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Photodielectrical properties of the modified C₆₀ films. Maxwell – Vagner-type polarization between near-electrode and bulk layers

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Abstract. Within the frequency interval of 10^{-1} to 10^6 Hz investigated were the frequency dependences of the capacitance C and resistance R for modified C₆₀ films in darkness and on exposure to the focused white light. A clamping ITO electrode with an intermediate layer of isotropic liquid (glycerin or distilled water) was taken instead of the traditionally used deposited top metal electrode. Found are the conditions when C and R changes are caused by near-electrode ($f < 10^3$ Hz) and bulk ($f > 10^4$ Hz) processes. It was shown that the sharp reduction of C and R with growing the frequency corresponds to the transition from one condition to the other, and such process can be described with account of the “classical” Maxwell-Wagner mechanism of interlayer polarization. The relaxation time of such process was found to be equal approximately 10 ns. This time was shown to depend on the manufacturing technology of C₆₀ films. Having analyzed the obtained frequency dependences of C and R , an equivalent circuit of the sample was suggested. We estimated the thicknesses of the liquid layer (≈ 30 μm) and near-electrode layer of C₆₀ films (tens of nanometers). Comparing the frequency dependences of C and R on exposure to light of the bottom and top electrodes, it was assumed that the C₆₀ films under laser UV-irradiation is non-uniform in thickness.

Keywords: fullerene film, photodielectric properties.

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1. Introduction

After it was practically shown that organic materials can be effective converters of electric energy into the light one (organic light-emitting diodes have the increasingly more practical application), the interest to solve the inverse problem – conversion of light energy to the electric one [1-3] was rekindled.

As was shown that, in organic semiconductors, the active layer where generation and divisions of charge carriers occurs measures by tens of nanometers [4]. Therefore, perspective and multipurpose organic photosensitive materials can be produced by means of nanotechnology. In many works, it was shown that fullerenes can be one of the effective organic photosensitive nanostructures [5-10]. On researching these materials, the highest efficiency of photoconversion has been achieved in a case when the functional groups are attached to a fullerene due to

chemical reactions of synthesis. Such molecules are able to form the linked chains of molecules due to polymerization, which supports more effective transfer of photogenerated charge carriers. On the other hand, the fullerene with the attached group can form a complex with charge transfer. Partial separation of charges in the molecule itself increases the photoconversion efficiency (at the stage of their separation). To carry out the film formation process based on the polymerization of fullerene molecules with the attached groups, one should meet certain requirements to cleanness of initial material (i.e., to synthesis and cleaning of substances with molecules of a complex structure and complex chemical composition).

An alternative to polymerization by synthesis of monomer molecules based on fullerenes can be various methods of modification and, in particular, the chemical modification of C₆₀ films [11]. It is important to note that the modification of fullerene films can be carried out

already at the stage of producing the photoconverters. From the practical viewpoint, it is rather perspective as the single starting material provides production of a set of materials with variable functional properties, being based on this modification method.

The analysis of the published works showed that the influence of various modification methods on the photoelectric properties of fullerenes is scantily studied. Therefore, it is of interest to investigate how modification of the fullerene structure influences on their photosensitivity. And it was the main task of this work.

One task more in this work concerned the manufacturing technology of the photosensitive structures. To increase the efficiency of light conversion in photoconverters, transparent conducting electrodes (most commonly ITO) deposited onto glass substrates are usually used. There are no technical problems to deposit the photoconducting organic layer onto the ITO layer. The problem of creation of the top electrode is more complex. In most cases, for this purpose the Al [6, 8, 10] or Au [7] layers thermally deposited are used. However, in this case, there is a high probability of changing the properties of fullerene film due to penetration of atoms of metal into the bulk of organic layer. The range of penetration considerably increases with insignificant disturbances of the technological process (surface finish and roughness, a constancy of deposition rate, *etc.*). On the other hand, it is significant whether an organic film properties does not change with varying the thickness, what can be defined basically through the use of the electrodes identical in their chemical composition. Therefore, in this work considered is the opportunity to study the fullerene photoelectric properties due to application of the clamping electrodes through an intermediate layer of liquid. In such case, it is possible to change easily not only the electrode, but also the chemical composition of liquids used.

