



Method for obtaining textured ceramics

IITM Technology Available for Licensing

PROBLEM STATEMENT

- In general, Ultra High Temperature Ceramics (UHTC) have very **high melting points**, the only method to fabricate components is by using powder metallurgy.
- In order to synthesize dense compact of UHTC using pressure-less sintering, **temperatures in excess of 2050°C** is required, while usage of vacuum hot pressing can reduce the temperatures down to 1900°C.
- The use of such sintering conditions often leads to **uncontrolled grain growth & deterioration of mechanical properties**.
- Hence there is a need for new processes to overcome above issues.

INTELLECTUAL PROPERTY

IITM IDF Ref. 1372; IN Patent No: 478715

TECHNOLOGY CATEGORY/ MARKET

Technology: Textured ceramics;

Industry & Application: Optoelectronics, Microelectronics applications, LED/Laser diode;

Market: The global ceramic market is projected to grow at a **CAGR of 8.49%** during **2024-2032**.

TRL (TECHNOLOGY READINESS LEVEL)

TRL-4, Proof of Concept ready, tested in lab.

TECHNOLOGY

- Present invention describes a **method** for obtaining textured **fine grain UHTC** diboride compacts from elemental powders using SPS, wherein the compacts can be obtained at a **temperature of 1200°C**. (Refer Fig. 1)
- Said elemental powders are **Zirconium (Zr) and amorphous Boron (B)**.
- Textured ceramic formed by open die forging is **ZrB₂**. Said elemental powders are Titanium (Ti) and Boron (B).

Process Flow Diagram

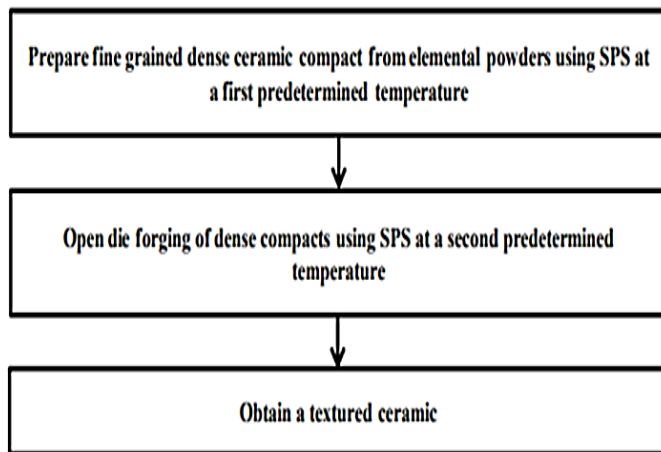


Fig.1

- Further, said method for obtaining textured ceramics, comprising a few steps described hereinbelow:

1. Preparing fine grain ceramic compact from ball milled elemental powders using Spark Plasma Sintering (SPS) at a temperature of 1200°C with a heating rate of 100°C/min;

2. Texturing texturing said ceramic compact by open die forging using SPS at a temperature of 1600°C with a heating rate of 100°C/min and an applied pressure of 40 MPa; and

3. Obtaining a textured ceramic with respect to forging direction

- Moreover, Textured ceramic formed by open die forging is TiB₂.

RESEARCH LAB

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KEY FEATURES / VALUE PROPOSITION

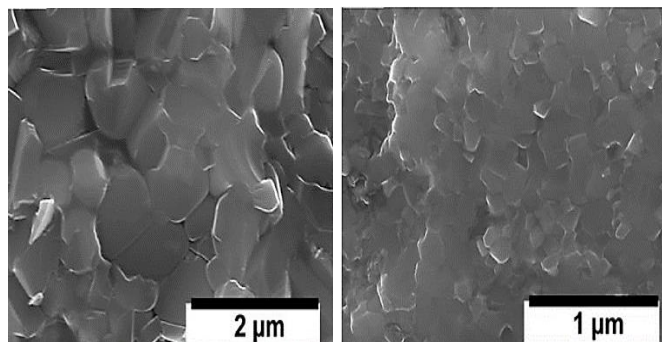
❖ Technical Perspective:

- The compact prepared by the proposed method is having a **relative density** which is **greater than 98%**, using Archimedes density measurement.
- The ceramic compacts is having an **elastic modulus** greater than **530 GPa**, **hardness** greater than **24 GPa** & moderate **fracture toughness** of **2.6 MPa.m^{1/2}** at room temperature.
- The proposed method is **simpler** & requires **lower temperature of 1600°C** & a pressure of **40 MPa** for producing textured compacts.
- The total processing time involved in the texturing process is **less than an hour**.
- Facilitates **faster fabrication of textured UHTC compacts**.
- Easily useful for producing **highly textured UHTC discs**.
- The XRD patterns confirm **strong basal texture formation** in compacts of **both TiB₂ & ZrB₂ respectively**. (Figs 2a-2b)
- Textured UHTCs can be produced **by open die** forging using SPS equipment which is possible due to the **fine grain size** of the **compact prepared** through the reactive sintering process. (Refer Figs. 4a, 4b)

❖ Industry Perspective:

- Said method is **simple, cost-effective & easily adopted** by any industry.
- Claimed method can be implemented using **commercially available spark plasma sintering equipment**.
- Said method requires **significantly lower temperature & time** to prepare dense compact.
- Provides **high energy efficiency**.
- Applicable in the area of **optoelectronic & microelectronic applications** such as **LED/Laser diode**.

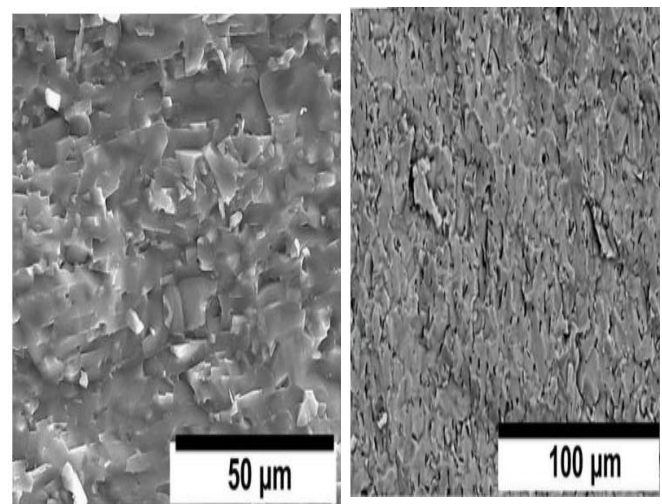
Images



Figs. 2a(Left) & 2b (Right) illustrate the images obtained using SEM from fracture surfaces of sintered TiB₂ & ZrB₂ respectively.



FIG. 3 illustrates the compacts of TiB₂ & ZrB₂ before & after texturing.



Figs 4a (Left) & 4b(Right): Illustrates the images obtained using SEM from fracture surfaces of textured TiB₂ and ZrB₂ respectively

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