Tungsten Diboride: Preparation and Structure

Abstract. *A new tungsten boride has been prepared and has been assigned the formula WB_2. The assignment is based on comparison of the x-ray diffraction data of this boride with those of diborides of the AlB_2 type structure. Values of $a_0 = 3.02$ and $c_0 = 3.05$ were calculated for a hexagonal unit cell.*

Although many attempts have been made to prepare a tungsten boride of the AlB_2 type structure, no WB_2 phase has been reported, according to a review of refractory binary borides by Post (*1*). We have prepared WB_2 (AlB_2 type structure) by heating an amorphous boron wire in an atmosphere of WCl_6 and argon. In a typical preparation, a boron substrate 100 μ in diameter was heated resistively, in an argon stream containing about 0.03 percent WCl_6 by volume, to 800°C and kept there for 30 minutes. The total pressure in the reaction chamber was 10 torr. As shown in Fig. 1, the material formed as a layer on the surface of the boron substrate. The dark objects that appear beneath the boride layer in the photomicrograph are voids in the boron, resulting from cleavage of the filament. Emission spectrographic analysis of the sample showed that only tungsten and boron were present in concentrations above 50 parts per million.

Debye-Scherrer x-ray diffraction photographs of the fiber were taken with a 114.7-mm-diameter camera and Ni-filtered Cu radiation. The diffuse halos from the amorphous boron substrate were observed on the diffraction film but did not interfere with the x-ray analysis. Observed and calculated values of *d*-spacings, relative intensities, and Miller indices are given in Table 1. All lines of the x-ray photographs were indexed on the basis of a hexagonal unit cell with $a_0 = 3.02 \pm 0.002$ and $c_0 = 3.05 \pm 0.002$. There is one molecule per unit cell, and the calculated density is 14.15 g/cm^3. Corrections were not made for film shrinkage.

Table 1. X-ray data for WB_2.

Lattice plane spacing (Å)		Relative intensity*	Miller indices
Observed	Calculated	(I)	(hk · l)
3.05	3.05	M	001
2.62	2.62	VS	100
1.99	1.99	VS	101
1.526	1.525	W	002
1.510	1.515	M+	110
1.354	1.354	M	111
1.320	1.318	M-	102
1.308	1.308	M-	200
1.202	1.202	M-	201
1.073	1.073	W+	112
1.016	1.017	VVW	003
0.9885	0.9889	M-	210
.9474	.9476	VVW	103
.9400	.9407	M	211
.8713	.8721	VVW	300
.8432	.8434	VVW	113
.8384	.8385	VW	301
.8296	.8297	VW	212
.8029	.8027	VW	203

* Intensities: M, medium; VS, very strong; W, weak.

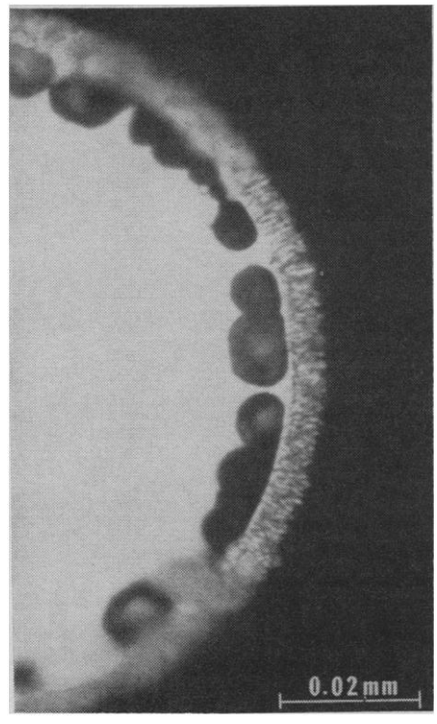

Fig. 1. Cleaved boron fiber showing layer of tungsten diboride.

Comparison of the x-ray data with those of other diborides (particularly MoB_2 and MnB_2, which have similar c/a ratios) suggests that this new boride is isomorphous with diborides of the AlB_2 type structure. Hence it is assumed that the material belongs to the space group C6/mmm and has the stoichiometric formula WB_2.

H. P. Woods
F. E. Wawner, Jr.
Barbara G. Fox
Texaco Experiment Incorporated, Richmond, Virginia

References and Notes

1. B. Post, in *Boron, Metallo-Boron Compounds and Boranes*, R. M. Adams, Ed. (Interscience, New York, 1964), p. 342.
2. We thank L. R. Taylor, Jr., for assistance and Gordon H. Miller for discussion. Work supported by NASA contract NAS 3-4196.

23 August 1965

Wormlike Fossil from the Pennsylvanian of Illinois

Abstract. Tullimonstrum gregarium *was a common, possibly marine, invertebrate in certain shallow, offshore waters of northern Illinois during the Middle Pennsylvanian. It had a flexible proboscis armed with teeth; a mobile tail; and a curious transverse bar behind the head, bearing a pair of round, external organs.*

In the past few years, fossil collecting from the Middle Pennsylvanian Francis Creek shale in the old strip-mine dumps of Will and Grundy counties in Illinois (*1*) has become less productive as the spoil heaps have become overgrown and as large areas have been set aside as private recreation land. A large and almost wholly undescribed fauna in the same beds, in the old McAlester pit 2 miles south of Braidwood and in the adjacent (and still active) Pit 11 of the Peabody Coal Company, astride the Will-Kankakee county line, was called to my attention about 1958 by Francis J. Tully, of Lockport, Illinois. One of the most abundant members of this fauna is the large, soft-bodied invertebrate described below. Since then, as the fervent amateur collectors of the Chicago area learned of the new locality, this fossil has come to be well represented in many private collections and is universally called the "Tully monster." In basing its proposed Linnean name on this designation, I honor Tully for his discovery, acknowledge his having disclosed it, and formalize a widely used common name.

Both the Tully monster and the fauna of which it is such an outstanding ornament are being studied (*2*), but it seems proper and necessary to present this brief description and preliminary discussion to establish a name for the animal and to call it to the attention of zoologists and others.

The Pit 11 fauna includes several other soft-bodied animals of uncertain systematic position, a variety of polychaete annelids, mollusks both naked and shelled, several eumalacostracan crustaceans, insects, primitive arthropods, a phyllocarid, a branchiopod, a xiphosuran, a holothurian, fishes, and amphibians. In contrast to the biota of the older collecting area, the fossils of Pit 11 and vicinity are predominantly animal; the plant remains found here are more fragmentary, but represent the same well-known flora. The Pit 11 fauna probably lived farther offshore