2. Materials and methods

For researches the chemically cleaned C_{60} fullerene (concentration of background impurities is less than 1 wt. %) were used. C_{60} layers were deposited onto the glass substrate covered by the ITO layer that is conducting and transparent to the visible spectrum. The thermal deposition was performed at the room temperature and pressure 10^{-6} Torr. The thickness of samples averaged 100 nm. Samples of three types were studied. The samples of the first type (1) were modified by means of laser UV-irradiation, the samples of the second type (2) were nonmodified (referent), the samples of the third type (3) were chemically modified in amine vapour. Initial cleaning of the C_{60} fullerene, thermal deposition of the films and their modification were carried out in Universidad Nacional Autonoma de Mexico (Mexico).

When studying the electric properties, the ITO layer deposited onto a glass substrate served as the top

electrode. Before measurements, the samples were kept in air for a long time (about a month). It stabilized their parameters to exposure to the atmosphere (as shown in [12], oxygen essentially influenced on the electric properties of C_{60}).

To create electric contacts, before clamping the top electrode, the liquid layer was deposited onto the fullerene film surface. Both isotropic (glycerin, distilled water) and anisotropic (ferroelectric liquid crystal) liquids were studied. In what follows, the data obtained for isotropic liquids (mainly for glycerin) will be considered.

The available liquid layer between the fullerene and electrode basically could result in partial passing the C_{60} molecules into solution and changing the properties of samples (such effect was observed in the work [13]). Therefore, it was important to study the stability of parameters of the obtained structures. Long-time researches showed, that even under exposure to light the properties of samples does not change. I.e., the studied C_{60} films were reasonably resistant to environmental influence (including even the available liquid phase).

The photoelectric properties of samples were analyzed by changing the capacitance and resistance under exposure to light. The values C and R were measured within the range of 10^{-3} to 10^6 Hz by means of the oscilloscopic method [14-16]. The analysis of frequency dependences enabled us to determine where certainty (in a bulk or near-electrode region) changes of properties of samples on exposure to light occur. This is much more complicated to do when analyzing, for example, the current-voltage characteristics. The samples were exposed to focused light from a halogen incandescent lamp with a power of 100 W directly or through the interferential filter with a transmission maximum for $\lambda = 485$ nm (this wavelength value is close to a region of the maximal absorption of C_{60} films). Both the top electrode (the ITO layer with deposited C_{60} film) and the bottom one were exposed to light. The water filter was used to decrease heating the samples as caused by the intensive infra-red radiation of the incandescent lamp.

All measurements were carried out at the temperature 293 K.

3. Experimental results and discussion

In Fig. 1, shown are the frequency dependences of the capacitance (a) and resistance (b) in darkness (curves d) and on exposure to the focused white light (curves p) for the sample 1. In this case, there was a glycerin layer between the top electrode and C_{60} film. At first, let's analyze the capacitance frequency dependences measured in darkness. According to our estimations, the sample capacitance measured at the frequency 0.1 Hz exceeds by more than one order the fullerene layer one. From this analysis it may be concluded that, at low frequencies, the electric field is applied to near-electrode

