Effect of Different Particle Sizes and Pore-Making Agent Ratio on Properties of SiC Porous Ceramics

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Abstract. In this paper, SiC particles of different particle sizes were used as aggregates to prepare SiC porous ceramics (50-70 mesh, 70-80 mesh and 80-90 mesh), and their flexural strength, filtration pressure drop and porosity were tested. On this basis, SiC with 80-90 mesh size was used as the aggregate, and the properties of porous ceramics were measured by using different proportions of pore-making agent. The results showed that when SiC particles were 80-90 mesh and the ratio of pore-making agent was 2:1, the samples prepared at 1300°C for 1.5h had the best comprehensive performance, the porosity was 33.9%, the flexural strength was up to 38.28 MPa, and the filtration pressure drop was relatively low.

1. Introduction
SiC has very high melting point, bending strength, fracture toughness, and thermal conductivity, as well as low thermal expansion coefficient and density. So SiC is a high temperature strength, strong thermal shock resistance, good thermal conductivity and corrosion resistance of ceramic materials. Therefore, silicon carbide can be chosen as the main material for high temperature dust removal.[1-3]

In the process of preparing porous silicon carbide ceramic support, the addition of flake graphite pore-forming agent is beneficial to the adhesion of ceramic binder on the surface of silicon carbide particles after melting and to reduce the blockage of pores formed by the ceramic binder. By adding activated carbon with a certain particle size, the pore size of porous silicon carbide ceramic support can be effectively controlled, and the pore porosity and pore connectivity of porous silicon carbide ceramic support can be effectively improved without destroying the uniformity of pore structure.[4-6]

In this paper, SiC particles of 50-70 mesh, 70-80 mesh and 80-90 mesh were used as aggregate, and carboxymethyl cellulose sodium (CMC), potassium feldspar, kaolin, quartz, graphite and activated carbon were used as additives to prepare SiC porous ceramic support. Then SiC particles of 80-90 aim were selected as the aggregate to prepare SiC porous ceramic support according to different ratio of pore-making agent. The influence of different particle size and pore-making agent ratio on the properties of SiC porous ceramics was studied by analyzing SEM, bending strength, filtration pressure drop and porosity.[7]

2. Experimental

2.1. Preparation of SiC Porous Ceramics with Different Particle Sizes
Respectively by 50-70 mesh, 70-80 mesh, 80-90 mesh in three different particle size of SiC particles as aggregate, on the basis of the 80-90 mesh size of SiC particles to aggregate with different ratio of
pore-forming agent (as shown in Table 1), using the layered coating method, in turn, add sodium carboxymethyl cellulose (CMC, 2 g/ml), binder, potassium feldspar, quartz, kaolin, pore-forming agent (graphite and activated carbon) stir well, then the blocking body, per minute in the muffle furnace burning heat up the rate of 2 °C to 1300 °C for sintering.

Table 1. Pore-making agent (graphite and activated carbon) ratio

| Number | The ratio of graphite to activated carbon | SiC (g) | Binder (g) | Graphite (g) | Activated carbon (g) |
|--------|------------------------------------------|---------|------------|--------------|----------------------|
| 1      | 3:1                                      | 16.8    | 2.1        | 1.575        | 0.525                |
| 2      | 2:1                                      | 16.8    | 2.1        | 1.4          | 0.7                  |
| 3      | 1:1                                      | 16.8    | 2.1        | 1.05         | 1.05                 |
| 4      | 1:2                                      | 16.8    | 2.1        | 0.7          | 1.4                  |
| 5      | 1:3                                      | 16.8    | 2.1        | 0.525        | 1.575                |

2.2. Characterization of Samples
The analyte was characterized by SEMS4800/TM3000. The filter pressure drop of the sample is measured by vacuum psump. The system consists of glass flowmeter, vacuum pump and differential pressure meter. The porosity of the sample was measured by Archimedes method and ohau electronic balance analysis. Three-point method and YLN electronic press method were used for bending strength.

