Vapor-Mediated Synthesis of Silicon Carbide Matrices for Ceramic Matrix Composites

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BACKGROUND

Current techniques for the synthesis of dense silicon carbide (SiC) matrices for ceramic matrix composites (CMCs) involve the infiltration of molten silicon into a fiber preform — which contains carbon — where the reaction between the silicon and carbon forms SiC. Because molten silicon does not readily wet carbon, the rate of infiltration is controlled by the relatively slow formation of a thin SiC layer on the carbon surface ahead of the melt front. Once wetting occurs, the reaction can proceed relatively rapidly, and the SiC product often fills the narrower spaces in the porous network, choking the flow and limiting the thickness that can be infiltrated and converted into SiC.

DESCRIPTION

Researchers at the University of California, Santa Barbara have circumvented the issue of wettability in CMC fabrication by using silicon vapor generated from embedded particles or an external source to precondition the internal surfaces of the carbon component of the matrix preform. SiC from the vapor reaction grows slowly so there is no blockage of the narrow flow passages. Moreover, the SiC formed from the vapor is porous on a nanoscale and regulates the access of the melt to the underlying carbon. This allows the pore space to be filled entirely and quickly by the reactive melt, and the reaction with the rest of the carbon can be completed subsequently and uniformly over the entire surface. In combination with the appropriate selection of a Si-alloy melt for the subsequent infiltration, this technique further enhances the temperature capability of the CMC and overall mechanical robustness.

ADVANTAGES

- Reduced infiltration time
- Minimized defects
- Increased material utilization
- Carbon source flexibility

APPLICATIONS

- High Temperature Ceramic Matrix Composites
- Gas Turbines for Aerospace Propulsion
- Gas Turbines for Power/Electricity Generation
- Prospective Applications in Nuclear Energy Systems

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OTHER INFORMATION

KEYWORDS

CMC, silicon carbide matrices, silicon, ceramic matrix composites

CATEGORIZED AS

- **Materials & Chemicals**
  - Ceramics
  - Composites

RELATED CASES

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PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	12,577,172	03/17/2026	2020-721

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