

Cost-effective Manufacturing of Robust Ceramic/Metal Composites

A low-cost process that converts porous metal preforms into dense, dimensionally accurate ceramic/metal composites for high-temperature turbine and nozzle parts.

Current turbine blades are comprised of single-crystal, nickel-based superalloys with internal cooling channels and contain a thermal barrier coating to achieve desired properties at high temperatures. To improve turbine efficiency, there is ongoing research to develop robust ceramic composite materials that can operate at even higher temperatures and resist deformation and failure more effectively than current materials. However, traditional methods for producing these ceramic composites are costly and often result in appreciable and non-uniform shrinkage, leading to distortions from the final desired component shapes and dimensions.

Purdue researchers have developed a cost-effective method for fabricating robust ceramic/metal composite materials without such shrinkage, for high-temperature devices. The composite materials are manufactured via a unique process. A porous metal component with a desired complex 3-D shape is first prepared by a low-cost forming process. The porous metal component is then infiltrated with a multi-element liquid reactant. This liquid reacts internally with the porous metal to yield ceramic and metal products that fill the pores. The resulting non-porous ceramic/metal composite retains the complex shape and external dimensions of the starting porous metal component. This cost-effective process can be tailored to manufacture ceramic/metal composites that are resistant to plastic deformation, erosion, and fracture at high temperatures. Robust ceramic/metal composites with intricate and complex designs can be produced for advanced high-temperature aerospace, power generation, and related applications.

Technology Validation:

Methods for fabricating ceramic/metal composites comprised of a variety of high-melting oxides and metals were provided.

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Category
Chemicals & Advanced
Materials/Coatings, Adhesives &
Sealants
Aerospace & National
Security/Hypersonics &
Propulsion Systems

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Advantages:

- Robust, high-temperature materials
- Resistance to deformation, erosion, and fracture
- Precise manufacturing of complex-shaped components
- Cost efficient

Applications:

- Turbine blades and other components for jet engines
- Nozzles for rocket engines
- High-temperature machinery and equipment components

TRL: 3

Intellectual Property:

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