3. Results and Discussion

3.1. SEM of Sic Porous Ceramic Samples with Different Particle Sizes

![Figure 1](image)

Figure 1. SEM of samples with different SiC particle sizes (a)50-70; (b)70-80; (c)80-90

Figure 1 shows that with the decrease of SiC particle size, the surface of SiC samples becomes denser and the pores become smaller.
3.2 Flexural Strength and Porosity of SiC Porous Ceramic Samples with Different Particle Sizes

![Figure 2](image1.png)

**Figure 2.** Flexural strength of SiC porous ceramics with different particle sizes

![Figure 3](image2.png)

**Figure 3.** Porosity of SiC porous ceramics with different particle sizes with different particle sizes

From the figure 2 and figure 3, with the increase of SiC particle size, the flexure strength of porous ceramics increased, and the porosity decreased first and then increased.

3.3 Filtration Pressure Drop of SiC Porous Ceramic Samples with Different Particle Sizes

![Figure 4](image3.png)

**Figure 4.** Filtration pressure drop of SiC porous ceramics with different particle sizes

Figure 4 shows with the increase of particle size, the strength of SiC porous ceramic support also increased, and the pores first increased and then decreased. The filtration pressure drop of 50-70 mesh was larger, and the filtration pressure drop of 80-90 mesh was higher than that of 70-80 mesh at the beginning, the middle part overlapped, and finally showed a trend of lower than 70-80 mesh.
To sum up, the flexural strength of 80-90 mesh samples is 38.22, porosity is 25.8%, filtration pressure drop is low, and comprehensive performance is the best. Therefore, in the following experiments of different pore-making agent proportions, 80-90 mesh size SiC is selected as the aggregate.

3.4 SEM of Sic Porous Ceramics with Different Ratio of Pore-Making Agent

![Figure 5](image_url)

**Figure 5.** SEM of samples with different ratio of pore-making agent (a) 3:1; (b) 2:1; (c) 1:1; (d) 1:2; (e) 1:3

Figure 5 shows with the increase of activated carbon, the small bubbles in ceramic gradually increase. The formation of these small pores is due to the large particles of activated carbon pore-making agent containing a small amount of activated carbon powder mixed with ceramic binder produced.

3.5 XRD of Sic Porous Ceramics with Different Ratio of Pore-Making Agent

![Figure 6](image_url)

**Figure 6.** XRD of samples with different ratio of pore-making agent
From figure 6, we can see with the change in the proportion of pore-making agent, the materials of SiC porous ceramic support body have only different forms of SiC and Al₂O₃, without other impurities.

3.6 Flexural Strength and Porosity Of Sic Porous Ceramics with Different Ratio of Pore-Making Agent

Figure 7 shows Porous Ceramics with a ratio of 1:2 have the best bending strength. When the graphite proportion is more, the flexural strength is smaller. With the increase of activated carbon content, the bending strength of the sample increases. The reason is that activated carbon contains not only carbon, but also a small amount of chemical binding, functional groups of oxygen and hydrogen, such as carbonyl, carboxyl, phenols, lactones, quinones, ether. When activated carbon is burned and volatilized, these excess activation energies can effectively catalyze the oxidation of SiC surface and the chemical bonding of SiO₂ and Al₂O₃, so as to increase the meeting of mullite and thus increase the bending strength.

On the other hand, porous ceramics with a ratio of 2:1 had the highest porosity. The porosity of samples decreased with the increase of activated carbon content. The reason is that the density of graphite is smaller than the density of activated carbon powder, when the graphite content is more, the volume is large, in the high-temperature sintering, leaving more space, so the porosity is larger.
3.7 Filtration Pressure Drop of SiC Porous Ceramics under Different Pore-Making Agent Ratio

When the proportion of pore-making agent is 1:1, the filtration pressure drop is the smallest. With the increase of activated carbon content, the filtration pressure drop of samples increases. The reason is that graphite acts as a lubricant and acts as a dispersant when mixing billets. When the graphite content is less than the activated carbon content, the activated carbon is easy to accumulate, making the gap unevenness decrease, the surface of the sintered sample is more sunken, and the filtration pressure drop increases.

4. Conclusion
When SiC particles are 80-90 mesh and the ratio of pore-making agent is 2:1, the flexural strength of SiC porous ceramics is 44.7MPa, the porosity is 33.9%, the filtration pressure drop is low, so the performance of porous ceramics is the best.

5. Acknowledgments
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6. Reference
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