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THE EFFECT OF PRESSING CONDITIONS ON THE STRENGTH OF LITHIUM HYDRIDE UPON COMPRESSION

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Lithium hydride is one of the most important materials in atomic engineering. The members from this material are usually fabricated using the pressing method. In this connection, the question concerning the effect of pressing conditions on the mechanical properties of the substance obtained is of practical and scientific interest. In the present paper, we study the effect of some factors such as the pressure and temperature of pressing and the size of the samples obtained on the strength of lithium hydride upon compression.

In the initial state, the material was a Li^6H powder with grain sizes ranging from 0.2 – 5 mm. The possible content of lithium hydroxide in the powder was within 3%. The samples were pressed in steel press molds with internal diameters of 10–20 mm for the same pressure P values. The process was performed at a temperature of 150°C at a minimum pressure. The samples were tested for compression on an Instron 1185 device with a loading rate of 2 mm/min. The sample characteristics (diameter d, height h, and density ρ) and the values of the fracture stress σ are given in Table 1. In each case, three identical samples were fabricated and tested. The values obtained were averaged over three measurements. The r.m.s. deviations were also given for the fracture stress.

The results obtained point to a fairly insignificant spread in the pressed-material strength in small series of tests (each from three trials). The results for the samples obtained by cold pressing can be presented graphically in the coordinates ρ–σ and d–σ. Based on this graphic form, one can draw some preliminary conclusions. The natural and expected result is a considerable effect of either the pressing pressure or the pressed-material density, which is due to the action of this pressure, on the strength of lithium hydride samples. The less expected result turned out to be the fact that the characteristic size (diameter) of the samples has a great effect on their strengths, which affects identically three values of the pressing pressure. The scale effect is clearly expressed and is opposite, in its character, to the classical scale effect of statistical nature. This effect is likely to be due to the fact that the characteristic size of the structural nonuniformity of the pressed material is approximately 2 mm (as the average size of the material grains), i.e., it is different from the characteristic size of the samples (10–16 mm) by less than an order of magnitude. For the samples obtained by pressing at a higher temperature and having a density close to the limiting one, the scale effect of this kind was not observed, which, possibly, shows the large structural nonuniformity of the thus fabricated samples.

It is expedient to attempt to clarify some general trends associated with the strength properties of materials obtained by pressing the powders of ion crystals. The results obtained for lithium hydride could be compared in this case with those for sodium chloride, which were given in [1] where sample pressing was performed in a press mold with an inner diameter of 15.0 mm and the granulometric composition of the sodium chloride powder (grinding No. 1) was close to the granulometric composition of the lithium hydride powder used in the present study. Note that both substances have the same crystal structure.

Figure 1 shows the results concerning the effect of the density of 15-mm-diameter samples (1 refer to lithium hydride and 2 refer to sodium chloride) on strength during compression in relative coordinates. The limiting densities ρ_0 of these materials in our experiments were equal to 0.701 and 2.164 g/cm^3, respectively, and the corresponding limiting fracture stresses σ_0 were 127.0 and 64.3 MPa. In the range of governing parameters considered, the experimental results for each material can be described by the linear dependence

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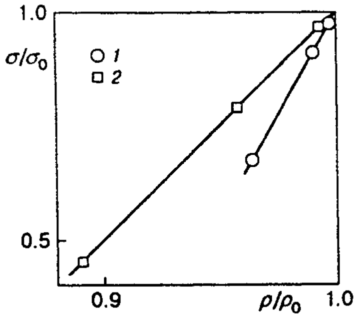

Fig. 1

TABLE 1

P, MPa	σ, MPa	d, mm	h, mm	ρ, g/cm^3
300	72.4 ± 1.4	10.04	11.64	0.667
	84.9 ± 5.0	15.08	15.62	0.676
500	99.3 ± 4.9	10.05	11.32	0.696
	115.4 ± 2.6	15.09	14.92	0.693
800	110.5 ± 7.3	10.04	13.36	0.699
	123.6 ± 3.5	15.09	14.98	0.699
	127.4 ± 2.4	16.17	16.50	0.698
300 (for 150°C)	122.4 ± 2.1	10.02	10.99	0.698
	126.7 ± 2.5	15.03	15.13	0.701
	119.9 ± 2.0	19.98	22.18	0.700

$\sigma/\sigma_0 - 1 = k(\rho/\rho_0 - 1)$. Moreover, the physically clear tendency toward an increase in the coefficient k as the limiting strength of the material σ_0 increases, which can be represented in a first approximation as the trivial relation $k = 0.075\ \sigma_0$, is evident.

Thus, based on this comparison, one can assume that the tendency toward the density effect on the strength $(0.4\text{–}1.0)\sigma_0$, which was revealed for the class of materials considered, is of a rather general character and, hence, can be used for prediction of the properties of brittle porous powder materials.

REFERENCES

1. V. K. Golubev, K. G. Rabinovich, G. V. Asabova, and T. V. Kazakovskaya, "The effect of the initial state of a powder and the pressing pressure on powder compressibility and the strength of the sodium chloride samples obtained," in: *Progress in Atomic Engineering, Ser. Production Engineering and Advanced Technology in Instrument Making*, No. 5 (1991), pp. 9–12.