Effect of sintering aids on microstructure and properties of textured SiC ceramics prepared in 6 T

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ABSTRACT

C-axis textured α-SiC ceramics were prepared by gel-casting in a strong magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h. The effects of sintering aids on the microstructure and properties of textured SiC ceramics were discussed. Results showed that highly textured α-SiC green bodies were obtained by gel-casting in a strong magnetic field of 6 T. The sintering process slightly suppressed the texture development of α-SiC ceramic. The degree of texture in the α-SiC green bodies and sintered bodies both showed a decreasing trend with the increase of sintering aids content. And the increase of the sintering aids content promoted the densification and improved the bending strength of α-SiC ceramics. Besides, the bending strength of textured SiC ceramics showed an anisotropy based on the grain orientation.

1. Introduction

Silicon carbide has been intensively studied and is suitable for a variety of structural applications such as molten metal filters, diesel particulate filters, gas sensors, and automotive engine parts due to its low density, high thermal shock resistance, high strength at room and high temperature, excellent corrosion, and oxidation resistance [1,2]. Recently, the formation of the crystallographic orientation in SiC ceramics has received much attention for the improvement of the properties and has been an interesting research topic. Many methods have been developed to fabricate the textured ceramics including hot forging, the TGG method, and so on [3,4].

So far, magnetic alignment technology based on the development of a superconducting magnet has been successfully used to control the crystallographic orientation in diamagnetic ceramics. When the particle with magnetic anisotropy in the suspension is placed in the magnetic field, it will be rotated to an angle minimizing the system energy by a magnetic torque generated from the interaction between the magnetic anisotropy and the applied magnetic field [5–7]. Previous studies show that highly textured SiC ceramics can be fabricated by slip-casting in a strong magnetic field of 12 T and subsequent sintering without the magnetic field [8–10]. However, there still exists a difficulty in the fabrication of a strong magnetic field (12 T) and the cost is very high for production or experiments. At present, a strong magnetic field (≥12 T) has a caliber of less than 100 mm in diameter.

And this narrow working space limits the further industrial application for the fabrication of textured ceramics. Conversely, the relatively lower magnetic field (about 6 T) with the bigger caliber (≥300 mm) can be easily fabricated and its cost is also relatively low, which is available for the preparation of textured ceramics with large size. Hence, the fabrication of highly textured ceramics in a relatively low magnetic field is very important for realizing industrial production.

Additionally, the capillary force is introduced to form the green body during the slip-casting process in a strong magnetic field, which influences the grain orientation and uniformity of the sample by competing with the magnetic force [11,12]. For example, the nonuniform texture is formed between the bottom near the porous plaster or alumina mold and the top surface in the samples. And it also needs a long time to complete the solidification of the slurry. However, the gel-casting method can avoid these problems caused by the slip-casting process. This process does not need the extra force and can realize an in-situ polymerization, which is beneficial for preparing the samples with high-quality, uniformity, and complex-shape. What is more, its polymerization time can be controlled by adjusting the amount of initiator and catalyst and the gelled green body has high strength so that the cost of machining is low [13–16]. Our preliminary research showed that the degree of texture could reach to 0.84 in SiC ceramics prepared in a low magnetic field of 6 T compared with other textured SiC prepared in 10 T or 12 T [8–10,17]. These results offer the further possibility to obtain a higher degree of texture in SiC.
ceramic by optimizing the preparation conditions. Therefore, highly textured SiC ceramics with uniformity and complex shape are expected to be obtained by gel-casting in a low magnetic field. Meanwhile, it is difficult to realize the densification of pure SiC ceramics below 2100 °C because of the strong covalent bonding and low atomic diffusion rate during sintering. For example, at 2100 °C, the self-diffusion rate of C and Si atoms is only $1.5 \times 10^{-15}$ cm$^2$/s and $2.5 \times 10^{-13}$ cm$^2$/s. And the sintering aids are required to densify SiC by liquid-phase sintering at a lower temperature. During solid-phase sintering of SiC ceramic, the mass transfer process is realized by the evaporation-condensation and diffusion mechanism. Because there is no liquid phase in the matrix, the mass transfer rate is far lower than that during liquid-phase sintering, leading to the lower sintering densification rate. However, the sintered SiC ceramics have high hardness, excellent high-temperature stability, and high chemical stability owing to the existence of no low-temperature glassy phase in microstructure [18]. S. Prochazka et al. [19] first added less number of B and C into the β-SiC submicron powders and realized the SiC ceramics with a relative density of 98% at 2020 °C by pressureless sintering. During sintering, B and formed B$_2$C were mainly located in the grain boundary, lowering the grain boundary energy. But B overdoses would cause the abnormal growth of grains. The introduction of C could react with silica on the surface of SiC to increase the sintering force of SiC particles. However, the SiC grains easily grow up because the solid phase sintering is realized at the higher temperature, leading to the appearance of the transgranular fracture with crack propagation. As a result, the fracture toughness of sintered SiC ceramic is low. Differently, during the liquid-phase sintering of SiC ceramic, the uniform and fine microstructure can be prepared owing to the lower sintering temperature when the sintering additives are introduced. The fracture mode changes from transgranular fracture to intergranular fracture, improving the fracture toughness evidently [20,21]. It is worth noting that the grain rearrangement and dissolve-precipitate stages could affect the grain texture during the liquid-phase sintering process. In the initial rearrangement stage, the grains will slide and rotate under the function of the liquid phase formed by sintering aids. As a result, these grains are located in a separated state. Further, the rearrangement of grains happens by capillary force, influencing the grain texture. Similarly, during the dissolve-precipitate stage, some small grain will disappear and big grain will grow up, affecting the grain texture. Therefore, the role of sintering aids in texture development is worth researching.

