Facile preparation of B_4C/C composite aerogel with high specific surface area and low thermal conductivity

Wei Wang[a,b], **Sheng Cui[a,b]**, Xiaodong Wu[a,b,c], Xiaodong Shen[a,b]

[a] *College of Materials Science and Engineering, Nanjing Tech University, Nanjing 211800, China*

[b] *Jiangsu Collaborative Innovation Center for Advanced Inorganic Function Composites, Nanjing Tech University, Nanjing 210009, China*

[c] *School of Materials Science & Engineering, Nanyang Technological University, 639798, Singapore*

Email address: weiw@njtech.edu.cn (W. Wang), scui@njtech.edu.cn (S. Cui), scbe.xdwu@ntu.edu.sg (X. Wu), xdshen@njtech.edu.cn (X. Shen)

Abstract

Due to the combination of covalent bonds, boron carbide has high hardness, high compressive strength and high oxidation resistance properties [1, 2]. Aerogels are three-dimensional network structure of nanoporous materials with low density, high porosity, low thermal conductivity and high specific surface area, which make aerogels have excellent thermal insulation properties. Based on the research of SiC aerogel [3, 4], we have combined boron carbide with aerogel to synthesis boron carbide-based aerogel. A novel boron carbide-based aerogel with high-temperature resistant and high-strength have been developed through sol-gel route and carbothermal reduction process. The B_4C/C composite aerogels are obtained from low-cost inorganic salt of boron and resorcinol–formaldehyde (RF) as raw materials. The effects of reactant molar ratios and heat treatment time on physicochemical properties of B_4C/C composite aerogels are investigated. The results show that the compressive strength of B_4C/C composite aerogel is as high as 4.25 MPa. The specific surface area of sample is as high as 601.02 m^2/g, which is beneficial for its application of thermal insulation at elevated temperatures. After heat-treated at 1650 °C for 5 h, the thermal conductivity of carbon fiber mat reinforced composite aerogel is as low as 0.051 W/m·K(25 ℃).

Keywords

Aerogel; Boron carbide; Silicon carbide; Compressive strength; Thermal conductivity

Reference

[1] Watts J L, Talbot P C, Alarco J A, et al. Morphology control in high yield boron carbide[J]. Ceramics International, 2016, 43(2): 2650-2657.

[2] Domnich V, Reynaud S, Haber R A, et al. Boron Carbide: Structure, Properties, and Stability under Stress[J]. Journal of the American Ceramic Society, 2011, 94(11):3605-3628.

[3] Zera E, Campostrini R, Aravind P R, et al. Novel SiC/C aerogels through pyrolysis of polycarbosilane precursors[J]. Advanced Engineering Materials. 2014, 16(6): 814-819.

[4] Kong Y, Zhong Y, Shen X, et al. Synthesis of monolithic mesoporous silicon carbide

from resorcinol–formaldehyde/silica composites[J]. Materials Letters. 2013, 99(20): 108-110

Acknowledgements

This work was financially supported by the Key Research and Development Project of Jiangsu Province (BE2019734, BE2017151,BE2016171), the Major Program of Natural Science Fund in Colleges and Universities of Jiangsu Province(15KJA430005), the Program of Science and Technology of Suqian City(M201704, H201801, H201803), the National Natural Science Foundation of China (51702156, 81471183),the Program for Changjiang Scholars and Innovative Research Team in University (IRT_15R35), the Priority Academic Program Development of Jiangsu Higher Education Institutions and the Brand Major Program Development of Jiangsu Higher Education Institutions (PPZY2015B128). China Scholarship Council under Grant (No. 201908320194), the General Program of Natural Science Fund in Colleges and Universities of Jiangsu Province (19KJB430023), Scientific Reasearch Starting Foundation of Nanjing Tech University, Science and technology innovation project for overseas of Nanjing City, Postdoctoral Science Foundation of Jiangsu Province (2019K005), the High Performance Computing Center of Nanjing Tech University for supporting the computational resources, China Postdoctoral Science Foundation (2019M661781). Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of these programs.