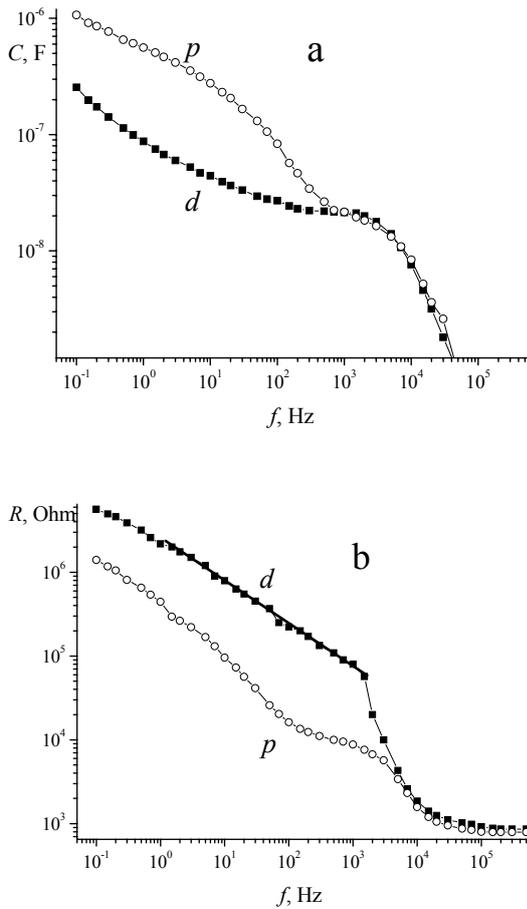


Fig. 1. Frequency dependences of the capacitance (a) and resistance (b) measured in darkness (d) and on exposure to the focused white light (p). The data for the sample 1. Illumination of the bottom electrode at the temperature 293 K.

layers. Such conclusion is confirmed by an essential increase in the capacitance of structures when exposing the latter to the focused white light (curve p in Fig. 1a).

In Fig. 2, for three different types of samples, resulted are the frequency dependences of the relation of the capacitance C_p , measured on exposure to the focused light of the bottom electrode, to the capacitance C_d , measured in darkness. From the obtained data, it follows that the ratio C_p/C_d has a sharply pronounced peak within the frequency range of 1 to 10^2 Hz (most clearly it is observed for the samples 1 and 3). Thus, the maximal value for C_p/C_d exceeds 6. Such a large change in capacitance is not responsible for the changes of polarizing properties of fullerene molecules on exposure to light, and it is most likely caused by change of near-electrode layer parameters (the thickness of near-electrode layer decreases when exposing to light). It is also significant to note that both the frequency at which the C_p/C_d value has its peak and the maximal C_p/C_d value depends on manufacturing technology of the C_{60}

films. In the samples 2 and 3, with decreasing the frequency observed is the increase of C_p/C_d (a new peak appears, probably). Hence, it follows that the suggested by us technique to analyze photoelectric properties of the samples allows us to study the influence of various technological factors on photoelectric properties of various substances and, in particular, fullerenes.

Since the glycerin does not absorb the light of the visible spectrum, the change of the capacitance of structures during their exposure to light is caused by the change of the parameters of near-electrode regions, mainly, in the fullerene layer. The presence of C_{60} and isotropic layers in the researched structures is essential for constructing the equivalent circuit of the sample, i.e., clarifying the reasons for changing the properties of the researched structure over all the frequency range.

To estimate how the liquid layer influences on the studied structure properties, let us analyze the frequency dependence of capacitance ($f < 10^3$ Hz) for the case when a layer of distilled water is located between the top electrode and C_{60} film. For the definite frequency, the

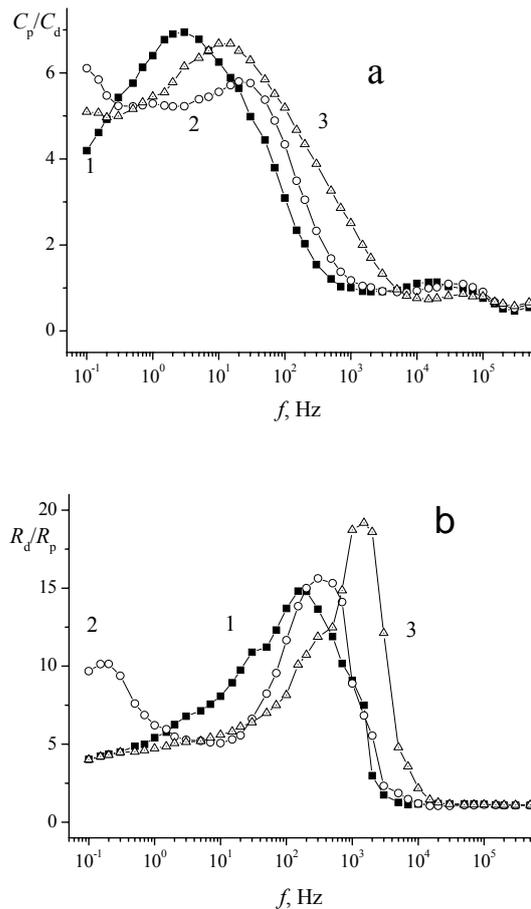


Fig. 2. Frequency dependences of C_p/C_d (a) and R_d/R_p (b) for the researched samples 1, 2, and 3. Exposure to the focused white light from the bottom electrode side at the temperature 293 K.

