

INVESTIGATION OF THE REGULARITIES OF NONSTATIONARY CURRENT IN METAL- DIELECTRIC-METAL SYSTEMS

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Fig. 1

Figure 1: Fig. 1

Abstract**Full Text**

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A. S. GERSHUN, B. L. TIMAN**INVESTIGATION OF THE REGULARITIES OF NONSTATIONARY CURRENT IN METAL-DIELECTRIC-METAL SYSTEMS***(Presented by Academician I. V. Obreimov, May 10, 1966)*

In the present work, on the basis of a study of the inertial properties of currents and of the current-voltage characteristics of the In-CdS-In system, certain regularities of the flow of nonstationary current in metal-dielectric-metal systems have been established.

Measurements were carried out on single-crystal specimens of cadmium sulfide ($\rho \sim 10^{12} \Omega \cdot \text{cm}$), 200 μ thick, with indium electrodes. Figure 1a gives a family of curves for the dependence of current on time at various values of the voltage applied to the crystal. Analysis of these curves shows that if the voltage V applied to the specimen is less than a certain voltage V_0 , then the current decreases with time. In the case $V > V_0$, on the inertial curves, at a certain value of the time t_m , a minimum appears, after which the current increases with time. As the voltage increases, the time t_m decreases according to the law

$$t_m = t_{m0} e^{-(V-V_0)/V_0}. \quad (1)$$

As a result of the presence of the indicated inertial properties, the values of the current depend on the time interval t_E that has elapsed from the moment a constant voltage was applied to the system; consequently, the current-voltage characteristics also depend on this time interval.

Fig. 1. Inertial characteristics of the In-CdS-In system

Figure 2 presents a family of current-voltage characteristics corresponding to different time intervals t_E , on which there are two characteristic regions—a linear one, corresponding to small voltages, and a nonlinear one (a steep rise of the current according to the law $I \sim V^n$, where $n = 8 \div 10$), corresponding to large voltages. As t_E increases, the linear region descends, while the nonlinear region

Fig. 2. Current-voltage characteristics of the In–CdS–In system

Figure 2: Fig. 2. Current-voltage characteristics of the In–CdS–In system

shifts toward lower voltages down to a certain limiting voltage coinciding with V_0 . The relation of the transition voltage from the linear law to the nonlinear one (V_T) to the time t_E obeys the same law (1).

There is a one-to-one correspondence between the different regions in the current-voltage and inertial characteristics. The region of current decrease with time t_E corresponds to the linear region in the current-voltage characteristics, and the region of current increase corresponds to the nonlinear region. Analysis of the curves also—

also shows that at no voltages $V < V_0$ can one obtain an increase of the current with time and, correspondingly, a transition on the current-voltage characteristics from the linear region to the nonlinear one.

It was found that the regularities indicated above are closely connected with the formation, in the system under consideration, under the action of the applied external voltage, of a back emf, observed and described in work ⁽⁹⁾. Under the action of this emf a discharge current I_3 begins to flow in the system; it is measured when the external voltage is removed. As already noted in ⁽⁹⁾, the magnitude of the arising back emf depends on the external voltage and on the holding time of the system under this voltage.

In Fig. 1b a family of curves is presented for the dependence of the current I_3 on the time t_E for different values of the applied voltage. (The current I_3 on all curves was read 120 sec after switching off the external voltage.) These graphs show that the magnitude of the current I_3 , proportional to the emf being formed, tends toward saturation at sufficiently large t_E .

Fig. 2. Current-voltage characteristics of the In–CdS–In system

On the basis of comparison of the given graphs of the inertial and current-voltage characteristics, as well as the discharge current, one can readily be convinced of the close interrelation between them. Thus, at voltages $V < V_0$, the growth of the back emf under the action of the external voltage is accompanied by a decrease of the current on the inertial characteristics. Owing to this, on the current-voltage characteristics, with increasing t_E , the magnitude of the current in the linear region decreases, which is clearly seen in the graphs of Fig. 2. At $V > V_0$, the time of transition to saturation on the curves $I_3(t_E)$ at various voltages corresponds to the time t_m for reaching the minimum on the inertial curves at the same voltages. In turn, as already noted, the law relating V and t_m on the inertial characteristics coincides with the law relating V and t_E on the current-voltage characteristics. On this basis it may be concluded that, on the current-voltage characteristics, the transition from the linear law to the nonlinear one is connected with the transition to saturation of the back

emf. As is seen from Fig. 1b, with increasing voltage, saturation of the back emf is reached in shorter intervals of time. Therefore, on the current-voltage characteristics (Fig. 2), when the time t_E is decreased, the value of the voltage V_T increases.

Thus, the established regularities of the inertial and current-voltage characteristics are due to the back emf formed in the system under the action of the applied voltage. A separate work will be devoted to elucidating the nature of this emf.

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CITED LITERATURE

1. M. A. Lampert, Proc. IRE, **50**, No. 8 (1962).
2. M. A. Lampert, A. Rose, Phys. Rev., **113**, No. 5, 1236 (1959).
3. A. Many, G. Rakavy, Phys. Rev., **126**, No. 6, 1980 (1962).
4. R. W. Smith, A. Rose, Phys. Rev., **97**, 1531 (1955).
5. A. Rose, Phys. Rev., **97**, 1538 (1955).
6. W. Ruppel, R. C. A. Rev., **20**, 702 (1959).
7. E. I. Adirovich, L. A. Dubrovsky, L. B. Suzdalkina, FTT, **7**, issue 3, 943 (1965).
8. Yu. S. Ryabinkin, FTT, **6**, issue 10, 2989 (1964).
9. A. S. Gershun, L. A. Sysoev, B. L. Timan, FTT, **8**, issue 5 (1966).

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