state of the Li atom, while the second corresponds to the process of excitation of the states He(1s2s) of the helium atoms. An estimate of the potential of the interaction of the particles in these systems in the region of medium and large R, with allowance for only the polarization interaction of the ion and the atom, points to an intersection of these two potentials at $R \sim 9$ at.un. Consequently, the exact $^1\Sigma$ terms of these systems experience a pseudo-intersection in the region $R \sim 9$ at. un. and the observed oscillation of the cross section (1) is expected to be connected with the oscillations of the cross section for the excitation

$$Li^+(1s^2) + He(1s^2) \rightarrow Li^+(1s^2) + He(1s2s). \quad (4)$$

At the present time there are no published experimental data on the excitation cross section of (4). The cross sections of (4) and of the process

$$Li^+(1s^2) + He(1s^2) \rightarrow Li^+(1s^2) + He(1s2p) \quad (5)$$

were calculated theoretically in [2] for the energy interval $0.1 \leq E \leq 3.5$ keV, and it was shown that these cross sections oscillate. However, the magnitude and the form of the cross sections obtained in [2] depend on the method of calculation. Therefore, to establish a correlation between the charge-exchange cross section (1) and the excitation cross section (4) it is necessary to have more exact information on the cross sections of the processes (4) and (5). The need for this information becomes obvious from the results of [1], according to which the correlation between the cross sections of the inelastic channels can have a complicated character, depending on the number of terms interacting at large distances.

In the energy interval investigated by us and at the indicated experimental errors, the charge-exchange cross section (1) oscillates at one frequency ($\beta = 3.25 \times 10^7$ cm/sec). The presence of one oscillation mode in this cross section indicates that at large R the term of the charge-exchange channel (1) interacts with the term of only one inelastic channel. This term, as indicated above, is the term of the excitation channel (4). The region of the interaction of the terms lies at $R \sim 9$ at. un.

Thus, the investigation of the structures of the cross sections of inelastic atomic collisions makes it possible to obtain, at relatively large collision energies ($E \gtrsim 1$ keV), information on the long-range part of the interaction potential of an excited system consisting of two atomic particles. At the same time, information on the long-range potential of the interaction of a system of two particles in the ground state is usually obtained in experiments on elastic scattering at low energies ($E < 10$ eV).

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INFLUENCE OF A STRONG ELECTRIC FIELD ON THE TEMPERATURE OF THE DIELECTRIC-METAL PHASE TRANSITION IN $(V_{0.91}Cr_{0.09})_2O_3$

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Intensive studies have been initiated recently of the substitution solid solutions V_2O_3-Me_2O_3, where Me = Al, Cr, and Ti [1 - 3]. These metals,

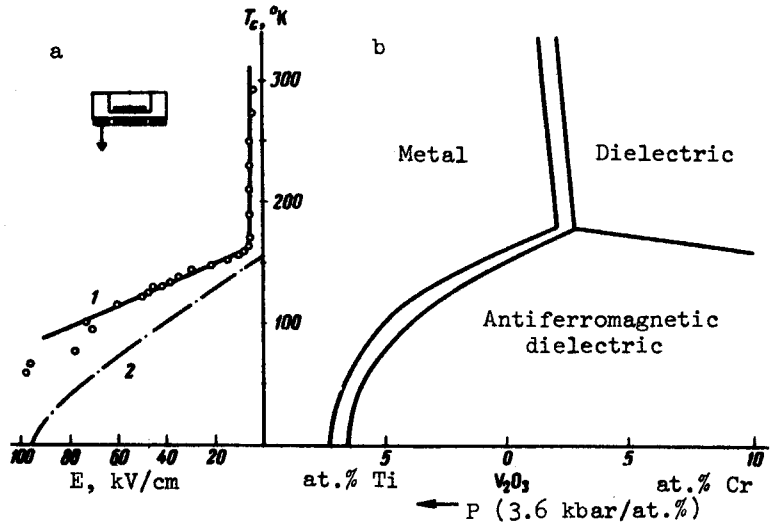

Fig. 1. a) Dependence of the transition temperature T_c on the electric field E: 1 - $(V_{0.91}Cr_{0.09})_2O_3$, 2 - V_2O_3. b) Phase diagram of V_2O_3 doped with Cr and Ti [3].

replacing V, decrease the lattice-parameter ratio c/a in V_2O_3, and lead to an essential change of both temperature and the character of the phase transition. Addition of Al or Cr leads to an increase of the distance between the V atoms, i.e., it effectively "stretches" the lattice [3, 4], while Ti "shrinks" it.

