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РОЗДІЛ 2

**ХІМІЧНІ, ФІЗИЧНІ ТА МАТЕМАТИЧНІ МЕТОДИ
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CARRIER MOBILITY IN POLYMER FERROELECTRICS

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The mobility of charge carriers is characterized by the electrical properties of the substance. At the same time, its experimental determination in ferroelectric polymers has serious difficulties, because the majority of carriers are localized at trapping levels (traps). Finding the mobility from the value of the space charge limited current is difficult due to the fact that the steady-state current is not stabilized even after 50 hours at a constant voltage application [1]. Lack of a reliable method and an adequate model leads to the fact that the carrier mobility of PVDF found by different methods differs in 5 orders of magnitude [2].

We tested on polyvinylidene fluoride (PVDF) films the galvanostatic method of determining the effective mobility of charge carriers developed by Fedosov and Sergeeva [2]. True mobility μ_0 is related to the effective mobility by the known relation $\mu = \mu_0 n_c / n$ where n_c is the density of the free carriers; n the total density of charge carriers. Initial total current equation and the Poisson equation, supplemented by the expression for the electret potential $V'(t')$, can be written in the following form

$$\varepsilon_0 \varepsilon \partial E' / \partial t' + \partial P / \partial t' + e \mu n E' + g E' = i_0, \quad (1)$$

$$\varepsilon_0 \varepsilon \partial E' / \partial x' + \partial P / \partial x' = e n, \quad (2)$$

$$V'(t') = \int_0^{x_0} E' dx', \quad (3)$$

where t' is the time; x the coordinate; i_0 the current density; P the ferroelectric polarization; x_0 the sample thickness; n the density of non equilibrium carriers; e the elementary charge; ε the dielectric constant. The experimentally measured values are i_0 and $V'(t')$. The initial and boundary conditions are as follows

$$E'(x', 0) = 0; \quad n(x', 0) = 0; \quad E'(0, t') = 0. \quad (4)$$

Eliminating n from (1) and (2) we get

$$\varepsilon_0 \varepsilon \partial E' / \partial t' + \partial P / \partial t' + \mu E' [\varepsilon_0 \varepsilon \partial E' / \partial x' + \partial P / \partial x'] + g E' = i_0. \quad (5)$$

In the initial charging stage when the field is smaller than the coercive one we get

$$\varepsilon_0 \varepsilon \partial E' / \partial t' + \mu E' \varepsilon_0 \varepsilon \partial E' / \partial x' + g E' = i_0. \quad (6)$$

Then, after solving the equation (6) and finding the expression for $V'(t')$ in accordance with (3), we construct a family of electret potential kinetics for different values of μ , and by comparing them with the experimental $V'(t')$ curve we find the carriers mobility.

Equation (6) is solved by the characteristics of the current lines method. After normalization of the variables and the introduction of dimensionless quantities we obtain

$$V = (\varepsilon_o \varepsilon \mu / i_o x_o^3)^{1/2} V'; \quad \tau = (\varepsilon_o \varepsilon \mu \cdot i_o / x_o g^2)^{1/2} \quad (7)$$

The expression for the kinetics of the potential in the real dielectric is given by

$$V(t) = \tau_o [1 + (\tau_o t - 1) \exp(-t / \tau_o) + (\tau_o^2 / 2) \{ \exp(-2t / \tau_o) - 1 \}], \quad \tau = \tau_o. \quad (8)$$

For the potential slowdown kinetics after turning off the charging current one has

$$V(t) = (1/3)(2 + t^2)^{3/2} - (1/3)t^3 - t. \quad (9)$$

By passing from dimensionless quantities to normal ones, we get

$$V'(t') = (i_o x_o / g) \{ 1 + (\mu \cdot i_o t' / x_o g - 1) \exp(-gt' / \varepsilon_o \varepsilon) - (\mu \cdot i_o \varepsilon_o \varepsilon / 2g^2 x_o) [1 - \exp(-2gt' / \varepsilon_o \varepsilon)] \}; \quad g \neq 0; \quad t' \leq (2\varepsilon_o \varepsilon x_o / \mu \cdot i_o)^{1/2} \quad (10)$$

Table 1 presents data on the kinetics of the electret potential during electrization of PVDF films with corona discharge under the following conditions: $x_o = 26 \mu\text{m}$, $i_o = 73 \mu\text{A}/\text{m}^2$, $g = 10^{-11} \Omega^{-1} \text{m}^{-1}$, $\varepsilon = 10$. The carrier mobility has been also calculated by substituting the above parameters into (10).

Charging time, s	Electret potential, V	Mobility, $10^{-14} \text{m}^2/\text{V}\cdot\text{s}$
15	109	58.5
30	218	14.9
60	364	4.5
90	437	2.5
120	510	1.6

Reducing mobility with charging time demonstrates a shift of the equilibrium between free and trapped carriers in the direction of increasing the concentration of the latter, indicating existence of the dispersed nature of the charge transfer in PVDF.

The mobility values of charge carriers in PVDF obtained by us are in good agreement with data reported by other methods [3,4] indicating the correctness of assumptions underlying in the developed and used technique.