capacitance of samples with a layer of distilled water was found to exceed that with a layer of glycerin by a factor 4 to 5. Like to the samples with a glycerin layer, the capacitance of samples with water increased with exposure to white light. Here the changes of C_p/C_d for the samples with water were much less than those for the samples with glycerin. For these samples with water, the maximal value C_p/C_d was equal to 1.5 at the frequency 0.1 Hz, and decreased with increasing the frequency (i.e., a peak that is characteristic for the samples with a glycerin layer was not observed).

For constructing the equivalent circuit of the sample, it is also of interest to analyze the dependence $R(f)$ (first for $f < 10^3$ Hz) as it was made for the $C(f)$ dependence. These data for samples with a glycerin layer are depicted in Fig. 1b. At first, it is reasonable to analyze the $R(f)$ dependence for the case when the sample was in darkness (curve d). It follows from Fig. 1b that, in the frequency dependence of R , it is possible to separate the section where the resistance decreases with increasing the frequency linearly in the logarithmic scale. It can be analytically expressed as follows

$$R_f = kf^{-m}, \quad (1)$$

where k is a factor of proportionality, and m is an exponent. The relation of this type is usually adduced for conductivity (in this case the sign minus before m is absent as the conductivity increases with growing the frequency) and characterizes the hopping mechanism of the charge carrier transport [17]. For the studied samples, as was shown when analyzing the capacitance frequency dependence, the considered section of $R(f)$ (for $f < 10^3$ Hz) characterizes the near-electrode region. Therefore, to proceed from the frequency dependence of R to that of conductivity, it would be necessary to find a near-electrode layer thickness that can be only estimated, as it will be shown below. Taking the above into account, it was the frequency dependence of R that has been analyzed. Despite it, the character of this dependence itself gives foundations to assume that the transport of charge carriers through the fullerene near-electrode region can be also described using the conception of the variable length hopping mechanism.

For this charge transport mechanism, the value m is an important factor. These values of m for studied samples are summarized in the table. Close inspection of these data shows that the m -value depends on conditions of preparation (modification) of C_{60} fullerene, for the samples 2 and 3 the value m being higher than that for the sample 1. Thus, the different type treatment of C_{60} films on their manufacturing results in the change of charge transport conditions, which can be connected uniquely with changing the film structure.

Let's consider how the shape of the dependence $R(f)$ changes after exposure to white light (Fig. 1b, curve p). In the dependence $R(f)$, there already observed no section where Eq. (1) would be obeyed. This fact has

been substantiated for all the studied samples. The reason of it can be an essential change of the near-electrode layer thickness (almost by a factor of 6 according to the data on the change of capacitance) and, as a consequence, more essential influence of effects of tunneling. On the other hand, reduction of the C_{60} film resistance after light illumination can result in a new distribution of the electric field inside the sample in comparison with that obtained in darkness measurements.

Similarly to the case of the sample capacitance, it is important to analyze the relative changes of resistance of samples on exposure to the focused white light in all the range of frequencies. In Fig. 2b, shown are the frequency dependences of the ratio of the resistance measured in darkness, R_d , to that measured in the course of illumination by white light, R_p . It is well seen that like to the case of the capacitance ratio, the peaks are observed, and not only the peak of R_d/R_p is higher (for the sample 3 it practically reaches 20, while the maximal value of $C_p/C_d \approx 7$) but the peak position shifts to the high-frequency region (in comparison with the corresponding position for peaks of C_p/C_d). Distinctions between Fig. 1a and b may be explained on the assumption that the studied structures consisted of two layers (C_{60} and liquids).

