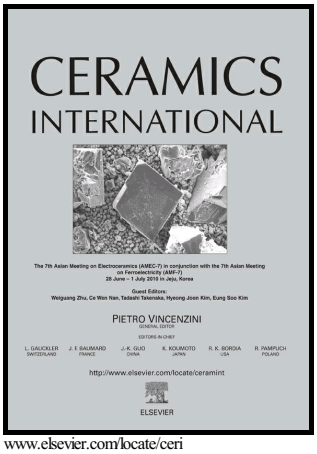

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Bola Yoon, Sea-Hoon Lee, HeeSoo Lee

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Low-temperature densification of nano Si-C powder containing Al-C additives prepared by high-energy ball-milling

Bola Yoon[a,b], Sea-Hoon Lee[b*], HeeSoo Lee[a]

[a]School of Materials Science and Engineering, Pusan National University, Busan, 609-735, Republic of Korea

[b]Division of Powder/Ceramics Research, Korea Institute of Materials Science, Changwon, Gyeongnam, 641-831, Republic of Korea

[*]Corresponding author.: Tel: +82-10-8992-6972, seahoon1@kims.re.kr

Abstract

This study investigates the low-temperature sintering of nano Si-C powder containing Al-C additives prepared by high-energy ball-milling. The synthesized powder was composed of ultra-fine β-SiC crystallites (~5 nm) and amorphous Si-C matrix. TEM-EDS analysis showed a relatively homogeneous distribution of Al in the synthesized powder (d_{50}: 170 nm). The relative density of SiC containing 6.5 wt% additives was 98.1% after sintering at 1650°C for 30 min at a pressure of 20 MPa. The SiC could be densified at 1800°C when the additive content decreased to 3.3 wt%. The Al content in the Si-C powders changed, e.g., from 4.11 to 2.6 wt%, after sintering at 1650°C, which value was much higher than the solubility limit (0.26 wt% at 1800°C) due to the homogeneous distribution of Al within the powder and the low sintering temperature. Al was segregated at the grain boundary while liquid phase formation was not identified by TEM analysis, indicating that grain boundary diffusion was the main densification mechanism. The mechanical properties of the sintered specimens were similar to those of a SiC-Al_4SiC_4 system, which has the same chemical components but containing large amount of sintering additives (5.6 vs. 13 wt%), sintered using higher pressure (20 vs. 60 MPa) and temperature (1650 vs. 1800°C).