

substance: boron compounds with group VI elements

property: properties of boron-tungsten compounds and boron uranium carbon compounds

Phase diagram of the ternary system U – B – C at 1600 °C in Fig. 1 [89R].

Thermodynamic properties of tungsten borides in a wide temperature range [90A] and [90B].

The low-temperature heat capacities of tungsten borides [88B].

W₂B

Metallic?; preparation [75S], crystalline structure [75S, 77L], electronic structure [79P]

Structure: tetragonal

Space group: I4/mcm

lattice parameters

<i>a</i>	0.55684(4) nm	<i>T</i> = 300 K	X-ray diffraction	95O1
<i>c</i>	0.47445(4) nm			

density

<i>d</i>	17.05(3) g cm ⁻³			95O1
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resistivity

<i>ρ</i>	22.0 μΩ cm	<i>T</i> = 300 K		95O1
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critical temperature of superconductivity

<i>T_c</i>	3.18 K			91F
				69E

High temperature thermodynamic properties in [86B].

microhardness

<i>H_V</i>	21.3(4) GPa	<i>T</i> = 300K	indentation plane (0001), B/W = 2.5	95O1
	26.1 GPa			80S

α-WB

Metallic?; preparation [75S, 77G], crystalline structure [75S, 77L, 77P], electronic structure [79P]

High temperature thermodynamic properties in [86B].

β-WB

Metallic?; preparation [75S, 77G], crystalline structure [75S, 77L, 77P], electronic structure [79P]

δ -WB

Preparation in [95O1].

Structure: hexagonal

Space group: $P6_3/mmc$

lattice parameters

(in nm)

a	0.3116(1)...0.3128(1)	$T = 300\text{ K}$	Al solution	95O1
c	1.6930(1)...1.6897(1)		for B/W ratio 0.8...1.5	
a	0.3101(1)...0.3128(1)		Cu solution	
c	1.6955(3)...1.6903(1)			

resistivity

ρ	171.6 $\mu\Omega\text{ cm}$	$T = 300\text{ K}$	Al solution	95O1
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microhardness

(in GPa)

H_V	26.7(12)	$T = 300\text{ K}$	B/W = 0.8	95O1
	25.3(4)		B/W = 1.15	
	36.3			80S

α -W₂B₅

Metallic; preparation [75S, 77G], crystalline structure [75S, 77L, 76S, 76P, 77P], electronic transport [79K]

Prepared as reaction product of boron carbide and WC [91Z].

High temperature thermodynamic properties in [86B].

Growth and crystal data for preparation by high temperature solution growth [84L] and references therein.

β -W₂B₅

Metallic; preparation [75S, 77G], crystalline structure [75S, 77L, 76S, 76P, 77P], electronic transport [75S]

WB₂

Preparation [68L], crystalline structure [68L, 76C]

Structure: hexagonal

Space group: $P6_3/mmc$

Preparation of single crystals by the floating zone method in [95O2].

Synthesis by solid state reaction [87I].

Preparation by hot-pressing [87M].

lattice parameters

a	0.2984(1) nm	$T = 300\text{ K}$	X-ray diffraction	95O1
c	1.3882(2) nm			

Hexagonal lattice constants for various compositions in [95O3].

density

d 13.05(4) g cm⁻³ 95O1

resistivity

ρ 312.6 $\mu\Omega$ cm $T = 300$ K Al solution 95O1

WB₄

Metallic; preparation [75S], crystalline structure [75S, 77L], electronic transport [79K]

WB₁₂

Semicond.; preparation [79A], solid state properties [79A]

U-B-C compounds

Variation of the unit cell dimensions of UB_{1-x}C_{1+x} in Fig. 2 [89R].

References:

