Plane №	Cone №	Force F, kg	Area $S \cdot 10^6$, cm^2	$P \cdot 10^{-6}$, kg/cm^2
22	26	30 ± 1	20.6 ± 1.0	1.5 ± 0.1
18	26	30 ± 1	12.1 ± 1.0	2.5 ± 0.2
23	26	30 ± 1	21.3 ± 1.0	1.4 ± 0.1
21	26	30 ± 1	25.8 ± 1.0	1.2 ± 0.1

The table lists the data on the pressures developed in the contact between the plane and conical diamond anvils.

It can be stated on the basis of the results that we have obtained a material suitable for the production of a high-pressure chamber in which pressures up to 2.5 - 3 megabar can be obtained in a volume sufficient for physical tests.

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THERMAL CONDUCTIVITY OF ALUMINUM IN STRONG MAGNETIC FIELDS AT LOW TEMPERATURES

N.N. Sirota, V.I. Gostishchev, and A.A. Drozd
Institute of Solid State Physics and Semiconductors, Belorussian Academy of Sciences

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The investigation of the thermal conductivity of metals in strong magnetic fields at low temperatures is of interest in connection with the possibility of analyzing the electronic energy spectrum and separating the electronic and lattice components of the thermal conductivity [1, 2].

The present paper is devoted to a study of the thermal conductivity of pure aluminum in the region of low temperatures, 6 - 57°K, in transverse magnetic fields of intensity up to 50 kOe.

The object of our investigation was an aluminum single crystal cut from an ingot, with a resistivity 1.2×10^{-10} ohm-cm at helium temperature. After the sample was prepared and mounted in the chamber, the ratio R(273°K)/R(4.2°K) was of the order of 6000. The sample measured 3 × 4 × 60 mm, and its long axis coincided with the crystallographic [110] direction. The sample was oriented by x-ray diffraction using the Laue pattern.

The thermal conductivity was measured by the method of stationary heat flow. The temperature difference along the sample was produced by two electric heaters mounted on its end. This difference over the length of the measured part (~30 mm) ranged as a rule from 0.2 to 1.2°K. The temperature was measured with Allen Bradley resistance thermometers. The sample in the calorimeter was enclosed in a radiation shield to prevent heat loss by radiation and through the connecting leads. To this end, a temperature gradient close to the temperature distribution on the sample was produced in the shield. In the two sections passing through the thermometers, the temperatures of the sample and the screen were maintained equal and monitored with Cu-AuFe differential thermocouples. All the connecting leads to the sample were placed only at these sections.

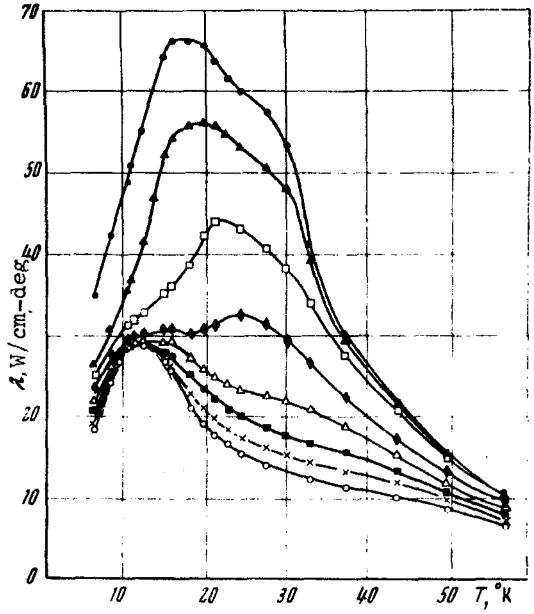

Fig. 1

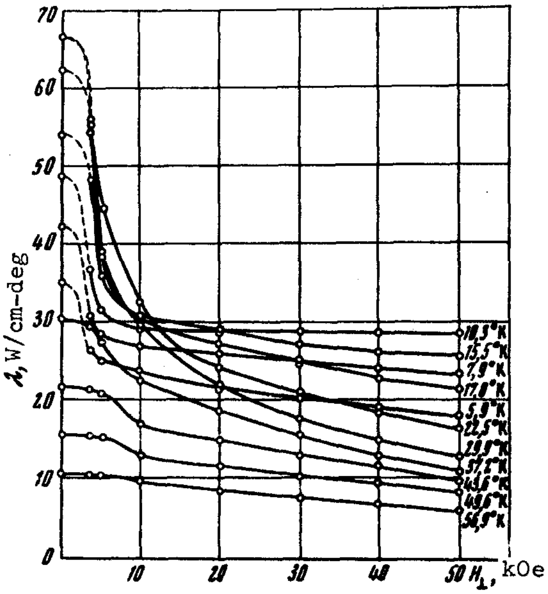

Fig. 2

Fig. 1. Temperature dependence of the coefficient of thermal conductivity of single-crystal aluminum, measured in the [110] direction in magnetic field H || [111] of intensity from 0 to 50 kOe: ●) H = 0; ▲) H = 3.5 kOe, □) H = 5 kOe, ◆) H = 10 kOe, Δ) H = 20 kOe, ■) H = 30 kOe, ×) H = 40 kOe, o) H = 50 kOe. Dashed line - calculated temperature dependence of λ_{latt}.

