be found from the spectra by known methods. By this method we have determined the optical constants of the thin films BaF_2, $Ba_{0.98}Mg_{0.02}F_2$, CaF_2, $CaYF_5$ and various materials of the transmissive optics in the absorption bands region in the middle IR spectral range.

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