- 68L Lundström, T.: Ark. Kemi 30 (1968) 115.
- 69E Engelhardt, J.J.: Phys. Rev. 179 (1969) 452.
- 75S Samsonov, G. V., Serebryakova, T. I., Neronov, V. A.: Boridy, Moskva Atomizdat, 1975.
- 76C Champagne, B., Beauvy, M., Angers, R.: Metallography 9 (1976) 357.
- 76P Pauling, L.: Acta Crystallogr. B. 32 (1976) 3359.
- 76S Sinel'nikova, V. S., Gurin, V. N., Pilyankevich, A. N., Strachinskaya, L. V., Korsukova, M. M.: J. LessCommon Met. 47 (1976) 265.
- 77B Berezin, A. A., Golikova, O. A., Zaitsev, V. R., Kazanin, M. M., Orlov, V. M., Tkalenko, E. N., in: Boron and Refractory Borides, (Matkovich V. I., ed.) Springer: Berlin, Heidelberg, New York 1977, p. 52.
- 77G Gurin, V. N., Sinel'nikova, V. S.: see [77B], p. 377.
- 77L Lundström, T.: see [77B], p. 351.
- 77P Pastor, H.: see [77B], p. 457.
- 79A Avlokhavili, J. A., Tavadze, F. N., Tavadze, G. F., Tsikaridze, D. N., Gabunia, D. L., Tsomaya, K. P.: J. Less Common Met. 67 (1979) 367.
- 79K Kovalchenko, M. S., Bodrova, L. G., Nemehenko, V. F., Kolotun, V. F.: J. Less-Common Met. 67 (1979) 357.
- 79P Povzner, A. A., Zilichiklis, A. L., Abel'skii, Sh. Sh., Borukhovich, A. S., Gel'd, P. V., Knyshev, E. A.: J. Less-Common Met. 67 (1979) 211.
- 80S Samsonov, G.V., Vinitskii, I.M.: in: Handbook of Refractory Compounds, IFI/Plenum: New York, 1980, p. 143.
- 81A Armstrong, D. R.: Proc. 7th Int. Symp. Boron, Borides and Related Compounds. Uppsala, Sweden, 1981; spec. issue of J. Less-Common Met. 82 (1981) 357.
- 81W Werheit, H., de Groot, K., Malkemper, W.: see [81A1], p. 153.
- 84L Lundström, T.: J. Less-Common Met. 100 (1984) 215.
- 86B Bolgar, A.S., Lyashchenko, A.B., Klochkov, L.A., Blinder, A.V., Muratov, V.B., Serbova, M.I., Fesenko, V.V.: J. Less-Common Met. 117 (1986) 303. (Proc. 8th Int. Symp. Boron, Borides, Carbides, Nitrides and Rel. Compounds, Tbilisi, Oct. 8 - 12, 1984).
- 87I Itoh, H., Naka, S., Matsudaira, T., Hamamoto, H., Obayashi, M.: in: Proc. 9th Int. Symp. Boron, Borides and Rel. Compounds, University of Duisburg, Germany, Sept. 21 - 25, 1987, H. Werheit ed., University of Duisburg: Duisburg, Germany, 1987, p. 436.
- 87M Matsudaira, T., Hamamoto, H., Obayashi, M., Itoh, H., Naka, S.: in: Proc. 9th Int. Symp. Boron, Borides and Rel. Compounds, University of Duisburg, Germany, Sept. 21 - 25, 1987, H. Werheit ed., University of Duisburg: Duisburg, 1987, p. 438.
- 88B Bolgar, A.S., Blinder, A.V., Novoseletskaya, L.M., Klochkov, L.A., Lyashchenko, A.B.: Russ. J. Phys. Chem. 62 (1988) 239.
- 89R Rogl, P., Bauer, J., Debuigne, J.: J. Nucl. Mater. 165 (1989) 74.
- 90A Ahmed, M.: in: Solid State Physics-1. Proc. 1st Int. Symp. Solid State Phys. Kandy, Sri Lanka, 20-25 April 1987, Dissanayake, M.A.K.L., Attele, R.; Tennakone, K.. ed., Nova Science Publ.: Commack, NY, USA, 1990, p. 253.
- 90B Blinder, A.V., Bolgar, A.S.: High Temp. 28 (1990) 377.
- 91F Fisk, Z.: in: Boron-Rich Solids, Proc. 10th Int. Symp. Boron, Borides and Rel. Compounds, Albuquerque, NM 1990 (AIP Conf. Proc. 231), D. Emin, T.L. Aselage, A.C. Switendick, B. Morosin, C.L. Beckel ed., American Institute of Physics: New York, 1991, p. 155.
- 91Z Zakhariev, Z., Radev, D.: in: Boron-Rich Solids, Proc. 10th Int. Symp. Boron, Borides and Rel. Compounds, Albuquerque, NM 1990 (AIP Conf. Proc. 231), D. Emin, T.L. Aselage, A.C. Switendick, B. Morosin, C.L. Beckel ed., American Institute of Physics: New York, 1991, p. 464.
- 95O1 Okada, S., Kudou, K., Lundström, T.: Jpn. J. Appl. Phys. 34 (1995) 226.
- 95O2 Otani, S., Ishizawa, Y.: J. Cryst. Growth 154 (1995) 81.
- 95O3 Otani, S., Ohashi, H., Ishizawa, Y.: J. Alloys Compounds 221 (1995) L8.

U – B – C system. Isothermal section of the ternary system U – B – C at 1600 °C [89R].

U-B-C

1 UBC
2 UB_2C
T $U_5B_2C_7$

Uranium [at%]

liquid

I + UB_2 + UC

UBC + T + UC

UC

UC + T + U_2C_3

U_2C_3

U_2C_3 + T + α - UC_2

α - UC_2

UBC + α - UC_2 + T

UBC + α - UC_2 + C

UB_2C + UBC + C

UB_4 + UB_2 + C

" B_4C " + UB_4 + C

UB_2 + UBC + UC

UB_2 + UB_4 + UBC

UB_4 + UB_{12} + " B_4C "

UB_{12}

" B_4C "

UB_{12} + β -B + B_4C

B

C

Boron [at%]

Fig. 2.

$UB_{1-x}C_{1+x}$. Variation of the unit cell dimensions at 1600 °C. Samples prepared on a water-cooled copper boat in a Ti/Zr-gettered Ar atmosphere using a 25 kW-500 mHz high frequency furnace vs. B/C substitution [89R].

