



उच्च-एंट्रॉपी बोराइड

अति-उच्च तापमान वाले सिरेमिक पदार्थों का एक नया वर्ग

High-Entropy Borides

A new class of ultra-high-temperature ceramics

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High-entropy borides (HEBs) are a class of multi-principal-element ultra-high-temperature ceramics (UHTCs) in which multiple transition metals occupy the metal sublattice of a diboride structure, typically forming a hexagonal AlB-type solid solution. Their distorted lattice can promote high configurational entropy, leading to distinctive combinations of mechanical properties like high hardness, thermal stability, oxidation resistance. These characteristics have attracted considerable interest in HEBs for demanding applications such as high-temperature structural components, hypersonic systems, and energy systems.

In the present study, Equiatomic (Ti . Nb . Ta . Hf . Zr .)B and non-equiatomic (Ti . Nb . Ta . Hf . Zr .)B high entropy borides were synthesized via boro/carbothermal reduction and consolidated by hot pressing and spark plasma sintering at 1900 °C. Both compositions formed single phase hexagonal AB solid solutions, as confirmed by diffraction and microscopy. Densification followed Coble creep behaviour, with higher activation energies observed

for hot pressing than spark plasma sintering. Microstructural analysis revealed a largely homogeneous matrix with localized Nb-rich and minor Ta-rich segregations, contributing to limited grain coarsening. The non-equiatom composition showed slightly reduced hardness but improved fracture toughness (~4.1 MPa·m^{1/2}). Hardness ranged from 16 to 23 GPa (Vickers) and up to ~28 GPa by nanoindentation, with elastic modulus reaching ~455 GPa. Flexural strengths of 500–525 MPa were obtained, with fracture dominated by transgranular brittle mechanisms.

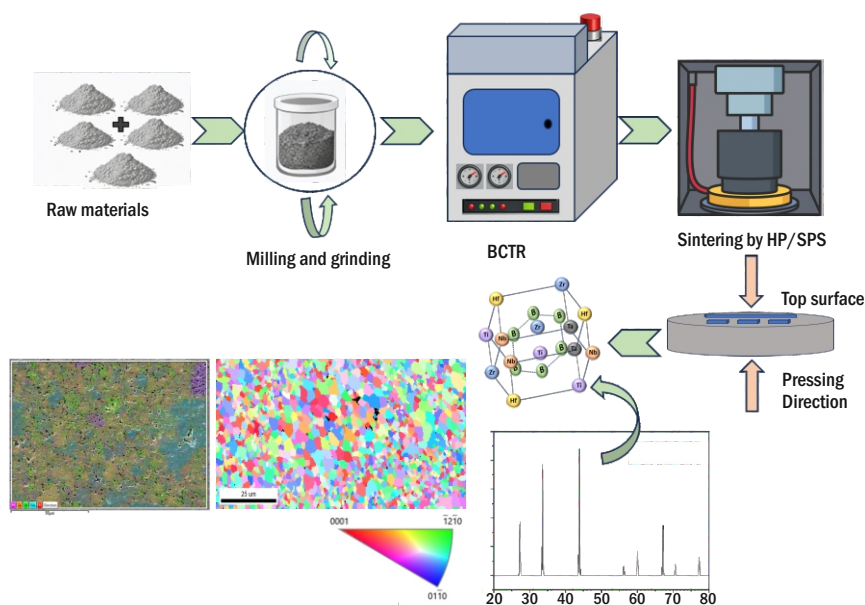
Reference:

[1] Jhaya Gomathy Shivakumar, T. S. R. C. Murthy, J. K. Sonber, Vinod Kumar, Shovit Bhattacharya, Sanjib Majumdar, "Synthesis, Densification Behaviour, and Mechanical Properties of High-Entropy Borides: Role of Composition and Sintering Route" *Ceramics International*, <https://doi.org/10.1016/j.ceramint.2026.08.243>.

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Miss. Jhaya Gomathy S, DDFS-PhD Scholar currently working under the guidance of Dr. Tammana S.R.C. Murthy, Head, Mineral Processing Division (MinD) of BARC. Her research focuses on ultra high temperature ceramics, high entropy ceramics, powder metallurgy-based processing of non-oxide materials.



Schematic representation of Synthesis, densification and characterization of High entropy Borides [1].