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Flash sintering: New opportunities

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FLASH SINTERING: NEW OPPORTUNITIES

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It is well know that due to both localized heating and the reduced sintering time in Spark Plasma Sintering (SPS), processing can produce a significant energy saving and metastable microstructures if compared to Hot Pressing [1]. In order to further improve the energy saving we have developed a very rapid sintering technique called Flash SPS (FSPS) with heating rates in the order of 10^4-10^5 ^oC/minute. Unlike the Flash Sintering based on high voltage, FSPS is based on low voltage and it can be up-scaled to samples volumes of several tens of cubic centimeters. Flash SPS allows densification of ZrB_2 [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 to 96% with a discharge time as short as 17s (as shown in the Figure 1). In Figure 1, the rapid densification (i.e. normalized displacement) of SiC by novel FSPS is compared to the conventional SPS process. The developed methodology was scaled up to produce samples as large as 60 mm as shown in Figure 2.

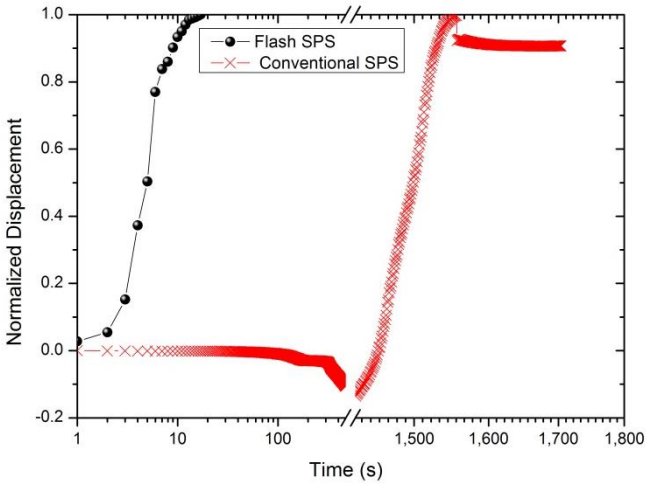

Figure 1 –Comparison of normalized displacement (SiC, Φ 20mm) as function of time for Flash and Conventional SPS

Figure 2 – Φ60mm flash sintered SiC sample

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 ^oC/minute. Results on other types of materials (IP pending) may also be presented.

References

1. Grasso, S., Y. Sakka, and G. Maizza, *Electric current activated/assisted sintering (ECAS): A review of patents 1906-2008.* Science and Technology of Advanced Materials, 2009. **10**(5).
2. Grasso, S., et al., *Flash spark plasma sintering (FSPS) of pure ZrB2.* Journal of the American Ceramic Society, 2014. **97**(8): p. 2405-2408.