METODS OF MEASURING THE DIELECTRIC COEFFICIENTS OF HIGHLY ABSORBING SOLID AND LIQUID SUBSTANCES

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Abstract: *the dependences of the wave reflection coefficient on the layer thickness of a liquid absorbing dielectric and a magnet in free space and in a TE waveguide are studied. The functional relationships between the position and the magnitude of the extreme of these dependences and the values of the dielectric or magnetic properties of the substance are determined.*
Keywords: *dielectric loss, dielectric constant, liquid and solid substances.*

МЕТОДЫ ИЗМЕРЕНИЯ ДИЭЛЕКТРИЧЕСКИХ КОЭФФИЦИЕНТОВ СИЛЬНО ПОГЛОЩАЮЩИХ ТВЕРДЫХ И ЖИДКИХ ВЕЩЕСТВ

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Аннотация: *исследованы зависимости коэффициента отражения волны от толщины слоя жидкого поглощающего диэлектрика и магнетика в свободном пространстве и в ТЭ волноводе. Определены функциональные зависимости между положением и величиной экстремума этих зависимостей и величинами диэлектрических или магнитных свойств вещества.*
Ключевые слова: *диэлектрические потери, диэлектрическая проницаемость, жидкие и твердые вещества.*

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A number of microwave methods for measuring the dielectric properties of liquid and solid substances with $tg\delta < 0.8$, have been developed with the use of a resistance transformer in the measurement circuit. Their practical application allows obtaining reliable information on the dielectric and magnetic properties of liquid objects of research, and on their basis about their molecular structure. In particular, the analysis of the behavior of the frequency and temperature

dependences of the permittivity and dielectric loss of polar liquids and their solutions allows us to determine the dipole moments of polar molecules, polarizability, relaxation times, and energy activations of dipole relaxation, the nature of the orientations of the dipoles and a number of other important molecular characteristics of the substance [1]. It is very promising to apply it, to assess the influence of the nearest environment on the relaxation processes of dipole molecules when analyzing the dielectric properties of concentrated solutions, the components of which have different molecular nature [2]. They allow to determine the possibility of the formation of molecular associates and complexes due to the action of inter- and intramolecular hydrogen bonds.

In this regard, one of the relatively simple methods for determining the wave impedance and the associated values of the dielectric coefficients of a substance is the inserting of a thickness-adjustable, flat layer of a non-absorbing liquid located on the surface of the study into the measurement circuit blown substance [3]. Measurement scheme ε' and ε'' using a waveguide water-guiding system, in which as an analogue of a variable resistance transformer a flat quarter-wave non-absorbing dielectric that is adjustable in position is used the plate is shown in Fig. 1.

As matching liquid, it is permissible to use non-polar liquids that do not have absorption, for example, benzol, hexane, etc. [4]. To measure the standing wave coefficient, two directional couplers 10 are used, the outputs of the detector sections 11 of which are connected to the standard voltage standing wave meter 12.

The consideration of Fig. 2 implies the possibility at definite choices of the dielectric properties of the coating material to achieve one of the minima of the function $\rho(x)$ of zero value. It is characteristic that, with a decrease in wave attenuation in matter, the interface between the normal and anomalous regions shifts toward higher x values. The latter indicates that the conditions for the complete absorption of incident radiation in the dielectric layer are satisfied. It is associated with the appearance of zero minima of the function $\rho(x)$.

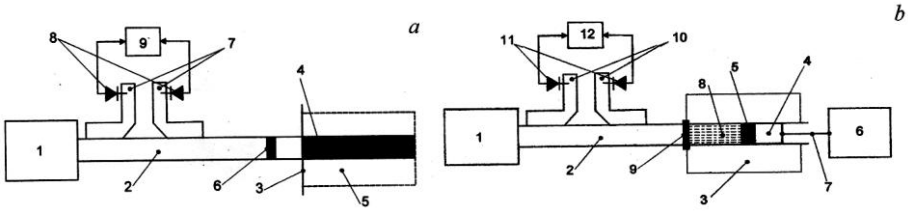

Fig. 1. Block diagrams of measuring the dielectric coefficients of highly absorbing solid and liquid substances using a panoramic standing wave coefficient meter and using a quarter-wavelength plate (a) and matching liquid (b). 1 - klystron generator with an attenuator and a wave meter; 2 - a directing path; 3 - directional coupler; 4 - detector; 5 – coefficient of stand wave's meter; 6 - plate; 7 - measuring cell; 8 - thermostat; 9 - measured substance; 10 - matching liquid; 11 - piston; 12 - micrometric device

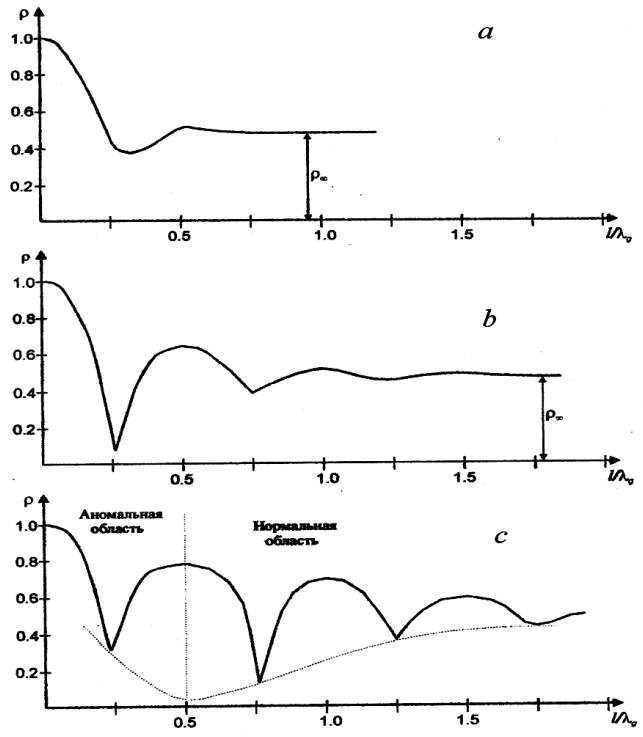

Fig. 2. The dependences of the modulus of the reflection coefficient of the wave ρ on the thickness of the layer l of the substance with values of its loss factor y equal to 0.6 (a), 0.3 (b), and 0.1 (c). λ_d is the wavelength in the substance

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