atus with a comparatively high rate of current buildup ($I_n \lesssim 400$ kA, T = 25 μsec), confirmed the presence of a magnetic-confinement stage and of threshold currents I_{min} and I_{max}, in full quantitative agreement with the theory. In the interval (1), the radiation of the discharge is closely similar to that of a black body with temperature determined in accordance with the theory by the expression[2]

$$T_0 = \frac{3.6 \cdot 10^{13} I_n^2}{N_n (1+Z)}, \qquad (2)$$

where Z is the average charge of the ions and N_n is the total number of ions per unit length of the discharge. The percentage transformation of the energy invested in the discharge into ultraviolet radiation in the region from 2200 up to 2700 Å was $\eta \approx 4-5\%$ under optimum conditions (at $I_n \approx I_{min}$). The stability of this discharge was verified on long wires (longer than 25 cm); it was found that stability is determined by the time for development of large-scale force instabilities and does not exceed r_0/v_s, where r_0 is the radius of the discharge. When $I_n < I_{min}$, the discharge becomes optically transparent, and it radiates a complex line spectrum in the case of explosions of wires made from various elements. Under these conditions, the discharge in lithium vapor[3], which exhibits good radiative selectivity, shows quite high ($\eta \approx 4\%$) radiative characteristics. However, the emission in this discharge experiences local nonregular variations that are apparently due to the development of overheat instability.

In addition to the vacuum discharges, heavy-current discharges in air at atmospheric pressure were investigated. During the expanding stage, the discharge is of quiet nature, with no instabilities, and its dynamics is described quite well by the self-similar theory[4]. During the confined stage, the discharge acquires the nature of a vacuum discharge and is subject to constriction instability. At this stage, the behavior of the basic equilibrium characteristics of the discharge is well described by numerical experiments[5]. The emission of the discharge in the atmosphere is also close to black-body, and the efficiency of conversion of the energy invested in the discharge into radiant energy is the same as in the case of a vacuum discharge (4–5%).

When wires 75 cm long were exploded in the experiments, an absolute ultraviolet (2200–2700 Å) radiation yield of 9 kJ was attained for a time on the order of 60 μsec.

Thus, direct heavy-current discharges exhibit approximately the same efficiency of conversion into radiation in the ultraviolet as ordinary xenon lamps, but are substantially brighter, a fact that makes it possible to obtain an absolute radiation yield one order of magnitude higher at similar geometrical dimensions. Attempts to increase further the absolute radiation yield and the duration of the stable state of the discharge should be oriented to the design of coaxial discharges with back current (inverse pinches). Estimates indicate that it would be possible to increase the absolute radiation yield by one to two orders of magnitude by comparison with linear pinches if this approach were taken.

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V. N. Andreev, A. G. Aronov, and F. A. Chudnovskiĭ. The Phase Transformation in V_2O_3 in an Electric Field.

A sharp change in resistivity is observed in a number of transition-metal oxides, e.g., V_2O_3, VO_2, Fe_3O_4, Ti_2O_3, and others, at a certain (critical) temperature (for V_2O_3, T_c = 150°K, and for VO_2, T_c = 360°K). In VO_2, for example, the resistivity changes by a factor of 10^5, while the sharpest resistivity change occurs in V_2O_3 and amounts to a factor of 10^7-10^8. Below the critical temperature, conductivity is of semiconductor (activational) nature, and above it it is metallic (decreases weakly with temperature). The presence of temperature hysteresis, volume change, and heat release offer evidence that the semiconductor-metal transition is a first-order phase transition. It was shown in[1] that when an isostatic pressure is applied, and when V_2O_3 is doped with Cr and Ti atoms, which are substitutional in the vanadium lattice, there are changes in both the transition temperature and the nature of the transition (Fig. 1b). For example, with a 10% Cr content and rising temperature, the phase transition from the antiferromagnetic semiconductive phase to the metallic phase is absent, but there is a phase transition from the antiferromagnetic semiconductive phase to the nonmagnetic semiconductive phase.

