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Self-Propagating High-Temperature Synthesis of Nanocomposite Ceramics $TaSi_2$-SiC with Hierarchical Structure and Superior Properties

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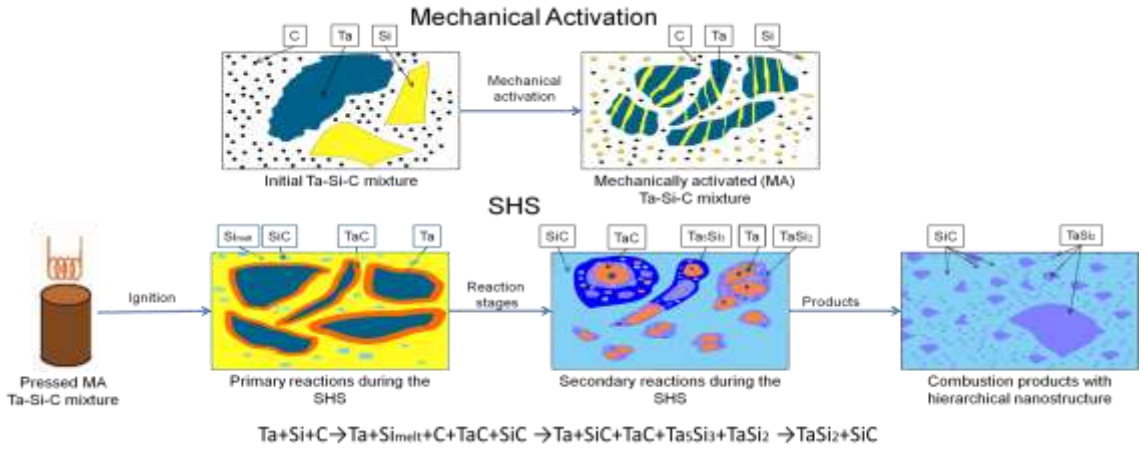
Graphical abstract



Abstract

This study focuses on the investigation of the combustion kinetics and mechanisms, as well as the phase and structure formation processes, during elemental self-propagating high temperature synthesis of ceramics in Ta-Si-C system.

Thermodynamic and kinetic features of SHS are discussed. Thermodynamic calculations, time-resolved XRD and investigation of stopped combustion front suggest the following chemical reactions sequence in combustion wave for the Ta-Si-C system: $Ta+Si_{solid}+C \rightarrow TaC+Si_{solid}+C \rightarrow TaC+SiC+Si_{liquid}+C \rightarrow TaC+TaSi_2+Ta_5Si_3+SiC+Si_{solid}+C \rightarrow TaSi_2+SiC$.

Significant microstructure refinement occurs due to the formation of SiC within the TaC, Ta_5Si_3 and $TaSi_2$ particles during the SHS. Combustion products consist of agglomerated SiC and $TaSi_2$ particles with the size of individual grains equal to 15-50 nm. Hot pressing of $TaSi_2$-SiC powders at 1600°C produces the bulk