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Flash spark plasma sintering of advanced materials

Salvatore Grasso[1, 2], Theo Saunders[1, 2] and Mike Reece[1, 2]
[1]Nanoforce Ltd., UK
[2]Queen Mary University of London, UK

It is well know that due to both localized heating and the reduced sintering time in SPS processing can produce a significant energy saving and metastable microstructures if compared to Hot Pressing. In order to further improve the energy saving, we have developed a very rapid sintering technique called Flash SPS FSPS with heating rates of the order of 5-10 10^3 ^{0}C/minute. Unlike the Flash Sintering based on high voltage, FSPS is based on low voltage and it can be up-scaled to sample volumes of several tens of cubic centimeters. Flash SPS allows densification of ZrB_2 up to 95% under a discharge time as short as 35 seconds, which results in an energy saving greater than 95% compared to conventional SPS. A novel processing methodology that allows both preheating and FSPS of silicon carbide based materials (both of α and β SiC) has been developed. We were able to densify a SiC disc (Φ 20 mm) from initial density of 53% up 96% under a discharge time as short as 17s. The rapid densification (i.e. normalized displacement) of SiC by novel FSPS is compared to conventional SPS process. The developed methodology was up-scaled to samples as large as 60 mm. A novel route allowing full consolidation from loose powder to dense bulk in less than 30 seconds was also achieved. Following this recent work, we will present the first attempt of achieving materials flash sintered in contactless mode where the heating rate approaches 10^5°C/minute. Results on other types of materials like permanent magnets and thermoelectrics (IP pending) is presented. A general understanding of the mechanism is proposed by using FEM simulation, TEM, SEM, ESR etc.

Biography

Salvatore Grasso joined the School of Material Science and Engineering (SEMS) at Queen Mary University of London in 2011 as experienced Researcher in Ceramics Processing. He performed his Doctoral work (2008-2011) at the University of Tsukuba-NIMS (National Institute for Material Science) Japan, where he received a Dean Award for Excellent Doctoral Thesis. His research work was been mainly focused on Spark Plasma Sintering (SPS) and other processes assisted by intense electrical (106A) and magnetic fields (>10T). Recently, he pioneered the development of Flash Spark Plasma sintering processes. At present he published 90 papers and 10 patents.

s.grasso@qmul.ac.uk

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