Abstract

Thesis title: ***Processing of oxide bonded porous silicon carbide ceramic membrane for microfiltration applications***

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Porous silicon carbide ceramics have been considered as an excellent filter material for various industrial applications such as hot gas filtration, wastewater filtration, molten metal filtration, etc. due to its excellent properties e.g. high mechanical strength, excellent corrosion, and thermal shock resistance properties, highly porous structure with narrow pore size, low thermal expansion coefficient, etc. However, a major problem associated with SiC-based ceramic is their low sinterability due to their strong covalent bonds between C and Si which limits its practical application in industries. Most of the common processing techniques require a high sintering temperature along with expensive atmospheres, costly equipment, highly pure starting materials, and delicate instrumentation. But recently SiC ceramics are fabricated by the most simple and cost-effective oxide bonding method at a lower temperature. However, there are many unresolved issues, e.g. processing cost of the material, effect of additives on the evolution of the bonding phase, mechanical strength, thermal and corrosion resistance properties, etc. need further attention. Moreover, the effects processing parameter on the filtration behavior of SiC membrane needs systematic investigations. In this thesis work, detailed investigations are carried out on the fabrication of porous oxide bonded SiC ceramic membrane at comparatively lower sintering temperature using low-cost bond phase additives and suitable pore former. The detailed studies are carried out on the effects of processing parameters and bond phase additives on the morphology, pore size distribution, porosity, corrosion, and thermal shock resistance properties, air and water permeability. The efficiency of the developed membrane in oily wastewater and kaolinite water filtration are evaluated.

Chapter 1 contains the introduction of oxide bonded porous SiC ceramic membrane, limitations of the reported method, and the aims of the present thesis work for further improvement of the membrane.

Chapter 2 provides information about porous ceramics, properties, applications and importance of porous SiC ceramics, different processing methods for porous SiC ceramics and their drawbacks, importance of oxide bonding method and their limitations, secondary oxide bond phases and their properties, and a short description on different application areas.

Chapter 3 summarizes the objectives of the thesis work.

Chapter 4 describes the detailed experimental procedure of processing porous SiC membrane, test set up used for air and water permeation study, method of wastewater filtration,

characterization of wastewater and water after filtration, method of corrosion and thermal shock resistance study.

Chapter 5.1 depicts the recycling of industrial waste fly ash as a source of bonding phase for the development of porous SiC ceramics by the oxide bonding method at 1000°C. The effect of the amount of MoO_3 sintering catalyst on the mullitization reaction and mullite phase formation is described. The effect of different pore former addition on the properties, mechanical strength, pore size, air-water permeability, and wastewater filtration studied are discussed.

Chapter 5.2 illustrates the effect of alkaline clay as a sintering additive on the properties, and the phase evolution of mullite bonded porous SiC ceramics sintered at 1400°C. Mullite bonded porous SiC ceramics with various porosity and flexural strength are prepared using only 1 wt% of clay additive, alumina, and various pore former. Air and water permeation flux, permeability coefficient, oily wastewater filtration, and high turbid water filtration efficiency are measured using the as-prepared membrane.

Chapter 5.3 elaborates the fabrication of multiple oxides bonded porous SiC ceramics followed by infiltration of cordierite precursor sol into porous compacts of SiC and alumina. The microstructures, phase components, mechanical properties, and air permeation characteristics of multi-oxide bonded porous SiC ceramics are examined and compared with materials obtained via a powder processing route. Particulate filtration efficiencies are calculated theoretically using model equation and experimental air permeability results.

Chapter 5.4 represents the effects of processing parameters on the phase evolution, microstructure, pore size distribution, flexural strength, thermal shock, and corrosion resistance properties of mullite bonded porous SiC ceramics.

Chapter 6 signify concise concluding remarks and future scope of work

Dulal Das
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Nijhuma Kayal
19/04/2022

Dr. Nijhuma Kayal
Principal Scientist
CSIR- Central Glass and Ceramic Research Inst.
196, Raja S.C. Mullick Road
Kolkata-700032