Development of High Strength-High Porosity Si_3N_4 Bodies via a Modified Gel-Casting Process

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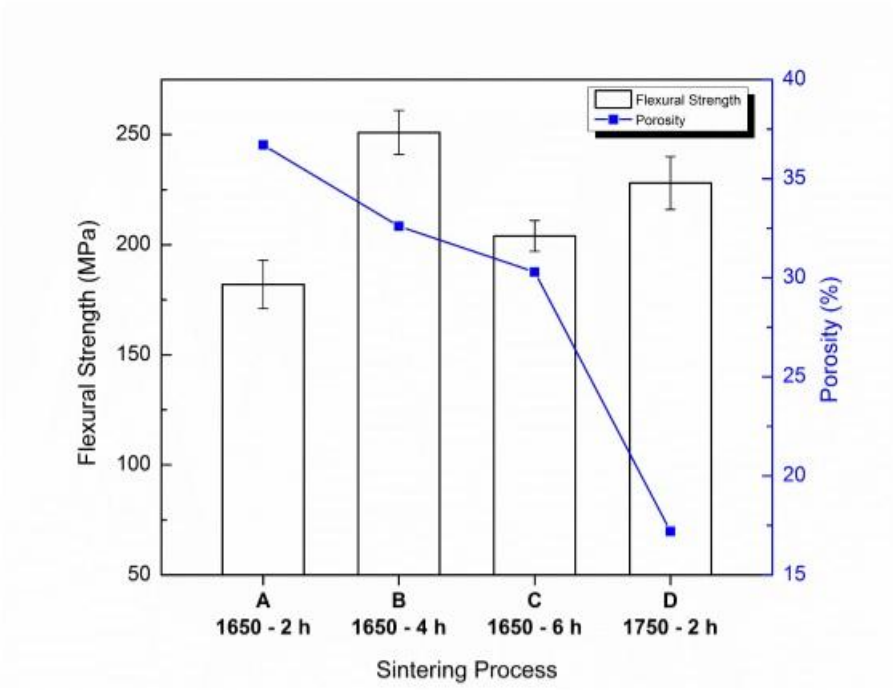
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Abstract

Porous Si_3N_4 bodies are of interest in various applications including bio and aerospace. Silicon nitride bodies were prepared with porosity and flexural strength of about 38% and near 180 MPa, respectively. The processing was via gel-casting method employing acrylamide (AM) and N, N′ −methylene bisacrylamide (MBAM) for primary slurry, followed by coke bed sintering. The concentrations of APS and TEMED as initiator and catalyst, the sintering time and temperature were studied and optimized. Phase evolution and microstructure observation, as well as flexural strength and porosity of porous Si_3N_4 bodies, were investigated. It was found above, sintering process at 1650 °C with prolonged time had a significant effect on strength in a way that bodies with 33% porosity could experience of 250 MPa. Development of interlocking microstructure of fine β-Si_3N_4 grains was found to be the key factor for increase of strength. Controlling the primary slurry components was also vital for maintaining the high strength. The results were explained with emphasis on potential applications.

Image



Flexural strength and porosity of porous Si_3N_4 ceramics with 35 vol.% solid loading after sintering at (a) 1650 °C for 2 h ; (b) 1650 °C for 4 h ; (c) 1650 °C for 6 h ; (d) 1750 °C for 2 h.

Recent Publications

1. W. Zeng, X. Gan, Z. Li, K. Zhou, The preparation of silicon nitride ceramics by gelcasting and pressureless sintering, Ceram. Int. 42 (10) (2016) 11593-11597.

2. K. Bodisova, M. Kasiarova, M. Domanicka, et al., Porous silicon nitride ceramics designed for bone substitute applications, Ceram. Int. 39 (2013) 8355-8362.

3. H. Wang, J. Yu, J. Zhang, et al., Preparation and properties of pressureless-sintered porous Si_3N_4, J. Mater. Sci. 45 (2010) 3671-3676.

4. W. Han, Y. Li, G. Chen, Q. Yang, Effect of sintering additive composition on microstructure and mechanical properties of silicon nitride, Mater. Sci. Eng. A 700 (2017) 19-24.

5. J. Yang, J. F. Yang, S. Y. Shan, J. Q. Gao, T. Ohji, Effect of sintering additives on microstructure and mechanical properties of porous silicon nitride ceramics, J. Am. Ceram. Soc. 89 (12) (2006) 3843-3845.

6. L. Hui, P. Xueman, X. Mingxia, et al., Dispersion mechanisms of aqueous silicon nitride suspensions at high solid loading, Mater. Sci. Eng. A 465 (2007) 13-21.

7. X. Yang, B. Li, C. Zhang, et al., Fabrication and properties of porous silicon nitride wave-transparent ceramics via gel-casting and pressureless sintering, Mater. Sci. Eng. A 663 (2016) 174-180.

Biography



Amir Parsi received the B.Sc. degree in Materials Science and Engineering from Sharif University of Technology (SUT), Tehran, Iran, in 2012, and the M.Sc. degree in Ceramic Engineering from Iran University of Science and Technology (IUST), Tehran, Iran, in 2015. Since then, he has been working under supervision of Prof. Golestanifard in the Refractory and Ceramic Synthesis Lab in the IUST. He is not carrying on research on synthesis ceramic powders but also being the lab manager. He has won the Best Poster Award from 10th Congress of the Iranian Ceramic Society (ICerS) & First International Conference on Advanced Ceramics for a paper entitled "Rheological Properties of Silicon Nitride Slurries for Gelcasting". In recent years, he has focused on preparing porous Silicon Nitride ceramic bodies with high strength with the intention of utilizing in bio applications.

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