Let's analyze the frequency dependence C_p/C_d when instead of a glycerin layer we used that of distilled water. The resistance of structures with water on exposure to the focused white light appeared to decrease, but this drop was smaller by several times than that with glycerin. In the frequency dependence R_d/R_p the peak also was observed, however, the maximal value R_d/R_p equaled to 1.6 (i.e., it is almost one order less than that with glycerin). A peak position by itself was shifted insignificantly to the more high-frequency region in comparison with the samples containing glycerin.

Analyzing the frequency dependences of C and R , it should be pointed out the sharp change of these parameters for $f > 10^3$ Hz as one of the most important effects. Especially, it is clearly observed in the darkness measurements (Fig. 1a and b, curves d). For liquids, such sharp changes of parameters can be associated with dipole polarization of molecules, while in solids these changes were not observed. Our researches have shown that the dipole polarization of glycerin begins since the frequencies $f > 2 \cdot 10^5$ Hz. In the work [16], it was shown that the sharp change of dielectric properties of glycerin for $f > 10^2$ Hz is caused by change of conditions for distribution of the electric field in a sample (from a condition when the electric field is applied to the near-electrode region for $f < 10^2$ Hz to a condition when that becomes homogeneous at $f > 10^4$ Hz).

Therefore, and for the studied samples, it is possible to assume that the sharp change of C and R at $f > 10^3$ Hz is also caused by transition from a condition when the field is applied to near-electrode regions to a condition when the field in a sample is practically homogeneous (contrary to the samples with glycerin studied in the

work [16], the electric field in our samples should not be strictly homogeneous as we have a case of contact of two layers – C₆₀ fullerene and glycerin). In [16], it was shown that the transition between various conditions can be considered within the framework of the general theory of relaxation processes on the basis of Debye's equation modified by Cole – Cole (as Cole – Cole's diagram has the shape of an arch). Taking into account the presence of C₆₀ layer and glycerin in studied samples, it was difficult to find the components of complex dielectric permeability from the values *C* and *R*. Therefore, instead of the dependence ε'(ε'') (Cole – Cole's diagrams) we analyzed the dependences ω⁻¹R⁻¹(*C*) (where ω = 2π*f* is the circular frequency). This dependence for the sample 1 is presented in Fig. 3. As the analysis showed the dependences ω⁻¹R⁻¹(*C*) obtained experimentally may be approximated by semicircles, which corresponds to the relaxation process with one relaxation time τ in accord with the theoretical representations [18]. For the studied samples, the values τ are summarized in Table. Hence, it follows that modifying the C₆₀ films tends to change τ. It confirms that researching the relaxation processes basically make it possible to estimate the changes of C₆₀ properties under various influences.

It is important to compare the obtained value τ with the data obtained for glycerin. In accord to the data [16], the relaxation process corresponding to the transition from a condition when the electric field is applied to the near-electrode regions to that when the field is homogeneous lasts 1.4·10⁻⁴ s (i.e., this value is higher by the order than the data resulted in the table). It once more confirms a conclusion that the sharp changes of *C* and *R* observed experimentally for *f* > 10³ Hz are caused not only by the change of properties of liquid, but also by those of C₆₀ films.

Similarly to the relaxation processes caused by redistribution of the electric field between two layers of dielectrics, the observed relaxation process can be named the polarization of Maxwell–Wagner, too. However, the relaxation process considered in the work is more complex for the analysis than the classical Maxwell–Wagner effect, since not only the bulk processes but also the near-electrode ones must be taken into account. From this fact, the considered relaxation process, strictly speaking, cannot be a full analog of the

classical Maxwell–Wagner effect. Therefore, we called this effect as the Maxwell–Wagner-type polarization.

Except the relaxation time, the minimal and maximal values of the capacitance have been estimated from the analysis of dependences ω⁻¹R⁻¹(*C*). Using the analysis of frequency dependences for dielectric permittivities, it is assumed that C_{min} = C_∞ and C_{max} = C₀, where C_∞ and C₀ are the capacitances of samples at *f* → ∞ and *f* → 0, respectively. The values *C* and C₀ are shown in the table. Hence, it follows:

1. For the researched samples 1, 2, 3, the values C_∞ practically coincide.
2. The values C₀ differ appreciably (the greatest distinctions take place between the data for the sample 1 and those for the samples 2 and 3).

