

at the point  $\bar{k} = 0$ .

\*\*\*\* The changes in the narrow-line spectra of the ZnS crystals with stacking faults were noted in [5].

\*\*\*\*\* The possibility of introducing an average potential in the analysis of the band scheme of ZnS crystals with stacking faults was first pointed out by Birman [6].

\*\*\*\*\* The Bohr radius of the exciton in ZnS is  $R = 30 \text{ \AA}$  [3].

\*\*\*\*\* When  $\alpha = 0.10$ , the average distance  $l = d/\alpha$  between the stacking faults ( $d = 3.1 \text{ \AA}$  - distance between two closest-packing layers) is equal to  $31 \text{ \AA}$ , i.e., it practically coincides with  $R$ .

#### MEASUREMENT OF TEMPERATURES OF SHOCK-COMPRESSED $\text{CCl}_4$ AND OF A $\text{CCl}_4\text{-C}_6\text{H}_6$ SOLUTION

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Information on the equation of state of substances (particularly organic ones) at high pressures can be obtained by studying states attained under shock compression. The shock adiabats of certain organic liquids were determined in [1,2] and in a number of other papers; on the basis of a statistical reduction of these data, the following general formula was proposed for organic substances [3]:

$$D = 1.2C_0 + 1.7U,$$

where  $D$  is the shock-wave propagation speed,  $U$  the speed of the substance behind the wave front, and  $C_0$  the speed of sound in the substance in the initial state. Calculation using this formula makes it possible to predict the dynamic compressibilities with an accuracy sufficient for the solution of most gasdynamic problems. At the same time, there are practically no published data on the shock-compression temperatures of organic liquids.

We report here the results of measurements of the brightness temperature of shock-compressed carbon tetrachloride ( $\text{CCl}_4$ ) and a 63/37 carbon tetrachloride and benzene ( $\text{C}_6\text{H}_6$ )

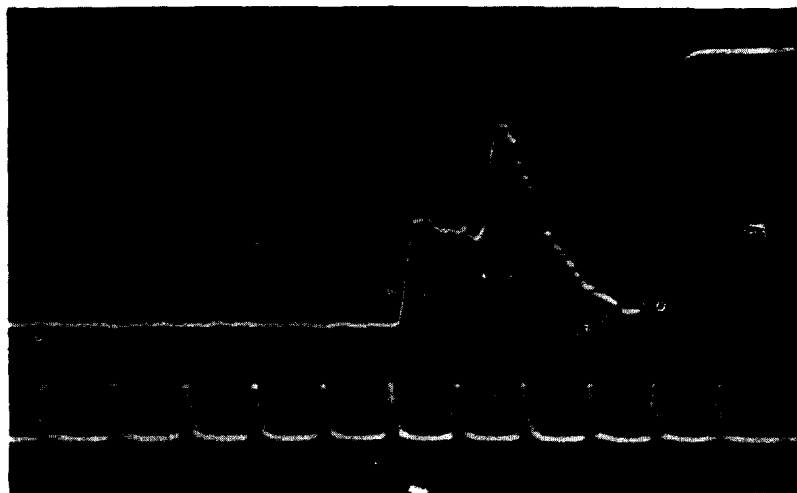


Fig. 1. Shock-front brightness oscillogram

solution. The radiation of the shock front was recorded through a layer of still-uncompressed substance with the aid of a setup similar to that used earlier in a study of the detonation of liquid explosives [4]. The light-sensitive element was an FEU-28 photomultiplier, the current of which was recorded with an OK-17M pulse oscilloscope. The brightness was determined experimentally in the pass band of the KS-19 light filter (700 - 800 nm). The dimensions and construction of the charges whose detonation produced the shock wave in the investigated liquids ensured a pressure drop behind the front of not more than 5% during the first microsecond. The pressure was determined accurate to 5 kbar, and the scatter of the pressures in identical experiments did not exceed 1%. The glow was recorded with a time resolution of approximately 0.1 - 0.2  $\mu$ sec.

A typical oscillogram of the brightness of the shock front passing through the sample is shown in Fig. 1. The brightness saturation (formation of an equilibrium-emitting layer) occurred within 0.2  $\mu$ sec, followed by a slow decrease. The measurements were made at the maximum glow. The obtained temperatures (designated by circles in Fig. 2) are the results of averaging of 3 - 5 experiments, the deviation in individual experiments not exceeding 100°K.

