



Carbide surface layers on refractory high-entropy alloys

Hard, homogeneous high-entropy carbide surface layers formed in situ during pressure-assisted sintering.

Institution



CEITEC, Brno University of Technology

Development Status

Laboratory-validated; Technology Readiness Level (TRL) 4. Demonstrated on SPS-sintered specimens and verified by SEM and Vickers microhardness.

IP Protection Status

Patent application submitted.

Partnering Strategy

Licensing, industrial collaboration, co-development.

The Problem

Refractory High Entropy Alloys (HEA) combine chemical, thermal and mechanical stability, but their performance in severe operating environments is often limited by surface degradation. When refractory HEA powders are sintered using standard graphite tooling, carbon diffusion is inadequate to form a homogeneous and crack-free protective layer. This technology overcomes this problem by incorporating the synthesis of High-Entropy Carbide (HEC) directly into the HEA sintering process.

Technology Description

The HEA powder is milled together with a source of carbon to obtain a homogeneous mixture. The HEA with HEC surface layers is prepared using pressure-assisted Spark Plasma Sintering (SPS) or similar in graphite dies at a sintering temperature above 1600 °C. The added carbon promotes enhanced carbon diffusion, forming a homogeneous HEC surface layer with a graded transition region between the HEC layer and alloy core.

The HEC surface layer parameters depend on processing conditions and are approximately:

- Thickness of 20–200 µm.
- Vickers hardness HV0.1 of 20–30 GPa.
- High adhesion between the bulk material and the HEC layer.

Commercial Opportunity

The process combines bulk consolidation and surface modification using a single manufacturing route. It is relevant for advanced components requiring a metallic HEA core with hard, adherent carbide surface layers. Potential benefits include superior hardness, wear resistance and pathways toward enhanced oxidation resistance. Commercialisation opportunities may include licensing and application-specific co-development with industrial partners in powder metallurgy, SPS and high-temperature materials.