Preparation and Characterization of Silicon Nitride Bonded Silicon Carbide Ultrafiltration Membrane

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ABSTRACT

Silicon nitride-bonded silicon carbide multiphase ceramic ultrafiltration membranes were prepared by using SiC, silicon powder and nitrogen as raw materials and yttrium oxide as sintering aids. The membranes were characterized by XRD and SEM. The effects of different amounts of SiC on the crystal growth and properties of multiphase ceramic ultrafiltration membranes were investigated. When SiC is 10g, silica powder is 0.75g and yttria is 0.5g, the properties of the ceramic membranes are better, and the average pore size distribution is about 0.1µm.

INTRODUCTION

Inorganic ceramic membrane is a kind of thin film material with high separation efficiency prepared by inorganic non-metallic oxides. Its main principle is to promote the screening of different substances by pressure difference. At present, organic membranes are widely used in industry. Compared with organic membranes, ceramic membranes have many advantages, such as high temperature resistance, chemical resistance, high mechanical strength, strong anti-microbial ability, large permeation flux, strong cleanability, narrow pore size distribution, long service life and so on. At present, the main ceramic films are Al₂O₃, CoO₃, SiO₂, TiO₃, Al₂SiO₅, SiC and so on. [1-4].

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EXPERIMENTAL

The well-weighted experimental drugs were poured into the ball mill pot of the experimental instrument, and 20mL distilled water was added according to the appropriate solid content ratio. This experiment adopts planetary ball mill, the ball milling time is set to 4h, and the speed is set to 160r/min. Tweezers were used to clamp the support and immerse it in the coating solution for about 2~3 seconds. The first layer of coating solution is adsorbed onto the surface of the support and then is coated repeatedly. The silicon nitride-bonded silicon carbide ceramic film was removed after holding at 1440 °C for 3 h and adopting natural cooling mode.

RESULTS AND DISCUSSION

As shown in figure 1, the addition of SiC is 12g, 10g, 8g A, B and C, respectively. We can observe that the main phases of the samples are alpha-SiC and beta-SiC, followed by alpha-Si3N4 and beta-Si3N4, and a small amount of Y2Si2O7. There is no diffraction peak of Si in the samples, but there is SiO2 impurity peak and SiO2 phase content. This indicates that the silicon powder does not nitrate with nitrogen completely.

As shown in figure 2, the appearance of the B group is better, the film type is smooth and has no obvious defects. Silicon nitride whiskers adhere to the surface of silicon carbide particles, connecting adjacent silicon nitride particles, play a role in whisker toughening, improving the strength of ceramic films, with good results, which is also a group of samples closer to the experimental purpose. But silicon carbide particles do not form ideal monomer particles, but condense into lumps, which may affect the performance of the film. At the same time, lumpy silicon carbide leads to the reduction of porosity. Although we have obtained a smaller pore size of the film, but there is no higher porosity.

Figure 1. XRD pattern of sintered samples with different SiC content (A: 12g, B: 10g, C: 8g).
As shown in figure 3, a large number of needle-like whiskers can be found on the surface of group C. Some needle-like whiskers are connected between the particles, which proves that the silicon nitride whiskers have a growth. However, a short rod-like object can be seen in the sample at 1K-fold angle of view, which is not consistent with the shape of SiC particles.
The pore size distribution of ceramic membrane was measured. The pore size distribution of sample B was within the range of 0.07~0.1 m. The aperture distribution of sample C is in the range of 0.5-1.3 micron, and that of sample B is more concentrated than that of sample C, and the average aperture is much smaller.

CONCLUSIONS

In the sintered samples, the sintered samples with 10 g SiC, 0.75 g Si powder and 0.5 g yttrium oxide have obtained the ceramic membrane materials with an average pore size of about 0.1µm, which is more in line with the expected experimental samples.

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