The obtained brightness temperatures of the shock fronts were identified, taking into account the small width of the shock transition in liquids, with the temperatures of the matter directly behind the shock front. The conversion from brightness temperatures to true temperatures was by means of the formula

$$T_{tr}^{-1} - T_{br}^{-1} = \frac{\lambda}{c_2} \ln \epsilon_\lambda,$$

where  $c_2 = 1.438^\circ\text{K}\cdot\text{cm}$  and  $\lambda$  is the radiation wavelength (750 nm). The emissivity  $\epsilon_\lambda$  of the equilibrium-emitting body is connected with the transmission and reflection coefficients  $\tau_\lambda$  and  $r_\lambda$  by the relation  $\epsilon_\lambda = 1 - \tau_\lambda - r_\lambda$ . The reflection coefficient of the shock front in  $\text{CCl}_4$  at pressures 100 - 200 kbar is less than 0.1 [5], and the transparency of the investigated liquids behind the shock front is small at  $T > 1500^\circ\text{K}$ . This is evidenced by the rapid saturation of the shock-wave brightness on entering the liquid, and also by the sharp in-

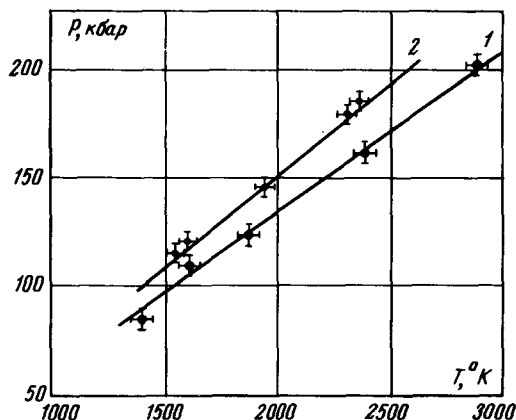


Fig. 2. Connection between temperature and pressure under shock compression of  $\text{CCl}_4$  (curve 1) and of  $\text{CCl}_4\text{-C}_6\text{H}_6$  solution (curve 2).

crease of the brightness when the second shock wave catches up with the first (second peak on the oscillogram in Fig. 1). If the substance behind the shock wave were transparent, then the brightness would increase smoothly when the shock fronts came together. When  $\epsilon_\lambda = 0.8$ , the difference between the brightness and the true temperatures is smaller than the possible measurement error. The difference between  $T_{br}$  and  $T_{tr}$  was therefore neglected in the comparison of the experimental shock-compression temperatures with the calculated ones.

To describe the state of the organic liquid we used the molecular-crystal model under the assumption that the characteristic frequencies (temperatures) of the intramolecular interaction remain constant during the compression. The expressions for the pressure and for the internal energy were written in the form

$$P = P_x(V) + \frac{3R\Gamma}{MV}T; \quad E = \int_V P_x dV + \int_T C_V dT,$$

where  $\Gamma = -\partial \ln \theta / \partial \ln V$  is the Gruneisen coefficient, equal in the initial state of the substance to  $\Gamma_0 = \beta_0 C_0^2 M / 3R$ ,  $\beta$  is the coefficient of thermal expansion,  $M$  the molecular weight, and  $R$  the gas constant. The temperature of the substance behind the shock front was determined by solving simultaneously the isotherm equation and the energy-conservation law:

$$P_{T_0} = P - \frac{3R\Gamma}{MV}(T - T_0); \quad 0.5 P(V_0 - V) - \int_{V_0}^V P_{T_0} dV = \int_{T_0}^T C_V dT.$$

The solution should satisfy the thermodynamic relation

$$\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1.$$

The shock adiabat of the substance was assumed known.

The temperature-pressure relation of the shock-compressed substance calculated in this manner (the solid lines in Fig. 2) were compared with the experimental values. The good agreement between these quantities is, in our opinion, a confirmation of the assumption that the characteristic temperatures of the intramolecular interaction remain unchanged when organic liquids are compressed by a factor less than 1.5 - 1.7.

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