Preparation and Properties of Silicon Carbide Ceramic Film

Xiao-yu HUANG, Dong MA, Chang-lian CHEN* and Zhi-liang HUANG
School of Materials Science and Engineering, Wuhan Institute of Technology, China
*Corresponding author

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Abstract. As the raw materials, the silicon carbide (SiC) and silicon nitride (Si$_3$N$_4$), were using to prepare the pure SiC ceramic membrane in the argon atmosphere with different addition of Si$_3$N$_4$ by atmospheric pressure sintering process. The microstructure, pore size distribution, morphology of crystal and phase of SiC membrane which influenced by different amount of Si$_3$N$_4$ have been discussed. Result shows the silicon carbide are the primary phase of membrane, With the increase of the addition of Si$_3$N$_4$, the pore diameter of the film increases gradually. The membrane with the 28.5% Si$_3$N$_4$ has the suitable diameter(2µm) and sintering degree

Introduction

The main raw material of inorganic ceramic film is inorganic ceramic material, which is prepared after some special process. The surface of flat ceramic membrane is covered with small cavity, which has the function of filtering. Therefore, it is generally used as filter membrane \cite{1,2}. As the liquid flows through the membrane surface, the small particles can pass through the micropore due to the effect of the pressure, while the larger particles cannot pass through, thus providing a filter effect. The surface of silicon carbide particles is not smooth, and the sintering temperature is high. Silicon nitride and silicon carbide have extremely strong covalent bonds \cite{4}, and their physical and chemical properties are similar, and the bonding strength is still high in high temperature. When silicon carbide film is formed, the addition of silicon nitride can promote its film formation, resulting in a dense network structure of silicon carbide particles \cite{3}. Therefore, the addition of silicon nitride makes silicon carbide products have a series of excellent performances such as high temperature resistance, wear resistance, acid and alkali corrosion resistance, and the addition of silicon nitride can also reduce the membrane forming temperature of silicon carbide.

In this experiment, the method of solid particle sintering is adopted. Silicon carbide ceramic film is usually used as the main raw material directly. However, the surface of SiC particles is not smooth, and the membrane formation is difficult, and the temperature is higher. By adding different amounts of silicon nitride as raw materials, the effect of addition and conversion of SiC on the formation of SiC membrane and its pore size was investigated.

Experimental

Materials and Synthesis

SiC, Si$_3$N$_4$ and suitable amount of distilled waste were weighed and mixed as shown in the Tab1. Then TMAH were added, and the mixing time were 3h with a speed of 160 r/min, after that, they were put into vacuum for drying oven 2h, next, they were put into sintering furnace at the temperature of 2000 °C.

Characterization

X ray diffraction (XRD) instrument (bruKer, D8 ADVANCE, Germany) was used for analysing the phase composition of these samples, scanning Angle were 10 ° ~ 80 °, scanning speed was 6 (°)/min. Scanning electron microscope (SEM) was used to observe the micromorphology of membrane. The pore diameter distribution of ceramics is measured with aperture analyzer (POROLUXTM500, Germany)
Table 1. Experimental formula.

<table>
<thead>
<tr>
<th>No.</th>
<th>SiC(g)</th>
<th>Si&lt;sub&gt;3&lt;/sub&gt;N&lt;sub&gt;4&lt;/sub&gt;(g)</th>
<th>H&lt;sub&gt;2&lt;/sub&gt;O(g)</th>
<th>PVP(wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>0</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>1</td>
<td>20</td>
<td>0.4</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>2</td>
<td>20</td>
<td>0.8</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Results and Discussion

Figure 1 is an XRD patterns of samples of different sinter additives. As shown in the figure, the main contents of the sinter samples are SiC, the group A is blank, and the XRD graph after sintering indicates that the film contains only one kind of silicon carbide, namely, 6h-sic.

![XRD patterns of ceramic membranes.](image)

Figure 1. XRD patterns of ceramic membranes.

Figure 2 is SEM images of ceramic membranes; the blank group contains a large amount of individual SiC particles. From the scanning electron microscope images of the three sets of B, C and D groups, the sintering strength of the particles increases gradually with the addition of silicon nitride. Therefore, adding Si<sub>3</sub>N<sub>4</sub> is beneficial to sintering silicon carbide particles, forming through hole. At the same time, high strength sintered ceramic membrane can enhance the strength of silicon nitride. There will show grain growth with adding 40% (D group) Si<sub>3</sub>N<sub>4</sub>, which will reduce the strength of the membranes and the membrane pore size.

![SEM images of ceramic membranes.](image)
The addition of silicon nitride is 0, 14%, 28.5%, 42.8% and the pore size distribution of the sample is shown in figure 3. The pore size distribution of all samples is narrow, and the average pore size is 1.7 microns when the amount of silicon nitride is 28.5%, which is consistent with that of SEM.

Conclusions
At 2000 DEG C, silicon nitride reacts with carbon source to form 6H SiC, which forms pure SiC film, promotes the sintering of SiC and improves the strength of SiC ceramic film. While promoting the sintering of SiC and improving the strength of the SiC ceramic film. The pore diameter of the silicon carbide film increases with the increase of the addition of the silicon nitride silicon. This is because silicon nitride and carbon source react to form small silicon carbide particles forming the bridge link between the original silicon carbide particles. Among them, the amount of silicon nitride is 28.5%, which is the best scheme. The average pore size is 1.7 mu m. The particles are bonded to each other, but they are not growing.

References