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Synthesis of ultrafine nano-polycrystalline cubic boron nitride by direct transformation under ultrahigh pressure

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[Abstract]

Using a turbostratic pyrolytic boron nitride as a starting material, we synthesized a variety of ultrahard polycrystalline cubic boron nitride (PcBN) as a function of the heating duration changing from 1 to 60 min under a constant temperature and pressure conditions (1950 °C and 25 GPa) using a multi-anvil apparatus. When the heating duration was less than 13 min, ultrafine nano-polycrystalline cBN (U-NPcBN) with the mean grain size of < 50 nm was produced. Among these U-NPcBNs those synthesized with 11–13 min were found to have a uniform texture composed purely of cBN (i.e. with no wurzite BN residue) and a Knoop hardness of > 53 GPa, which is 20 % higher than that of the hardest conventional binderless PcBN in practical use. Furthermore, the PcBNs synthesized with 18–20 min showed a unique nanocrystalline texture composed of relatively coarse grains dispersed in a fine grained matrix and even higher Knoop hardness (54.5–55.2 GPa).

Keywords: Nano-polycrystalline cubic boron nitride, Direct transformation, Ultrahigh pressure, Heating duration, Knoop hardness

1. Introduction

Cubic boron nitride (cBN) has much better thermal and chemical stability than diamond [1–3]. Therefore, it is widely used as the most suitable tool for machining work-materials such as ferrous metals, super heat-resistant alloys, and titanium alloys,

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