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Synthesis and Characterisations of Cordierite Bonded Porous SiC Ceramics by Sol Infiltration Technique

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Abstract : Recently SiC ceramics have been a focus of interest in the field of porous materials due to their unique combination of properties and hence they are considered as an ideal candidate for catalyst supports, thermal insulators, high-temperature structural materials, hot gas particulate separation systems etc. in different industrial processes. Several processing methods are followed for fabrication of porous SiC at low temperatures but all these methods are associated with several disadvantages. Therefore processing of porous SiC ceramics at low temperatures is still challenging. Concerning that of incorporation of secondary bond phase additives by an infiltration technique should result in a homogenous distribution of bond phase in the final ceramics. Present work is aimed to synthesis cordierite (2MgO.2Al2O3.5SiO2) bonded porous SiC ceramics following incorporation of sol-gel bond phase precursor into powder compacts of SiC and heat treating the infiltrated body at 1400 °C. In this paper the primary aim was to study the effect of infiltration of a precursor sol of cordierite into a porous SiC powder compact prepared with pore former of different particle sizes on the porosity, pore size, microstructure and the mechanical properties of the porous SiC ceramics. Cordierite sol was prepared by mixing a solution of magnesium nitrate hexahydrate and aluminium nitrate nonahydrate in 2:4 molar ratio in ethanol another solution containing tetra-ethyl orthosilicate and ethanol in 1:3 molar ratio followed by stirring for several hours. Powders of SiC (α-SiC; d50 =22.5 µm) and 10 wt. % polymer microbead of two sizes 8 and 50µm as the pore former were mixed in a suitable liquid medium, dried and pressed in the form of bars (50×20×16 mm3) at 23 MPa pressure. The well-dried bars were heat treated at 1100° C for 4 h with a hold at 750 °C for 2 h to remove the pore former. Bars were evacuated for 2 hr upto 0.3 mm Hg pressure into a vacuum chamber and infiltrated with cordierite precursor sol. The infiltrated samples were dried and the infiltration process was repeated until the weight gain became constant. Finally the infiltrated samples were sintered at 1400 °C to prepare cordierite bonded porous SiC ceramics. Porous ceramics prepared with 8 and 50 µm sized microbead exhibited lower oxidation degrees of respectively 7.8 and 4.8 % than the sample (23 %) prepared with no microbead. Depending on the size of pore former, the porosity of the final ceramic varied in the range of 36 to 40 vol. % with a variation of flexural strength from 33.7 to 24.6 MPa. XRD analysis showed major crystalline phases of the ceramics as SiC, SiO2 and cordierite. Two forms of cordierite, α-(hexagonal) and µ-(cubic), were detected by the XRD analysis. The SiC particles were observed to be bonded both by cristobalite with fish scale morphology and cordierite with rod shape morphology and thereby formed a porous network. The material and mechanical properties of cordierite bonded porous SiC ceramics are good in agreement to carry out further studies like thermal shock, corrosion resistance etc.

Keywords : cordierite, infiltration technique, porous ceramics, sol-gel
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