In this paper, textured SiC ceramics with different contents of sintering aids were prepared by gel-casting in a strong magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h. The effects of Al$_2$O$_3$ and Y$_2$O$_3$ as the sintering aids on the microstructure and properties of textured SiC ceramics were discussed.

2. Experimental procedure

Commercially available α-SiC powders with an average diameter of 0.4 μm (supplied by Qingzhou Micro-Powder Co., Shandong, China, 99.8% purity, irregular shape) were used as the starting materials. The XRD pattern and SEM image of raw α-SiC powders were shown in Figure 1(a and b), respectively. The grain size distribution of the powders measured by the laser particle analyzer (LS-POP, supplied by Omec Instrument Co., Zhuhai, China) was shown in Figure 1(c). And the powders showed four peak particle size distribution. A mixture of Y$_2$O$_3$ (Yuelong Co., Shanghai, China) and Al$_2$O$_3$ powders (Yuejiang Titanium Dioxide Chemical Products Co., Shanghai, China) at the weight ratio of 2:3 was used as the sintering aids. The relative content of added sintering aids was 5 wt%, 7.5 wt%, 10 wt%, and 12.5 wt%, respectively. Distilled water was used as the dispersing medium. The TMAH was used as the dispersant. The 5 wt% NaOH solution and 5 wt% HCl solution were used to adjust the pH of the slurry.

The premixes were firstly prepared by dissolving the acrylamide (AM, provided by Shanghai Sinopharm Chemical Reagent Co. LTD, China) as a monomer and methylenebisacrylamide (MBAM, provided by Shanghai Sinopharm Chemical Reagent Co. LTD, China) as a cross-linker into the distilled water. The slurries with 30 vol% solid loading were prepared by adding the powders into premixes slowly. The added TMAH dispersant content was 1 wt% (relative to the total powders). The slurries were ball-milled for 6 h in a plastic bottle with ZrO$_2$ balls to break up the agglomeration. After the pH of the slurries was adjusted at about 11, they were degassed for 15 min in a vacuum desiccator. And then after a certain amount of initiator and catalyst were added into the slurries to reach the well dispersion by stirring for 5 min, the slurries were poured into the mold which was located in the central position of the magnet. The initiator was ammonium persulfate (APS) and the catalyst was tetramethyl ethylenediamine (TEMED). The magnetic field intensity was controlled to be 6 T. The suitable polymerization time was controlled in ~15 min by tailoring the added initiator and catalyst content to complete the grain orientation in the slurries as much as possible. The illustration of the direction of the magnetic field and the orientation of textured SiC grains were showed in Figure 2. The direction of the magnetic field was parallel to that of gravity. After the slurries were solidified completely in a strong magnetic field, the green bodies with 30 mm×10 mm×10 mm were removed out. And the green bodies were dried at 70 °C and 100 °C for 12 h, respectively. The green bodies were heated at 600 °C for
2 h to eliminate the polymer and were then isothermally sintered at 1950 °C for 2 h in a graphite-resistance furnace (supplied by Chenhua Electric Co., Shanghai, China) by using the powder bed at Ar atmosphere. For comparison, these samples with different content of sintering aids were also prepared by gel-casting without the magnetic field.

