Crystallography

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Photo of polycrystals of cubic boron nitride

Figure 1: Photo of polycrystals of cubic boron nitride

Abstract

Full Text

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Synthesis of Polycrystalline Formations of Cubic Boron Nitride

Cubic boron nitride (CBN) was first synthesized in 1957 (^1). This fact confirmed the hypothesis that there exists in boron nitride a hexagonal (graphite-like) modification analogous to diamond, obtained at high pressures and temperatures. After the successful synthesis of CBN, its unique properties were discovered: hardness close to that of diamond; thermal stability higher than that of diamond; chemical inertness, in particular, toward iron.

The latter circumstance (chemical inertness toward iron) immediately attracted the attention of specialists in metalworking. This is explained by the fact that diamond, because of the reaction of carbon with iron, cannot be used for the efficient machining of steels, and the bulk of the products of the machine-building industry lies outside the sphere of machining with hard materials of the diamond type. However, from 1957 to the present, CBN crystals no larger than 1 mm have been synthesized, which permits this unique material to be used only in abrasive tools.

In connection with the production of polycrystalline diamond formations of the "ballas" and "carbonado" types (^2, ^3), the authors considered it possible to carry out the synthesis of large-size polycrystalline CBN formations. The main difficulty lay in obtaining a strong CBN formation. It was necessary to create physicochemical conditions for growing a polycrystal that would ensure firm coalescence and mutual intergrowth of crystallites.

Fig. 3. Photograph of polycrystals of cubic boron nitride

As a result of the investigations carried out, such conditions were found, and strong polycrystalline CBN formations were synthesized. Figure 1 shows the microstructure of the grown polycrystal, where the dominant phase is represented by small CBN grains that have coalesced and mutually intergrown to form a strong aggregate (white field); impurities (dark areas) are distributed uniformly. The Laue photograph (Fig. 2) of the CBN polycrystal indicates its finely crystalline structure (Figs. 1 and 2, see insert to p. 335).

In the reaction chambers used by us, polycrystals 7 mm in size were grown (Fig. 3); polycrystals of a specified shape were also synthesized, for example, in the shape of a single-crystal tool. This undoubtedly has great practical significance. As preliminary tests have shown, the unique mechanical properties of monocrystalline

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Fig. 1

Fig. 2

Fig. 1. Microstructure of a polycrystal of cubic boron nitride, 450×. White areas—cubic boron nitride; black areas—impurities

Fig. 2. X-ray diffraction pattern of a polycrystal of cubic boron nitride

crystals of CBN are largely preserved in the synthesized polycrystalline formations as well, and in some cases the properties of the polycrystals prove to be higher.

Thus, a polycrystalline material has been created that possesses unprecedented mechanical properties, in particular making it possible, when used as cutting tools, to perform efficient cutting of hard-hardened steels.

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REFERENCES

1. R. N. Wentorf, *J. Chem. Phys.*, **26**, 956 (1957).
2. L. F. Vereshchagin, Ya. A. Kalashnikov et al., *DAN*, **172**, No. 1 (1967).
3. L. F. Vereshchagin, E. N. Yakovlev et al., *DAN*, **185**, No. 3 (1969).

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