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Authors: Barak Ratzker, Maxim Sokol, Sergey Kalabukhov, Nachum Frage



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## High-pressure spark plasma sintering of silicon nitride with LiF additive

Barak Ratzker, Maxim Sokol, Sergey Kalabukhov and Nachum Frage\*

Department of Materials Engineering, Ben-Gurion University of the Negev,  
P.O.B. 653, Beer-Sheva 84105, Israel

\* Corresponding author. Tel.: +972 8 646 1468; Fax: +972 8 647 9441  
E-mail: nfrage@bgu.ac.il

### Abstract

High-pressure spark plasma sintering of  $\text{Si}_3\text{N}_4$  with  $\text{Y}_2\text{O}_3$ ,  $\text{Al}_2\text{O}_3$  and LiF additives was employed to fabricate high quality dense ceramics comprising approximately 92%  $\alpha$ - $\text{Si}_3\text{N}_4$  phase and 8%  $\beta$ - $\text{Si}_3\text{N}_4$  phase. The relatively high pressure applied (up to 650 MPa) had a substantial effect on densification by enhancing particle rearrangement, making it possible to obtain dense  $\text{Si}_3\text{N}_4$  at a significantly lower sintering temperature (1350°C). Consequently, virtually no  $\alpha$  to  $\beta$  phase transformation transpired during the liquid phase sintering process. The LiF additive had an indispensable influence on the densification process by lowering the viscous glass formation temperature, which also contributed to enhanced particle rearrangement. The nearly fully dense samples (theoretical density  $\geq 99\%$ ) obtained displayed a good combination of mechanical properties, namely elastic modulus (304-316 GPa), hardness (1720-1780 HV2) and fracture toughness ( $6.0 \text{ MPa}\cdot\text{m}^{1/2}$ ).

**Keywords:** Silicon nitride; Spark plasma sintering; High pressure; LiF

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