Experiments on the influence of hydrostatic pressure [3], and also experiments on nuclear magnetic resonance [5] have shown that the phase diagram of V_2O_3 in which up to 10% of V atoms are replaced by Al, Cr, or Ti has the form shown in Fig. 1b. It is seen from the diagram that when the temperature of the $(V_{1-x}Cr_x)_2O_3$ is increased, a transition occurs in the region 170 - 180°K from the "antiferromagnetic-dielectric" state into the dielectric state. It is seen from the same diagram that it is possible to realize in the $(V_{1-x}Cr_x)_2O_3$ system also a transition to the metallic state if the sample is subjected to hydrostatic pressure. For example, to transform into the metallic state a sample of $(V_{0.91}Cr_{0.09})_2O_3$, which is in the "antiferromagnetic-dielectric" state at T = 100°K, the pressure required is p $\sim$ 52 kbar, and if this sample is at room temperature, then the pressure required to transform it from a dielectric into a metal is p $\sim$ 25 kbar.

In [6] it was shown that the action of a strong electromagnetic field on the dielectric-metal phase transition in V_2O_3 is connected with the deformation of the lattice as a result of the piezoeffect, which changes the binding energy of the excitons, and the phase-transition point shifts toward lower temperatures.

The present work was undertaken to determine the influence of a strong electric field E on the phase-transition temperature (T_c) in the $(V_{0.91}Cr_{0.09})_2O_3$ system. It is clear that if the action of the electric field is equivalent to a pressure, then the $T_c(E)$ phase diagram should be similar to the $T_c(P)$ phase diagram and should exhibit its characteristic kink at T $\sim$ 170°K, since the "antiferromagnetic dielectric - metal" transition is realized below this temperature, and the "dielectric - metal" transition above it (see Fig. 1b).

On the other hand, the presence of such a kink in the $T_c(E)$ plots of samples with large Cr content ($\sim$9 at.%), in which practically no change is

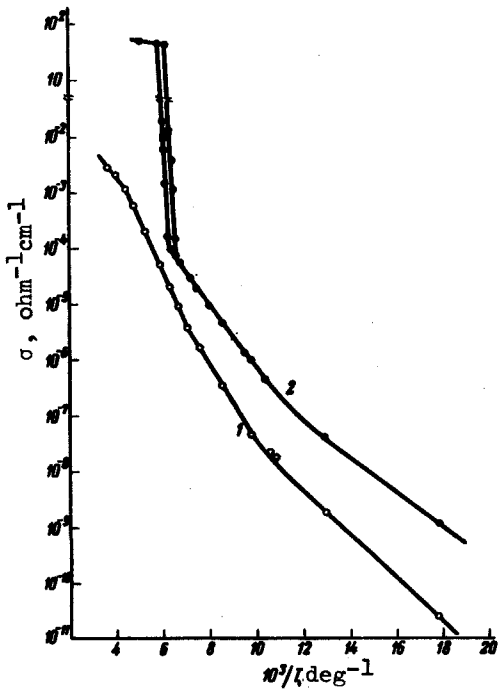

Fig. 2. Temperature dependence of the electric conductivity: 1 - $(V_{0.91}Cr_{0.09})_2O_3$, 2 - V_2O_3.

observed in the temperature dependence of the electric conductivity σ_0 in the region 170 - 180°K, may be direct evidence of the absence of a significant influence of the Joule heat on the phase transition occurring in an electric field.

The measurements were made on sintered polycrystalline $(V_{0.91}Cr_{0.09})_2O_3$ samples prepared by the usual ceramic technology. The initial V_2O_3 was obtained by reducing vanadium pentoxide of analytic grade in hydrogen at 800°C. After mixing the V_2O_3 with Cr_2O_3 in a ball mill and processing at approximately 2000 kg/cm^2, the samples were annealed in a vacuum of $\sim 1 \times 10^{-6}$ Torr at 1100°C for 5 h or in hydrogen with a dew point 20 - 25°C at 1500°C [2]. X-ray tests have confirmed that the solid solution $(V_{1-x}Cr_x)_2O_3$ was produced.