On the basis of the abovementioned analysis of experimental data, an equivalent circuit of the sample was suggested. Since both the bulk and near-electrode properties of glycerin and C₆₀ influence on properties of researched structures, the most simple equivalent circuit should have the shape shown in Fig. 4. Under the assumption made earlier, the capacitance C_∞ corresponds to the case when the field is applied to the overall bulk of liquid and fullerene (here the great values of capacitances for the near-electrode regions cannot be taken into account). Then

$$C_{\infty} = C_{bc} C_{bg} / (C_{bc} + C_{bg}), \quad (2)$$

where C_{bc} and C_{bg} are the capacitances of the bulk C₆₀ film and glycerin, respectively. Using the found geometrical parameters of a glycerin film, we estimated C_{bc} ≈ 7.7·10⁻⁹ F that is more than 20 times greater than C_∞. It immediately follows that C_∞ ≈ C_{bg}. On the basis of these data, the thickness of glycerin *d_g* in the researched structures was found to be equal to about 30 μm (these values *d_g* are summarized in the table) and practically did not depend on the type of modification of C₆₀ films.

As the capacitance C₀ corresponds to a condition when the electric field is applied to the near-electrode regions, on the basis of the offered equivalent circuit of researched structures, it is equal to

Table. The researched structure parameters obtained from the analysis of frequency dependences *C* and *R*, measured in darkness and on exposure to the focused white light.

Type of sample	<i>m</i>	τ, ns	C _∞ , F	<i>d_g</i> , μm	C ₀ , F	W _C , nm
1	0.50	19	2.5·10 ⁻¹⁰	28	1.8·10 ⁻⁸	43
2	0.66	11	2.2·10 ⁻¹⁰	32	1.2·10 ⁻⁸	70
3	0.57	9.1	2.2·10 ⁻¹⁰	32	1.0·10 ⁻⁸	77

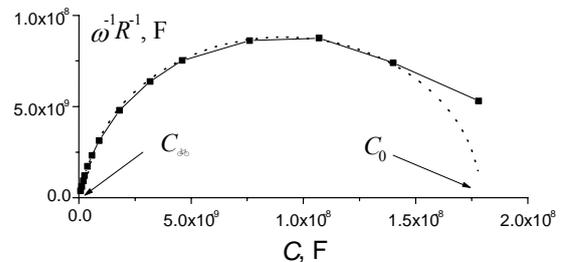


Fig. 3. ω⁻¹R⁻¹(*C*) is the sample 1 diagram in the darkness measurements at the temperature 293 K.

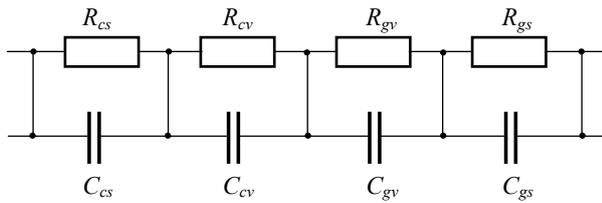


Fig. 4. The equivalent circuit of the sample. C_{cs} , R_{cs} are the capacitance and resistance of the C_{60} film near-electrode region, C_{cv} , R_{cv} are the capacitance and resistance of the C_{60} film bulk, C_{gv} , R_{gv} are those of the glycerin bulk, C_{gs} , R_{gs} are those of the glycerin near-electrode region.