Scientific Supervisor – DSc (Physics & Mathematics), Professor S.N.Fedosov

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THE ROLE OF NETWORK ACCESS NETWORKS INFOCOMMUNICATION

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There are several models of info-communication system. The model shown in the first figure, the proposed International Telecommunication Union (ITU). It allows you to accurately determine the location of network access infocommunication system.

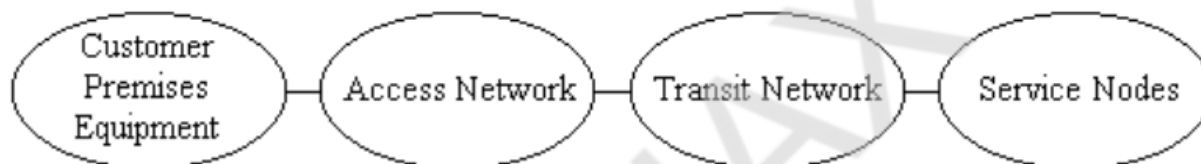


Fig. 1 – Model of info-communication system proposed by the ITU

An example of the equipment at the customer premises can be like an ordinary telephone (housing sector), and a complex set of hardware and software – private branch exchange (PBX), Ethernet LAN and other equipment (manufacturing sector). In the first case, the function element "access network" can perform subscriber line, which is a two-wire physical circuit. In the second case of the access network (for existing telecommunication systems) must include:

- Digital path E1 (or several of these paths) for connecting the PBX to the local telephone network;
- Digital link that supports a stack of TCP / IP protocol, for inclusion in a network Internet;
- Leased lines, if they are necessary to enable the equipment that does not use the telephone network or the Internet.

The primary purpose of network access – to ensure reliable and high-quality communication between all types of equipment installed in a room of potential clients of the operator, and the corresponding transit networks. The evolution of the three elements of info-communication system – "The equipment at the customer premises," "transit network" and "Means of support services" – led to the need for qualitative modernization of the access network. This process requires a serious analysis, it is advisable to start that with technological aspects.

One of the most successful examples of the convergence process can be considered near the functionality of wired (wireline) and wireless (Wireless) access technologies in fixed networks. If we consider the general characteristics of 4G and 5G technology systems, it is possible to talk about convergence fixed and mobile access. This topic is very interesting and important, goes the scope of this article.

ВПЛИВ ВОЛОГОСТІ НА ФІЗИКО- МЕХАНІЧНІ ВЛАСТИВОСТІ НАСІННЯ ЛЬОНУ Царенко К.С., Гришко С.Ю.	81
ФІЗИКО-МЕХАНІЧНІ ТА ТЕХНОЛОГІЧНІ ВЛАСТИВОСТІ ЗЕРНА ГРЕЧКИ – ОСНОВА ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ ЇЇ ПІСЛЯЗБИРАЛЬНОЇ ОБРОБКИ Черниш В.І.	83
СОРБЦІЙНІ РЕЧОВИНИ ТА ЇХ ВПЛИВ НА ПРОЗОРИСТЬ ПЛОДОВО-ЯГІДНИХ ВИНОМАТЕРІАЛІВ Яценко С.І.	85
CARRIER MOBILITY IN POLYMER FERROELECTRICS Adahovsky M.V.	87
THE ROLE OF NETWORK ACCESS NETWORKS INFOCOMMUNICATION Antonschuk A.V.	89
TO THE QUESTION OF REDETERMINATION OF FRICTION MODEL IN THE ROTATIONAL PAIR Branspiz E.V., Branspiz M.Y.	90
ABOUT APPLICATION OF ELECTROMAGNETIC PULLY FOR MAGNETIC SEPARATION OF GRAIN AND GRAIN MIXTURE Branspiz E.V., Branspiz M.Y.	91
SOLID-PHASE LUMINESCENT SENSORS IN BEER QUALITY CONTROL Cherednychenko Ie.V.	92
FERROELECTRIC FILMS OF PVDF HOMOPOLYMER AND P(VDF-TFE) COPOLYMER Gadzhileu N.V.	93
TECHNOLOGICAL ASPECTS OF IMPLEMENTING NON-TRADITIONAL INGREDIENTS IN BEER RECIPE Dasha Hnatovskaya	95
ANALYSIS THE FEATURES OF THE APPLYING OPTICAL TECHNOLOGIES IN THE DESIGN OF ACCESS NETWORKS Serhey Havva	97
COMPLEX APPROACH TO QUALITY IMPROVEMENT OF BAKERY PRODUCTS BY USING PHYTO-EXTRACTS Kozhevnikova V.	98
EFFECT OF STEVIA ON A WHEAT DOUGH MATURATION N. Sokolova, V. Lizak	100
APPLICATION OF THE MULTI-LAYER GRAPH DURING PLANNING THE WDM NETWORKS WITH OPTICAL CONVERTERS Serhey Marchenko	101
DETERMINING THE TOTAL TOXICITY OF FAST FOOD BY PHYSICAL CHEMICAL AND BIOLOGICAL METHODS Patyukova Natalia Serhiivna	102
INFLUENCE OF YEAST STRAINS AND YAN-LEVELS ON FERMENTATION KINETICS OF GRAPE MUST Pashkovskiy O.I., Voycekhovska O.V.	104

Наукове видання

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