small shifts of the line frequencies in the field of the powerful pulse, cannot be excluded in this case. Judging from the published data, Fermi resonance between the valence fundamental oscillations and an overtone of the deformation oscillations in C-H groups is a widespread phenomenon [10].

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ELECTRIC CONDUCTIVITY OF THIN Bi FILMS IN STRONG ELECTRIC FIELDS

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Quantization of the electron energy spectrum in crystals of limited dimensions leads to an oscillatory character of the dependence of the kinetic coefficients in thin metallic films on the thickness [1-3]. It is possible to obtain from these relations a number of data on the structure of the energy spectrum of the electrons in these films. Another possibility for the study of this question is to investigate the electric conductivity of thin films as a function of the electric field [4]. It must be borne in mind, however, that the structure of such films depends strongly on the thickness, on the preparation conditions, the state of the substrate, etc. It is known, for example, that in many cases very thin films cease to be continuous and constitute a two-dimensional assembly of islands of limited dimensions. Nonetheless, even in this case the discreteness of the energy spectrum should apparently lead to singularities on the current-voltage characteristics of the films in strong electric fields, provided the electron gas does not become "heated" in them [5].

The experiments were made with bismuth films sputtered in a vacuum not worse than 5×10^{-9} mm Hg on a mica substrate of temperature 70 - 80°C; the sputtering rate was 50 Å/min. The film thickness was determined by an optical method [1]. The fields needed to reveal the singularities of the current-voltage characteristics can be estimated for films of this type from the condition that the average electron energy in the field should change by an amount on the order of the distance between the discrete levels. At film thicknesses on the order of 100 Å this estimate yields $U \simeq 10^3$ V/cm. Such fields can be easily obtained as a result of the configuration of the samples, which is shown in Fig. 1. The investigated film 1 was sputtered on substrate 3 between gold contacts 2 forming a gap of 65 μ. Voltage was applied to the gold contacts with the aid of platinum leads 4. The strong-field measurements were made in a pulsed mode, with voltage pulse durations 10 msec and with a repetition frequency 10 Hz. In this case the film was not subject to Joule heating, as verified by measuring the pulse parameters over a wide range.

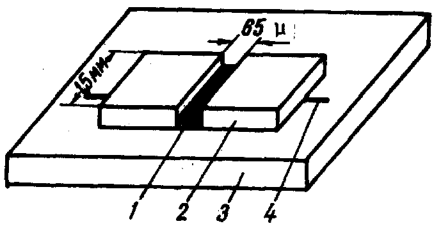

Fig. 1

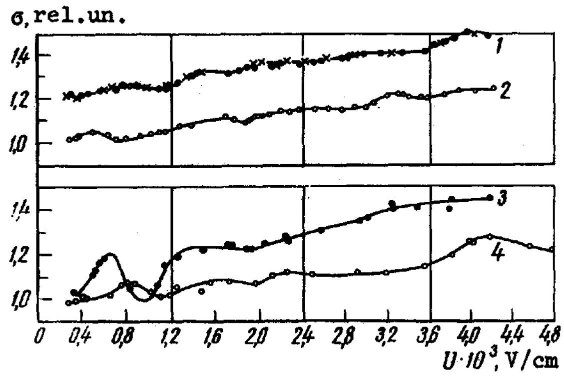

Fig. 2

The dependence of the electric conductivity, which we characterize by means of the quantity $1/\sigma$ (ampere/volt), on the electric field is shown in Fig. 2 (in the case of very weak fields, Ohm's law holds). Curves 1 and 3 were taken at room temperature, and curves 2 and 4 at liquid-nitrogen temperature. We investigated films of thickness 115 Å (1, 2) and 120 Å (3, 4). Against the background of the general growth of the electric conductivity, due to the electron "heating," conductivity oscillations are seen with amplitudes from 4 to 12°. We note here that the error in the measurement of each individual point did not exceed 2.5%. Such a dependence could be plotted for each investigated sample by successively increasing and decreasing the voltage, and the results were the same within the limits of experimental error. This is clearly seen from curve 1, where the points and crosses denote the corresponding relations. In fields on the order of 10^4 V/cm and stronger we observed irreversible processes whose nature is still unclear.

We therefore believe that the observed oscillations of the conductivity of thin films as a function of the electric field are due to quantum size effects. However, there are still no exact data on the structure of these films, and it is difficult to make a quantitative comparison of these results with the theory.

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