Fig. 2. Variation of the coefficient of thermal conductivity of single-crystal aluminum in a transverse magnetic field.

The measurements were made in steps of 1 - 2°K at different magnetic field intensities. The field was produced by an electromagnet with superconducting windings. The relative error in the determination of the thermal conductivity did not exceed 2%.

At the temperatures 10.1 and 22.5°K, the thermal conductivity was measured by successive variation of the direction of the transverse magnetic-field vector in a plane perpendicular to [110], in steps of 15°. The thermal conductivity at 10.1°K in a field of 50 kOe has a weak anisotropy in the crystallographic [001] direction. The anisotropy is smaller at 22.5°K.

When plotting the temperature dependence, the magnetic field was oriented in the [111] direction, in which the resistivity of the sample had the strongest variation as a function of the field intensity. Figure 1 shows the variation of the coefficient of thermal conductivity with the temperature at magnetic field intensities 0, 3.5, 5, 10, 20, 30, 40, and 50 kOe. As seen from the figure, the change of the specific thermal conductivity at a constant magnetic field intensity up to 20 kOe, in a temperature range from 6 to 57°K, goes through a maximum whose position shifts with increasing field towards higher temperatures, from 18°K in the absence of a field to 24°K at H = 10 kOe. In fields above 20 kOe this maximum vanishes, but a new temperature appears in the temperature interval 10 - 12°K. When the magnetic field intensity is increased to 50 kOe the thermal conductivity decreases in the entire temperature range, with the exception of the 10 - 12°K region. Saturation is attained in practice already in a 30 kOe field, and further increase of the magnetic field does not decrease the thermal conductivity. No saturation is observed up to H = 50 kOe, above 13°K and below 9°K (Fig. 2). According to extrapolation estimates, the saturation in the remaining part of the temperature range can occur in magnetic fields above 100 kOe.

The absolute minimum of the specific thermal conductivity in fields above 30 kOe, in the temperature region 10 - 12°K, can be regarded as the lattice component λ_{latt} of the thermal conductivity of aluminum at these temperatures.

The temperature dependence of the lattice part of the thermal conductivity in the region of its maximum can be approximately described by the expression $\lambda_{latt} = AT^3\exp(-BT)$, which can be reduced for our data to the expression $\lambda_{latt} = 0.38299T^3 \exp(-0.26087T)$.

The dashed curve in Fig. 1 shows the variation of the lattice part of the thermal conductivity of aluminum in the region of its maximum, as calculated with the foregoing expression. The features that can be noted on the curves (Fig. 1) correlate with the position of the Fermi surface in the first Brillouin zone, and will be discussed elsewhere. The relative change of the thermal conductivity in the temperature interval where the phonon component has a maximum and in a magnetic field H = 30 kOe is of the order of $(\Delta\lambda/\lambda_{latt}) \times 100 = 75°$. Our results indicate that a transverse magnetic field exerts a strong influence on the thermal conductivity of high-purity aluminum.

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LUMINESCENCE OF SOLID NEON

I.Ya. Fugol', E.V. Savchenko, and A.G. Belov
Physico-technical Institute of Low Temperatures, Ukrainian Academy of Sciences
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Experimental studies of the emission spectra of the simplest condensed systems, solidified inert gases, were initiated only recently, even though these crystals have been cited in the theory of free electrons as early as in the Thirties [1]. The experimental difficulties were aggravated by the need for using low temperatures and the technique of vacuum ultraviolet spectroscopy. The lowest excited state of solidified gases is separated from the ground level by a gap of 8 - 17 eV which is larger the lighter the gas. More studies were therefore made of the heavy gases xenon [2, 3], krypton [3], and argon [3]. The spectra of the neon and helium crystals fall in the wavelength region below 800 Å, where there are no optically transparent materials. It is presently impossible to carry out spectral measurements of the luminescence of solid helium, since it crystallizes at pressures above 25 atm. The radiation of crystalline neon was observed only once and quite recently [4]. We have obtained the spectrum of solid neon and observed a new phenomenon, the fine structure (splitting) of the atomic-luminescence band. We have also studied the luminescence of xenon, krypton, and argon crystals.

A special sensitive procedure was developed for the excitation and registration of the spectra of solidified gases. The luminescence was excited with slow electrons of average energy ∿500 eV, which produced no radiation damage in the crystal lattice. The sensitivity of the system used to register the radiation was 10^{-17} W. The investigations were carried out with the aid of the VMR-2 instrument in the range from 500 to 3000 Å. The spectral resolution was