CONCERNING THE MELTING POINT OF GRAPHITE UP TO 90 KBAR

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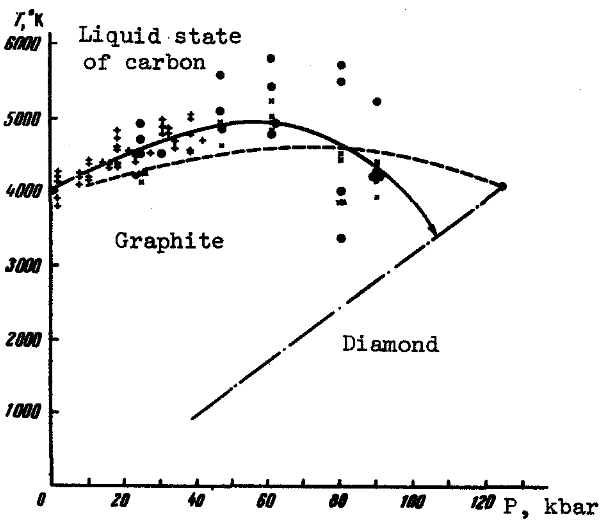
During the last decade, much research has been done on carbon. In spite of the increased interest, which is due to the solution of the problem of obtaining artificial diamonds, the diagram of state proposed by Bundy [1] for carbon cannot yet be regarded as sufficiently well investigated. Thus, for example, the temperatures along the melting curve were calculated from the electric power necessary to heat the sample, and in contradiction to the experimental data it was assumed that the specific heat C_p increases linearly with increasing temperature. The loss to electric conductivity and to thermal conductivity of insulating materials at high temperatures and high pressures was estimated practically arbitrarily.

We have previously undertaken an investigation of the melting curve of graphite up to 60 kbar by an optical method [2, 3], and in the present investigation the range of pressures was extended to 90 kbar. The investigations were carried out in a chamber made entirely of various types of structural steel and intended to operate up to 100 kbar [4].

The construction of the setup and the measurement procedure are described in detail in the paper cited above.

The melting temperature of the sample was determined, in accordance with the Planck radiation law, from the ratio of the intensities of two spectral lines $I_1(\lambda_1)/I_2(\lambda_2) = f(T)$ corresponding to two wavelengths λ_1 and λ_2. For greater reliability, each temperature was determined independently from two pairs of intensity ratios: $I_1/I_2 = f_1(T)$ and $I_2/I_3 = f_2(T)$, with $\lambda_1 = 420\ \mu$, $\lambda_2 = 622\ \mu$, and $\lambda_3 = 825\ \mu$.



Solid line - results of our measurements, dashed line - Bundy's data, dash-dot line - diamond-graphite equilibrium line. + - measurements based on I_2/I_3 in the setup up to 40 kbar, × - measurement based on I_1/I_2 in setups up to 60 and 100 kbar, ⊛ - measurement based on I_2/I_3, ⊛ - start of measurements in setups up to 60 and up to 100 kbar.

The measurement results are shown in the figure, from which it is seen that the melting curve has a temperature maximum corresponding to 4900°K at a pressure of approximately 60 kbar. The appearance of the curve suggests the existence of a triple equilibrium point (diamond - graphite - liquid state of carbon) at lower temperatures and pressures (near 3500 - 3700°K and 110 kbar) than assumed by Bundy (4000 - 4200°K and 125 kbar); up to 50 kbar, the melting curve obtained by us lies somewhat higher than the curve given by Bundy (the dashed line in the figure).

The reduction of our data has shown that the probable error in the temperature measurement does not exceed ±8%, and in the pressure measurements it amounts to ±4%.

L.P. Gorshkov and M.N. Vostrikova took part in the work.

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INTERACTION OF AN ULTRASHORT NEODYMIUM-LASER PULSE WITH GaAs

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1. In a GaAs sample at 77°K, we observed a decrease in the velocity of propagation of single pulses from a neodymium laser in the picosecond band, to a value (2 - 4) times 10^8 cm/sec as compared with the expected value $c/n \approx 9 \times 10^9$ cm/sec ($n = 3.3$ is the refractive index for light with wavelength $\lambda \approx 1.06\ \mu$).

The GaAs sample was irradiated with pulses separated from a train emitted by a mode-locked neodymium laser [1]. The number of pulses in the axial period and their relative amplitudes varied from flash to flash. The pulse duration τ was not measured. We attempted to satisfy all the conditions necessary for the operation of a laser in the mode-locking regime, in which τ amounts to $(10^{-11} - 10^{-12})$ sec [2]. The laser pulses were registered with a coaxial photocell FEK15 and an oscilloscope I2-7; the time constant of the apparatus was approximately 1 nanosecond.

The oscilloscope sweep was calibrated and made it possible to measure the time intervals between the maximum of the pulses with accuracy up to 0.5 nsec. The experimental setup is shown in Fig. 1. In Fig. 2a are shown oscillograms of light pulses in the absence of a sample. The first pair (1 and 2) of pulses corresponds to passage of light along the path AB, and the second (3 and 4) along ACB.

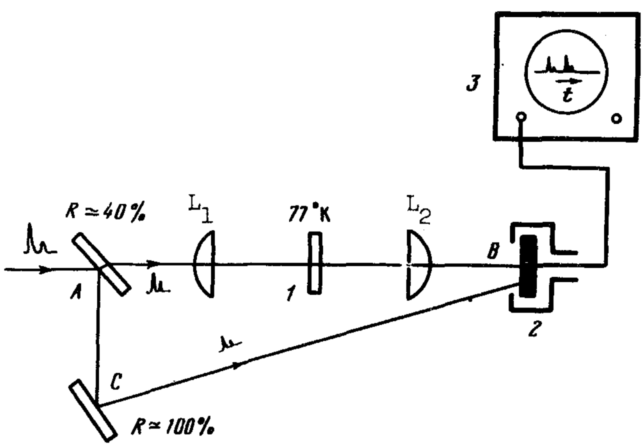

Fig. 1. Experimental setup: 1 - GaAs sample, 2 - coaxial photocell, 3 - oscilloscope, L_1 and L_2 - cylindrical lenses with focal lengths $f_1 = 16.5$ cm and $f_2 = 15.5$ cm respectively.

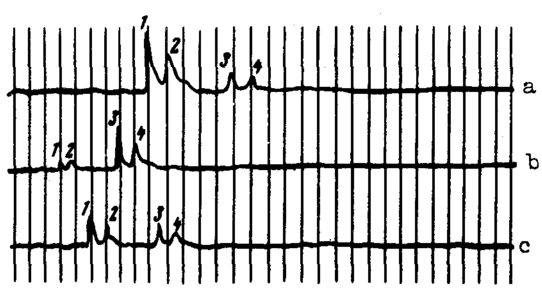

Fig. 2. Oscilloscope sweep 100 nsec. The parallel lines are drawn every three nsec with allowance for the nonlinearity of the sweep and correspond to the period of the sinusoidal signal with frequency 330 MHz, which was fed to the input of the I2-7 oscilloscope.