The viscosity of the slurries with different content of sintering aids was measured by the viscometer (Haake VT550). The crystallographic orientation on the top and side surface in the green bodies and sintered samples was analyzed by the X-ray diffraction (XRD, D/MAX2500V+/PC). The Lotgering orientation factor, \( f \), based on the XRD data determines the degree of texture in the green bodies and sintered samples. The Lotgering orientation factor, \( f \), was shown as following [22]:

\[
f = \frac{P - P_0}{1 - P_0}
\]

where \( P \) or \( P_0 = \sum I(00l)/\sum I(hkl) \). \( P \) was calculated from the peak intensities of the top surface perpendicular to the direction of the magnetic field. \( P_0 \) was calculated from the standard PDF card of α-SiC. Owing to that the calculation process was simple, fast analyzing speed, and inexpensive, the Lotgering orientation factor had been widely used for the characterization of various-textured ceramics. The relative density and apparent porosity of sintered samples were measured by the Archimedes method in the distilled water. The bending strength of sintered samples was measured at room temperature by using a three-point bending test with a span length of 16 mm and a cross-heading speed of 0.5 mm/min. Each data was the average of five samples. The anisotropic microstructure of textured SiC ceramics was scanned by SEM (JSM-6700 F) after the corrosion of polished surfaces using the molten NaOH at 400°C. The grain size measurement was conducted on SEM images by using an image analysis software.
The method was from the literature of Malik et al [23]. The grain size was measured from the top surface of textured SiC ceramics. The longest diagonal and shortest diagonal were measured from the side surface of textured SiC ceramics. The ratio of longest to shortest diagonal is defined to be the aspect ratio. About 300 grains were measured for each sample.

3. Results and discussion

Figure 3 shows the XRD patterns of α-SiC green bodies with different contents of sintering aids prepared by gel-casting with and without a magnetic field of 6 T. It is found from Figure 3(a) that the peak intensities of α-SiC between the top and the side surface in the samples with 10 wt% sintering aids do not show the difference, and these α-SiC peaks also have no difference compared with these in Figure 1(a). This indicates that the sample prepared by gel-casting in 0 T shows a randomly oriented polycrystalline texture. By comparison, in the green body with 10 wt% sintering aids prepared by gel-casting in 6 T, as shown in Figure 3(d), the peak intensity of (006) is extremely high on the top surface perpendicular to the magnetic field but becomes low

Figure 3. XRD patterns of α-SiC green bodies with different contents of sintering aids prepared by gel-casting with and without a magnetic field of 6 T. (a) 10 wt% sintering aids, 0 T; (b) 5 wt% sintering aids, 6 T; (c) 7.5 wt% sintering aids, 6 T; (d) 10 wt% sintering aids, 6 T; (e) 12.5 wt% sintering aids, 6 T.
on the side surface parallel to the magnetic field. Furthermore, the peak intensity of (110) is extremely low on the top surface but becomes relatively high on the side surface. These illustrate that textured α-SiC green bodies with the c-axis parallel to the magnetic field has been prepared by gel-casting in 6 T. Realizing the texture of ceramic in a magnetic field depends on the green fabrication process. It is well known that the colloidal forming approaches are needed to use for the fabrication of textured ceramic in a magnetic field, including slip casting, electrophoretic deposition, and gel-casting. One of the necessary conditions for the magnetic alignment is that the slurry prepared should have well dispersed and low viscosity owing to that only a single crystal can be oriented to align in the magnetic field. Another is that it will rotate when the anisotropic magnetic energy of the crystal is higher than the energy of the thermal motion. Figure 3(b–e) shows the XRD patterns of α-SiC green bodies with 5 wt%, 7.5 wt%, and 12.5 wt% prepared by gel-casting in 6 T, respectively. It is obtained that the green bodies with different content of sintering aids prepared by gel-casting in 6 T both show relatively high crystalline texture. And the other peak intensities except (006) peak show a slightly increasing trend with the increase of sintering aids content.

