TOUGH CRYSTAL OF CUBIC BORON NITRIDE

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Cubic boron nitride (cBN) is used mainly as abrasive grains and requires various properties to meet varied grinding purposes. In order to synthesize tough, sharp-edged grains, high-purity hexagonal boron nitride (hBN) should be used as the raw material, while synthesizing conditions should be strictly controlled. An electro-plated wheel made of tough sharp-edged cBN obtained through the process developed by the authors has proved to be very sharp in grinding.

1. Introduction

The demand for cBN as an indispensable industrial material is increasing year by year. This is due to the fact that steel materials are becoming harder, and better productivity and enhanced quality are demanded for grinding them.

While studies and development of bond systems for cBN wheels are in progress, diversification of the properties of abrasive grains are increasingly called for. One example is the demand for production of tough cBN crystals.

When any type of single crystal with high strength is needed, they should be almost perfect, in that they contain only negligible inclusions. Meanwhile, sharp-edged crystals are preferable as abrasive grains. Such nearly perfect, sharp-edged crystals can be produced under strictly controlled conditions.

The synthesis of cBN is to be conducted in an airtight space with high temperature and high pressure. Accordingly, it is important to use high-purity raw material (hBN) and catalysts. Oxygen and moisture will react with hBN and the catalysts to produce oxides, which deposit on the crystal surface and impair their smoothness. Therefore, the atmosphere surrounding the hBN and catalysts should be kept non-oxidative and dry. Catalysts which do not actively react with oxygen and moisture should be used.

As is generally pointed out, it is important to control the growth rate of crystals to obtain crystals with fewer defects. The difference in chemical potential in the conversion process from hBN to cBN is one factor affecting the growth rate.

The pressure and temperature should, therefore, be strictly controlled in the stable region for cBN around the thermodynamical equilibrium line.

2. Experimental procedure

Based on the concept mentioned above, we produced tough crystals of cBN. We obtained high-purity hBN by treating it at high temperature in a non-oxidative atmosphere. The raw material and catalysts were handled in a non-oxidative atmosphere and then sealed up in order to avoid contamination from the capsule during the synthesizing process at high temperature.

The pressure and temperature were fixed at specific levels in line with the findings from our experiments on hBN–cBN equilibrium conditions. Sufficient reproducibility was achieved in the process.

3. Results

Crystals obtained through the process had smooth surfaces and sharp edges since they were mainly composed of (111) faces. Many twinned crystals were also found. These crystals are shown compared with those produced without the above-mentioned care (Figs. 1 and 2).

The authors made an electro-plates wheel using the tough cBN crystals thus obtained in order to test their quality as abrasive grains. When used for

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