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MAGNESIUM BORIDES PREPARED UNDER SUPERHIGH-PRESSURE CONDITIONS

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During the synthesis of cubic boron nitride under superhigh-pressure (40–70 kbar) conditions and at high temperatures (1500-2200°K) from the system components Mg–B–N, magnesium borides are obtained as by-products [1], and these were used as the objects for our investigations.

According to the chemical analyses done by M. V. Kharitonova, these borides have the compositions corresponding to the formulas for magnesium diboride and hexaboride (Table 3). Magnesium borides are generally synthesized from a mixture of metallic magnesium and boron at atmospheric pressure in a hydrogen medium; the products obtained by this method are in the form of dark-brown dispersed powders, the particle size of which does not exceed 0.005 mm [2].

The magnesium borides obtained by us under superhigh-pressure conditions are usually well crystallized. Magnesium diboride is in the form of reddish-yellow platelets, the size of which, depending on the experiment, varies between 0.1 and 1.4 mm. Magnesium hexaboride crystallizes in the form of light-green isometric grains, whose size ranges from 0.02–0.04 to 0.1 mm.

The magnesium diboride and hexaboride which were separated from the products of the synthesis were subjected to x-ray diffraction and microscopic analyses, and their chemical stability and microhardness were determined.

The results of the x-ray diffraction analysis of magnesium diboride by the Debye method are shown in Table 1.

The calculation of identity periods from the 210 and 211 lines showed that a = 3.083 Å and c = 3.523 Å; according to data of [2], a = 3.083 Å and c = 3.521 Å. Thus, within the accuracy of the measurements, our data for d, a, and c are in good agreement with those of [2]. Consequently, the structure of magnesium diboride prepared by the superhigh-pressure technique does not differ from that of magnesium diboride synthesized under normal conditions.

TABLE 1. X-Ray Diffraction Characteristics of Magnesium Diboride, Obtained from a Debye Pattern Using Co Kα Radiation

Line No.	hkl	Our data		Data of [2], Fe Kα	
		I	d, Å*	I	d, Å*
1	001	–	–	< 5	3.54
2	100	m.s	2.671	25	2.673
3	101	v.v.s	2.123	100	2.126
4	002	m	1.763	10	1.760
5	110	s	1.542	30	1.542
6	102	m.w	1.466	10	1.469
7	111	w	1.414	5	1.412
8	200	w	1.335	5	1.337
9	201	s	1.251	20	1.2488
10	112	s	1.158	25	1.1596
11	103	m.s	1.073	15	1.0738
12	202	v.w	1.062	5	1.0638
13	210	m.w	1.009	10	1.0099
14	211	v.s	0.970		

*Calculated by us from kX in Å by multiplying by 1.00202.
Notation: v.v.s., very very strong; v.s., very strong; s., strong; m.s., medium strong; m., medium, m.w., medium weak; w., weak; v.w., very weak.

Results of the x-ray diffraction study of magnesium hexaboride (Table 2) showed that most of the d values are close to the corresponding values for magnesium boride (phase A) synthesized under atmospheric pressure [2]. It must be mentioned that several lines which were given for phase A [2] were not present on our Debye patterns, namely: