Manufacturing of **Ultra-High-Temperature Ceramics** **with** the use of (Ti, Hf, Zr)C + B_4C **reactions**

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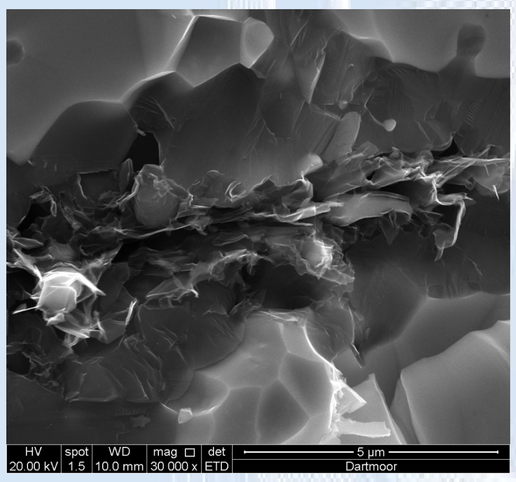
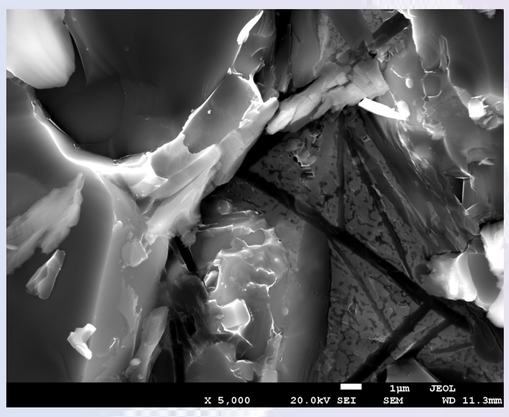
Advanced processing, variety of structures

nonporous UHTCs hot pressed at
1750 – 1850 °C and 30 MPa for 1 – 6 min

Carbon precipitates blunt cracks and increase **toughness** up to **10 MPa·m$^{1/2}$**

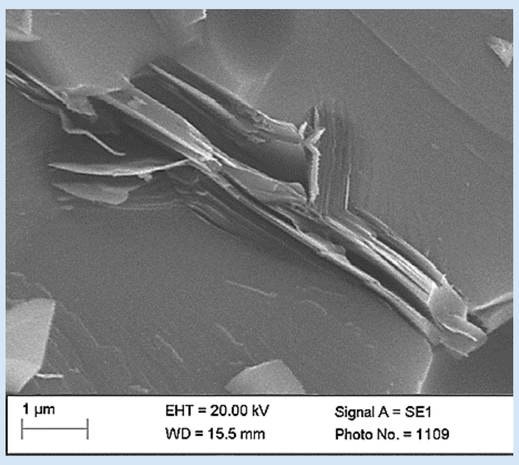




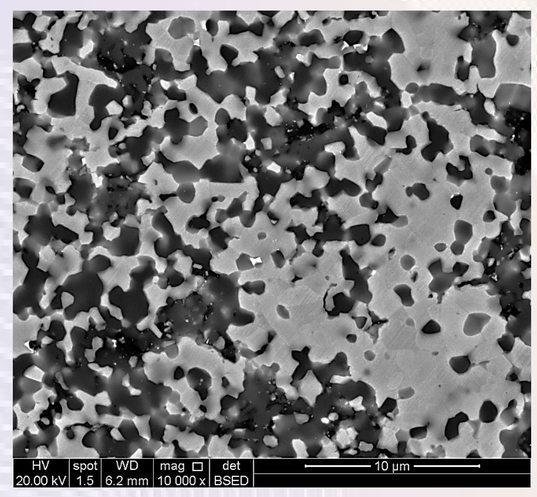
Al_2O_3-TiB_2-B_4C ceramics
Hardness **21 GPa**,
Toughness **9 MPa·m$^{1/2}$**

Machinable UHTCs

TiB_2-C ceramics **machined** with a **hand drill**
Hardness **10 GPa**,
Toughness **5.5 MPa·m$^{1/2}$**