$$C_0 = C_{cs} C_{sg} / (C_{cs} + C_{sg}), \quad (3)$$

where C_{sc} and C_{sg} are the capacitances of the near-electrode regions of C_{60} and glycerin, respectively. From the data [16], the thickness of the diffusion region of the double electric layer in glycerin measures 50 nm, which corresponds to the capacitance $C_{sg} \approx 1.8 \cdot 10^{-7}$ F. From the table data, the value C_{sg} exceeds the experimentally obtained value C_0 more than one order. Hence, it follows that $C_0 \approx C_{sc}$. This conclusion is supported by an essential capacitance change observed experimentally (the maximal value is equal to about 6) after exposing the samples to white light. From the value of the capacitance of the near-electrode layer, one can estimate the thickness of this layer:

$$W_c = d \frac{C_0}{C_{bc}}. \quad (4)$$

The values W_c stemmed from Eq. (4) are listed in the table. It is significant that the value W_c by itself measures of nanometers, which is peculiar to the majority of organic semiconductors [4]. From our analysis of these data, it follows that after UV-irradiation and treatment of C_{60} film in amine vapour (the samples 1 and 3), the value W_c increases, which, in principle, should increase the efficiency of phototransformation.

Using the equivalent circuit of the sample, let's consider why the ratio C_p/C_d has a peak at a certain frequency (Fig. 2a). To do that, one should take into account the frequency dependences of the components of complex dielectric permeability for glycerin [16]. The electric field will be applied practically to the near-electrode layer of C_{60} only for the frequencies close to those when C and R sharply reduce (in this case influence of the near-electrode layer of glycerin is weak because of "shunting" action of the capacitance of the double electric layer in liquid. Exchange of charges at the electrode-liquid interface takes place in a definite time interval [16], that's why with increasing the frequency the electric field will be more and more applied to the near-electrode layer of liquid, which

results in the decreased ratio C_p/C_d observed experimentally. The abovementioned analysis can be also used to explain for the reason of existence of the peak in the frequency dependence of R_d/R_p . The double electric layer in liquid consists of dense and diffusion regions, each of which is corresponded by an intrinsic frequency dependence of the components of complex dielectric permittivity. Just this fact based on the offered equivalent circuit can serve for explaining of the appearance of more low-frequency peaks that are observed especially clearly in the frequency dependence R_d/R_p for the sample 2.

In conclusion, it should be also considered what changes may appear if glycerin is replaced by distilled water. The experimental data for the sample 1 have shown that in the case of distilled water, there was not observed so sharp change of C and R at the certain frequency (it is well clearly observed in the frequency dependence of capacitance), as it follows from Fig. 1. From these facts, we have the important inference that for creating the conditions for which, at the certain frequencies, the field is applied practically to the near-electrode C_{60} layer it is necessary to have a liquid with the definite properties. It is associated not only with conductivity of liquid but also with its viscosity specifying the thickness of a liquid layer. Estimations of the thickness of the water layer by the capacitance C_0 have shown, that it is several times less than that of glycerin one. In the case when there is a water layer between the top electrode and C_{60} film, the absence of sharp transition from a condition when the electric field is applied to the bulk layer of liquid to that when the electric field is applied to the near-electrode layer of a fullerene results in a sharp decrease in the photosensitivity of structures. That's why the optimization of parameters of structures with the top clamping electrode should involve matching not only the organic film, but also a chemical composition of liquid.

Since the researched samples with two transparent conducting electrodes (ITO layers) were to be illuminated from any of two sides, it enabled to analyze how far the photosensitive properties of researched structures are tolerant to changing the thickness. As evident from the analysis of the received data, the frequency dependences of C and R for the samples 2 and 3 on exposure to white light through the top and bottom electrodes do not differ. Taking into account that the significant part of a visible spectra passes through the C_{60} layer reaching the opposite electrode, for purity of experiment the researched structures were illuminated through the interferential filter with a maximum transmittance for the wavelength 485 nm (as was already noted, this fact corresponds to the case of strong absorption of fullerene). Thus, it was also obtained that the illumination through the top electrode results in the same changes as illumination through the bottom one.

