Optimization of Polycarbosilane-Based Binding Agents for the Manufacture of SiC Micro-Features

Xiao Da Terrence Fu[1], Ganesh Kumar Meenashisundaram[1], Subramanian Sundarrajan[1], Seeram Ramakrishna[1] and Senthil Kumar Anantharajan[1,#]

1 Department of Mechanical Engineering, National University of Singapore, Singapore 117575, Singapore
Corresponding Author / Email: asenthil@nus.edu.sg

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Silicon carbide (SiC) with its high hardness and unique electrical properties has emerged as a material of choice for a wide range of applications in recent years. The formulation of SiC binding agents, particularly those based on polycarbosilanes, plays a crucial role in the development of micro and nano features for advanced technological applications in electronics, defence and sustainability. This study explores the formulation and optimization of polycarbosilane-based binding agents, focusing on the commercially available SMP-877, to enhance and optimise the mechanical properties and microstructural features of sintered SiC. The research investigates the effect of varying polycarbosilane compositions, ranging from 30% to 80%, on the hardness and density of SiC. A comprehensive experimental setup was employed, testing across a wide temperature range from 1100°C to 1300°C. The results indicate that an increase in polycarbosilane content significantly influences the sintering behavior, impacting both the mechanical properties and densification of SiC. Furthermore, the study examines the curing duration, which shows a direct correlation with the concentration of SMP-877, suggesting that higher polycarbosilane content necessitates longer curing times to achieve solidification. Initial findings reveal that specific composition ranges lead to enhanced hardness and optimal density, thereby suggesting potential for tailored applications in micro-device fabrication. The microstructural analysis of the sintered samples confirms the formation of SiC structures, with variable density and hardness which is critical as a binding agent suitable for use in a wide range of applications. This research contributes in the field of micro and nano fabrication of SiC by providing insights into the formulation of effective binding agents using polycarbosilanes. The findings hold significant implications for the advancement of SiC-based technologies, particularly in microelectronics and precision engineering.