High-temperature ceramics: Processing, performance, applications.

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Introduction

This review delves into recent progress in high-temperature thermal barrier coatings (TBCs), covering new materials, design strategies, and manufacturing techniques aimed at improving their thermal insulation and mechanical durability. It highlights challenges and future directions for these critical components in demanding applications like gas turbines[1].

This work investigates the microstructure and mechanical behavior of high-temperature ceramic composites, specifically focusing on how spark plasma sintering (SPS) influences their properties. It details the densification mechanisms and the resulting improvements in strength and toughness, crucial for structural applications[2].

This review provides a comprehensive overview of advanced ceramic matrix composites (CMCs) and their utility in high-temperature environments. It discusses various reinforcement types, matrix materials, processing routes, and the challenges associated with their design and application in extreme conditions[3].

This article offers a broad perspective on the current status of sintering processes for ceramic materials, covering conventional and advanced techniques. It evaluates their mechanisms, advantages, and limitations, while also projecting future trends in developing more efficient and controlled sintering methods[4].

This paper reviews the advancements in zirconia-based thermal barrier coatings, which are crucial for extending the lifespan and efficiency of gas turbine components. It details the challenges of phase stability, degradation mechanisms, and new material developments aimed at enhancing performance at elevated temperatures[5].

This article explores the development and application of new high-temperature ceramic materials specifically designed for demanding aerospace environments. It covers their unique properties, processing techniques, and the significant role they play in improving efficiency and safety of aerospace systems[6].

This review details the latest advancements in spark plasma sintering (SPS) for both ceramics and ceramic matrix composites. It highlights how SPS enables rapid densification and fine microstructure control, leading to enhanced mechanical and functional properties crucial for various engineering applications[7].

This research focuses on the innovative design and performance evaluation of high-entropy ceramic materials as thermal barrier coatings. It explores their unique microstructures and superior high-temperature stability, offering promising avenues for next-generation thermal protection systems[8].

This critical review examines various advanced sintering technologies specifically tailored for ultra-high temperature ceramics (UHTCs). It highlights how these methods enable the fabrication of dense and robust UHTCs, essential for extreme aerospace and industrial applications, by overcoming traditional processing challenges[9].

This study compares the microstructural development and mechanical characteristics of high-temperature silicon carbide ceramics produced using various sintering techniques. It provides insights into how different processing routes influence the final properties, impacting their suitability for high-performance applications[10].

Conclusion

Recent research extensively explores high-temperature materials crucial for demanding applications like gas turbines and aerospace systems. Thermal barrier coatings (TBCs), including zirconia-based and novel high-entropy ceramics, are key for enhancing thermal insulation, mechanical durability, and extending component lifespan. Developments focus on new materials, design strategies, and manufacturing techniques to improve performance at elevated temperatures, addressing issues such as phase stability and degradation mechanisms.

High-temperature ceramic composites, including advanced ceramic matrix composites (CMCs), are also a significant area of study. Investigations delve into their microstructure, mechanical behavior, various reinforcement types, and processing routes, particularly how techniques like spark plasma sintering (SPS) influence properties such as strength and toughness. SPS enables rapid densification and fine microstructure control, leading to enhanced mechani-

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cal and functional properties.

Sintering processes, from conventional to advanced methods, are evaluated for ceramic materials, with an emphasis on mechanisms, advantages, limitations, and future trends. Specialized sintering technologies are tailored for ultra-high temperature ceramics (UHTCs) to overcome traditional processing challenges and fabricate dense, robust materials. Studies on silicon carbide (SiC) ceramics prepared by different sintering methods provide insights into how processing routes influence final properties for high-performance use. The collective aim is to develop materials that improve efficiency and safety in extreme environments.

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