In Fig. 5, for the sample 1 shown is the frequency dependence of the capacitance ratio when illuminating the bottom electrode C_{ITO} to that when exposing the top

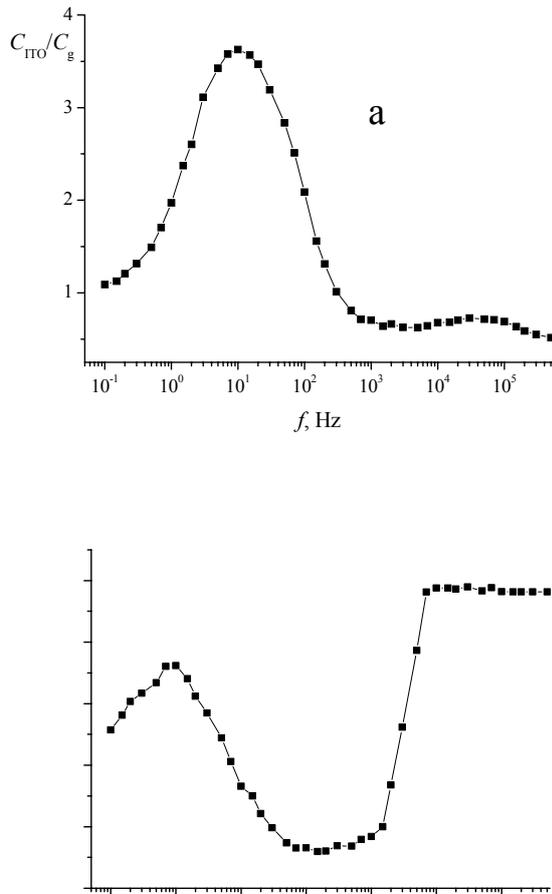


Fig. 5. Frequency dependences of C_{ITO}/C_g (a) and R_{ITO}/R_g (b) for the sample 1 at the temperature 293 K.

one C_g . As seen from the figure, the greatest changes are observed in the frequency range where C_p/C_d get to the greatest values. The same data are obtained for the frequency dependence of the resistance ratio when illuminating the bottom electrode R_{ITO} to that when exposing the top one R_g . I.e., this suggests that for the sample 1 the observable distinctions between C_{ITO} and C_g as well as R_{ITO} and R_g can be caused by the change of film structure with the thickness. These structural changes can be caused by the modification of the fullerene structure under the laser UV-irradiation.

4. Conclusions

Thus, it is shown when analyzing the photosensitivity of organic structures the method for using the clamping electrodes through a liquid layer is perspective and it does not effect on an organic film surface.

From the frequency dependences of C and R within the frequency interval of $10^{-1} - 10^6$ Hz which were

obtained in darkness and on exposure to focused white light, we managed to separate the processes caused by changes in the near-electrode region ($f < 10^3$ Hz) from those caused by the change of bulk properties of samples ($f > 10^5$ Hz), as well as to find experimentally the frequency region where the sharp changes of C and R with frequency growth were caused by the transition from the first process to the second one ($10^3 < f < 10^5$ Hz).

It is shown that, for the frequencies $f < 10^3$ Hz, the resistance of samples when measuring in darkness is proportional to f^{-m} and the value m being dependent on manufacturing technology of C_{60} films.

The frequency dependence of the resistance ratio measured in darkness, R_d , to that measured on exposure to focused light, R_p , was found to have a peak. The position of the peak ($f \approx 10^3$ Hz) and maximal value R_d/R_p (≈ 20) were experimentally shown to depend on conditions of preparation of C_{60} films and a chemical composition of liquid.

The frequency dependence of the capacitance ratio measured on exposure to white light, C_p , to that measured in darkness, C_d , was shown to have a peak, too. Like to the R_d/R_p case, the maximal value C_p/C_d and its peak position on the frequency scale depend on conditions of the manufacturing technology of C_{60} films.

It is experimentally shown that the transition from the processes caused by the near-electrode phenomena to those caused by changes of bulk parameters might be described basing on the "classical" effect of the interlayer Maxwell-Wagner polarization.

The equivalent circuit of sample is suggested.

We estimated the thicknesses of the glycerin layer ($\approx 30 \mu\text{m}$) and near-electrode layer of C_{60} film (tens of nanometers).

Comparing the frequency dependences of C and R on exposure to light of the top and bottom electrodes, it was shown the C_{60} layer exposed to UV-irradiation is non-uniform in thickness.

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