Since the ionization potential of rubidium is small, we assume that it is fully ionized in the discharge, i.e., $n_e \approx N_a^+$. The cross section Q_1 is of the order of 10^{-18} cm^2 [3]. The concentration of the metastable helium atoms is assumed to be of the order of 10^{13} cm^{-3} [2]. It is easily seen that the assumptions made concerning N_b and N_a^+ only underestimate Q_2. Then, assuming $v_T = 10^5$ cm/sec and $v_e = 10^8$ cm/sec we obtain a lower bound for the effective cross section of the process (III): $Q_2 \geq 2 \times 10^{-15}$ cm^2.

For other 5p levels of Rb, the cross sections are several times smaller.

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GASDYNAMIC METHODS OF LOW-TEMPERATURE COMPRESSION OF SOLID HYDROGEN

L.V. Al'tshuler, E.A. Dynin, and V.A. Svidinskii
Institute of Optical and Physical Measurements
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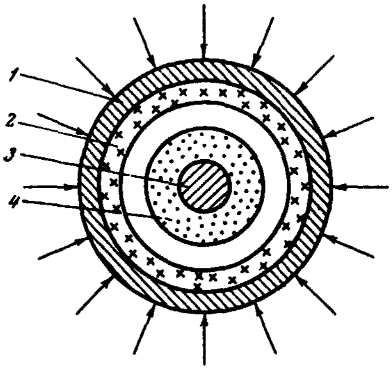
Progress in high-pressure physics following the development of dynamic methods, was accompanied by advances in high temperatures, which are particularly appreciable in shock compression of porous bodies. The P-T diagram regions in the immediate vicinity of the pressure axis remained inaccessible to dynamic methods. Yet their experimental study is of great importance for the solution of many problems in solid-state physics, and particularly for the problem of metallization of molecular hydrogen [3 - 6] and of other dielectrics. In spite of the unique information obtained in [7] on the compressibility of hydrogen from the gas state, the determination of the metallization pressures and the compression curve of its molecular phase remains a pressing problem.

As is well known, application of shock pressures increases the temperature and the entropy of a medium. However, under special conditions of explosive loading, when no strong ruptures are produced, the dynamic methods can be effectively used for strong low-temperature compression and for the determination of the compressibility of the medium, its conductivity, and the phase transitions into the metallic state under these conditions. According to [8, 2], at a certain specified regime of accelerated displacement of a surface in the loaded medium, a centered compression wave is produced. Its pole is located at a depth $x_0 = 2c_0^2/[(k + 1)g_0]$ (c_0 is the initial speed of sound in a medium with a polytropic equation of state, k is the polytropic index, and g_0 is the initial acceleration of the surface) on a tangential discontinuity separating the regions of the low-temperature isentropic compression and the high-temperature shock compression.

A region of complete isentropy, without formation of a pole, occurs also under other regimes of non-instantaneous loading. In particular, it is produced upon explosion of a charge separated by an empty gap from the surface of the sample (this effect was used in [9, 10] to decrease the heating of strikers in dynamic measurements and to produce a shock wave of square profile) and in bilateral compression of thin layers by the expanding explosion products. Modern explosives can produce by this method isentropic pressures close to 600 kbar. Further increase of the isentropic pressure calls for the use of cylindrical systems (see the figure). Their main elements are a metal shell (1) accelerated by the explosion products towards the cylinder axis, a light layer (2) that goes over into the gaseous state behind the shock-wave front, and a central copper rod (3) serving as a cold finger and cooling the concentric layer of solid hydrogen (or other substances surrounding the rod) to helium temperatures. During the first stage of the process, the isentropic compression is realized by gas streams flowing towards the center. During the succeeding stages the pressure increases as a result of convergence of the cylindrical shell.



When the shock wave propagates through a pad of the investigated substance, in a medium having a larger dynamic rigidity (larger value of $\rho_0 c_0$), the medium becomes quasi-isentropically compressed. The final pressures are reached in the pad as a result of multiple circulation of the shock waves. If the ratio of the dynamic rigidities is equal to m, then the growth of the entropy in such a system is smaller than the value estimated for shock compression to the same pressures by a factor not less than $4/(3m^2 + 1)$. A similar situation arises when a light layer is compressed by heavy plates moving towards each other. We have solved numerically the problem of compression of a layer of solid hydrogen by two copper plates moving at a velocity 2 km/sec. In such a system, at a final pressure 1180 kbar, the amplitude of the first shock wave in hydrogen is 8 kbar, that of the second is 32 kbar, and those of the third and fourth 64 and 125 kbar, respectively. Further increase of the pressures to the maximum is realized by waves of rapidly decreasing amplitude. The fraction of the thermal pressure in the final stage of compression does not exceed 4%. An even closer approach to the isentropic process is provided by a system of several pads, which increase gradually the amplitudes of the circulating shock waves.

Compared with magnetic compression [11], which is based on the idea of magnetic cumulation [12], the methods proposed here are simpler to realize and, in view of the absence of strong electromagnetic fields, are more convenient for electric registration of the conductivity. The latter circumstance is particularly important when the hydrogen metallization pressure is to be determined.

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