A voltage in the form of rectangular 2-μsec single pulses was applied to samples made in the form of washers with small craters (Fig. 1a). A guard ring made it possible to eliminate the surface components of the electric conductivity. The electric contacts on the sample were deposited with the aid of a conducting liquid based on silver. The current and the voltage were registered with an oscilloscope. When a certain field on a sample in the insulator state is reached at a given temperature (e.g., ~100 kW/cm at the boiling temperature of liquid nitrogen), the resistance of the sample decreases sharply (by a factor 10^5 - 10^7) and a dielectric - metal transition takes place. By measuring at each given temperature the electric field necessary to convert the sample into the metallic state, we determine in fact the shift of the temperature of the dielectric - metal phase transition (T_c) as a function of the electric field.

The $T_c(E)$ plot obtained in this manner is shown in Fig. 1a. In the interval from 160 to 170°K the $T_c(E)$ plot is linear. A similar linear relation, albeit down to lower temperatures, ~40°K, was observed by us for V_2O_3 single crystals (Fig. 1a). The slope of the $T_c(E)$ line for the $(V_{0.91}Cr_{0.09})_2O_3$ sample in the region of T from 160 to 100°K is $\sim 1.43 \times 10^3$ V/cm-deg, i.e., double the value for single-crystal V_2O_3. On the other hand, we observed a twofold decrease of the slope of the plot of log σ against E as compared with the same slope for the V_2O_3 single crystals.

The comparison of Figs. 1a and 1b shows that in the temperature range 160 - 100°K the field needed to convert the sample into the metallic state is double the corresponding field for the single-crystal V_2O_3, and the pressure needed to convert the $(V_{0.91}Cr_{0.09})_2O_3$ sample into the metallic state in the same temperature region is larger by approximately 2.5 times than the corresponding pressure for V_2O_3. This means that for the "antiferromagnetic dielectric - metal" transition 1 kbar of hydrostatic pressure corresponds to ~1.5 kV/cm of field intensity applied to the sample. In the region T ~ 170°K, a sharp kink of $T_c(E)$ is observed, and T_c above 170°K increases practically at one value of E.

A comparison of Figs. 1a and 1b shows that the electric field shifts the temperature of the phase transition in a manner similar to hydrostatic pressure

or doping. Furthermore, since no significant changes are observed in the temperature dependence of the electric conductivity near 170°K (Fig. 2), the experimental data show that the action of the electric field does not reduce to Joule heating, as is the case, for example, in amorphous semiconducting materials [7].

In conclusion, the authors thank A.G. Aronov for a number of valuable hints.

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DETECTING PROPERTIES OF METAL-InSb POINT CONTACT AT A WAVELENGTH OF 337 μ and T = 300°K

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The radiation of an HCN laser at 337 μ wavelength was focused on a contact between an InSb crystal and a metal spring. The crystal measured 0.5 × 0.5 × 0.2 mm, had n-type conductivity, a carrier density 10^{14} cm^{-3} and a mobility $\mu = 6 \times 10^5$ (at T = 77°K). The crystal was etched in a mixture of nitric, hydrofluoric, and acetic acids and was soldered to the base with pure indium. The beryllium-bronze needle was 25 μ thick and 1.5 mm long. The needle was sharpened electrolytically in aqua regia. The detecting pair was mounted in a screening cylinder, on one end of which was screwed a teflon lens, and on the other a piston. The laser power was measured with a calorimeter accurate to ±10%. The laser signal was calibrated with a set of plane-parallel plates of vinyl plastic, and the attenuation in each plate was measured beforehand with the aid of a pyroelectric indicator. The signal was modulated with a semiconductor modulator at a frequency 1 kHz. The loss in the modulator and modulation coefficient were also measured accurately.

The best results are as follows: The tangential sensitivity at an amplifier bandwidth 1 MHz and signal/noise ratio 5 dB is 25 dBm. The threshold sensitivity with a U2-6 amplifier is 4×10^{-10} $W\text{-}sec^{1/2}$; the voltage-power sensitivity with a load resistance of 10 kΩ is 20 - 25 V/W. The contact resistance is of the order of several thousand ohms. The inertia of the contact apparently is not worse than 10^{-12} sec. Biassing the operating point with dc voltage made it possible to increase the voltage-power sensitivity by a factor of 3 - 4, but the level of the low-frequency current noise increased more rapidly, and it was therefore meaningless to use bias in the video detection regime.

Contacts with a sensitivity lower by one order of magntidue can be obtained very easily. The results presented here cannot apparently be regarded as ultimate, since we do not know how effectively the radiation is applied to