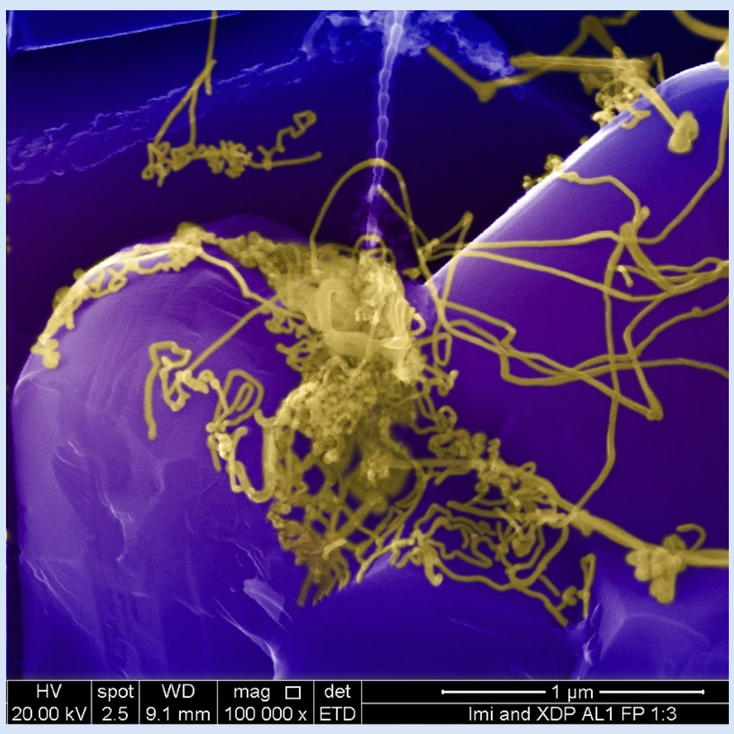


In-situ formed **carbon precipitates** in **HfB_2-SiC** (above) and **TiB_2** (left) matrixes



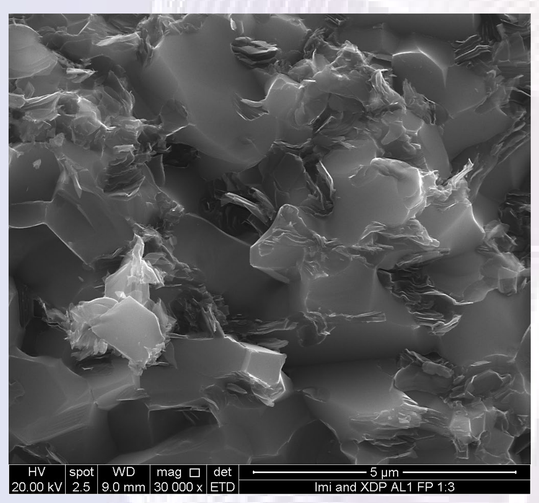
ZrB_2-SiC composite,
1750°C, 30 MPa, 6min

(Ti, Zr, Hf)C + B_4C → (Ti, Zr, Hf)B_2 + C

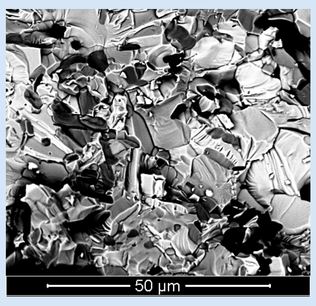


In-situ formed B-Si-C **nanofibers** on **TiB_2-SiC** fracture surface.
Toughness 9 MPa·m$^{1/2}$

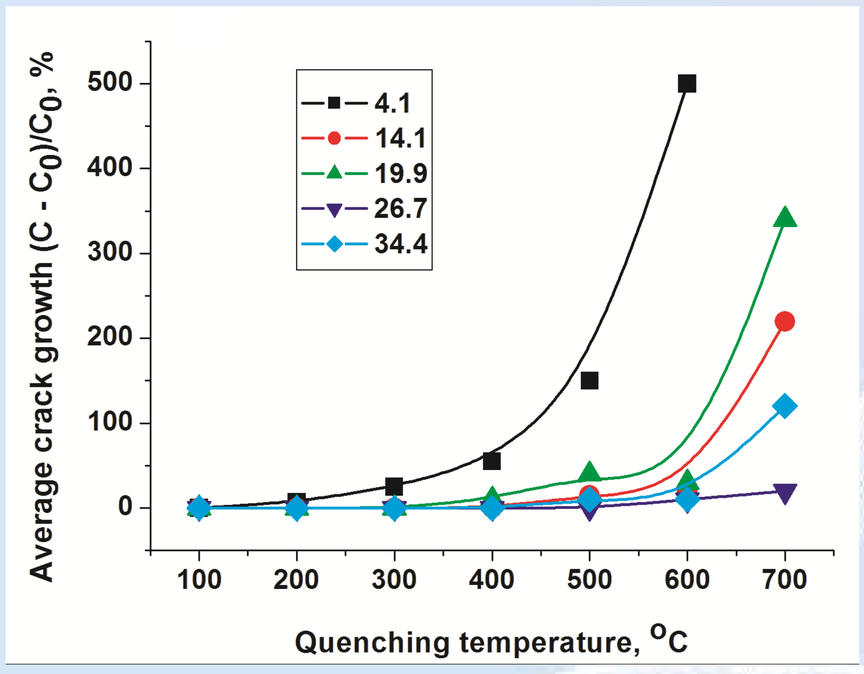
Thermal shock resistance improvement



TiB_2-SiC-C composite.
1850°C, 30 MPa, 1min
Hardness **19 GPa**
Toughness **7.6 MPa·m$^{1/2}$**



TiC-TiB_2-C composite.
1850°C, 30 MPa, 8min
Hardness **14 GPa**,
Toughness **9.2 MPa·m$^{1/2}$**



Indentation **crack growth after quenching** of **TiB_2-SiC-C** ceramics **decreases a 100 times** because of **carbon precipitates** content rise

References

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