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Nickel-catalyzed preparation of self-bonded SiC refractories with improved microstructure and properties

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Abstract:

3C-SiC was synthesized after 3 h firing of Si and expanded graphite in flowing Ar at 1300°C with *in-situ* formed Ni nanoparticle (NP) catalyst. First-principles calculations suggest that Ni catalyst accelerated the formation of SiC *via* weakening the bonds in adsorbed C=C bond, and CO and SiO molecules. Apart from this, Ni NP catalyst facilitated the epitaxial growth of SiC nanowires. Based on these findings, self-bonded SiC refractories were prepared by using black SiC grain, expanded graphite and Si powders as raw materials and Ni NP as a catalyst. Large amounts of SiC nanowires were catalytically formed in the fired refractories specimens, which resulted in significant improvements in both mechanical strength (MOR of 32.2 MPa at 1400°C) and thermal shock resistance. The catalytic formation method investigated in this work could be readily modified and extended to develop many other types of high performance refractories.

Keywords: Self-bonded SiC refractories; 3C-SiC nanowires; Ni nanoparticle catalysts; First-principles calculations; High-temperature properties.