A number of authors have also undertaken to shift the transition temperature with an electric field[2]

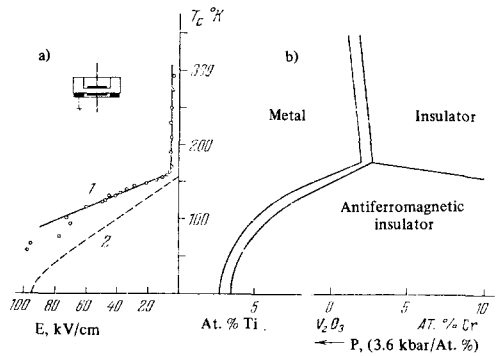

FIG. 1. a) Transition temperature T_c as a function of electric-field intensity E(1–$V_{1.8}Cr_{0.2}O_3$–polycrystal; 2–V_2O_3–single crystal; top–shape of specimen with guard ring on which T_c(E) curve was recorded). b) Phase-transition temperature as a function of the degree of doping with Cr and Ti and of the isostatic pressure p [1].

(VO_2, Fe_3O_4). The observed effects were explained in terms of joule heat, since VO_2 and Fe_3O_4 in the semiconductive phase have resistivities that are low by comparison, for example, with V_2O_3. Only in V_2O_3[3], and later under field-effect conditions in VO_2[4] was an effect of an electric field on the semiconductor-metal phase transition observed.

As a result of an experimental investigation of the influence of an electric field on the phase transition in V_2O_3, which we carried out on single-crystal samples in pulsed electric fields (pulse duration could be varied from 1 μsec to 2000 μsec), it was shown that the phase-transition temperature depends strongly on the electric field. It was found that the $T_c(E)$ phase diagram recorded on pure V_2O_3 and $V_{1.8}Cr_{0.2}O_3$ (Fig. 1a) is very closely similar to the $T_c(p)$ phase diagram (Fig. 1b). This definitely indicates that, on the one hand, an electric field has an effect equivalent to that of pressure and, on the other, that Joule heat is not a factor in our experiments, since, for example, the jump was absent on the temperature curve of resistivity for the $V_{1.8}Cr_{0.2}O_3$ samples.

Analysis of the experimental facts also indicates that the phase transition in V_2O_3 is unrelated to the appearance of instability in the carrier system. Figure 2 shows the electric conductivity as a function of reciprocal temperature in a zero field and at the critical point $E = E_c(T)$. Since σ_c is proportional to the carrier density n_c at the transition point, the anomalies in the temperature curve of σ_c should be reflected in the dependence of T_c on n_c if the phase transition were related to instability in the carrier system, owing to the relation of T_c to n_c. Thus, for example, the presence of a knee on the curve of σ_c vs. $1/T_c$ should lead to an anomaly in $T_c(E)$ (at these same temperatures). The observed difference in the activation energies of $\sigma_0(1/T)$ and $\sigma_c(1/T)$ also confirms the statement made above regarding the noncurrent nature of the instability.

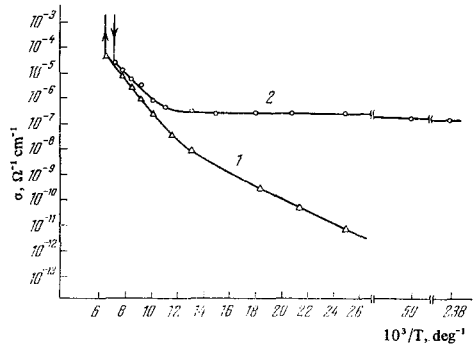

FIG. 2. Temperature curves of electric conductivity in zero σ_0 (1) and in critical σ_c(2) fields.

The experimental results can be explained qualitatively on the basis of a model in which instability arises in a system of noncurrent excitations. The latter might be, for example, both phonons and Frenkel' excitons, dragging of which appears natural in light of the strong electron-phonon coupling. Instability of the phonon system in V_2O_3 appears improbable, because: a) the constants characterizing the change in the conductivity activation energy and the transition temperature are practically the same in the electric field and b) a rough estimate indicates that the constant of the "deformation" potential is of the order of 10 eV, which would tend to indicate an electronic rather than a phonon origin.

A number of interesting phenomena are observed when an electric field is applied—for example, switching and the appearance of relaxation oscillations with frequencies up to 10^7 GHz—effects related to the existence of unstable phases ("memory" effect).

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