Figure 4(a) shows the Lotgering orientation factor of the green bodies with different contents of sintering aids prepared by gel-casting in 6 T. The $f_{(006)}$ value of the sample with 10 wt% sintering aids is calculated to be 0. However, it is seen from Figure 4(a) that the $f_{(006)}$ value of the green body with 10 wt% sintering aids prepared in 6 T reaches 0.84, which indicates that highly textured SiC green body can be obtained by gel-casting in 6 T. With the increasing content of sintering aids, the Lotgering orientation factor of green bodies decreases gradually. Especially for the green body with 12.5 wt% sintering aids, it has a lower Lotgering orientation factor of 0.74. This indicates that the increasing content of sintering aids inhibits the texture development in SiC green bodies. It is well known that one of the conditions for the magnetic alignment of grain during slurry consolidation is that the slurry must be well deagglomerated and has low viscosity so that single grain dispersed uniformly in the slurry can be easily rotated in the magnetic field [24,25]. The viscosity of the slurries with different content of sintering aids is shown in Figure 4(b). It is seen that the viscosity of the slurries increases gradually with the increasing content of sintering aids, which inhibits the rotation of SiC grains in the slurries. When a SiC crystal is placed in the magnetic field, its c axis will be rotated to the direction parallel to the magnetic field in order to decrease the system energy by a magnetization torque because the magnetic energy of its c-axis is smaller than that of its a- or b-axes. The magnetic torque is the driving force of magnetic alignment of a crystal, which is shown as the following equation [9]:

$$T = -\frac{\Delta \chi V B^2}{2 \mu_0} \sin 2\theta$$

in which $\Delta \chi$ is the anisotropic susceptibilities ($|\chi_c - \chi_{a,b}|$), $V$ is the volume of particle, $\mu_0$ is the permeability in a vacuum, $B$ is the applied magnetic field, and $\theta$ is the angle between the c-axis in a SiC crystal and the imposed magnetic field direction.

According to the model of Kimura et al, when a SiC crystal with spherical shape is suspended in the suspension, the equation of a crystal rotation by the function of the magnetic field is shown as the following [26,27]:

$$8\pi \eta r^3 \frac{d\theta}{dt} + \frac{2\pi}{3\mu_0} r^3 \Delta \chi B^2 \sin 2\theta = 0$$

In which $\eta$ is the viscosity of the suspension, $r$ is the radius of spherical SiC crystal. The first term is the torque caused by the suspension viscosity due to viscous resistance. This torque will hinder the rotation of a crystal. The gel-time of the slurry was controlled to be constant by the initiator and catalyst contents for each slurries. Therefore, the slurry with higher viscosity will

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**Figure 4.** (a) Lotgering orientation factor of textured α-SiC green bodies with different contents of sintering aids prepared by gel-casting in a strong magnetic field of 6 T; (b) the viscosity of the 30 vol% slurries with different contents of sintering aids versus the shear rate.
produce a higher resistance torque, which goes against the orientation of the crystal. That is, the increasing content of sintering aids decreases the crystal orientation by increasing the viscous resistance. Additionally, it is believed that the increasing number of $Y_2O_3$ and $Al_2O_3$ grains in the slurry may also make the rotation of SiC grains difficult owing to the collision action between the grains. Consequently, the degree of texture, which corresponds to the Lotgering orientation factor or the degree of preferred grain orientation, in the green bodies shows a decreasing trend with the increasing content of sintering aids.

The relative density and apparent porosity of SiC ceramics prepared by gel-casting without and with the magnetic field of 6 T and subsequent sintering are shown in Figure 5. By comparing the relative density and apparent porosity of untextured and textured SiC ceramics, it is found that the texture of the samples during gel-casting in a magnetic field has no evident effect on the densification process via sintering. After sintering, the relative density of the samples shows an increasing trend with the increasing content of sintering aids. Oppositely, the apparent porosity of the samples shows a decreasing trend. When the sintering aids content is 12.5 wt% ($Y_2O_3$: 5 wt%, $Al_2O_3$: 7.5 wt%), the sample with the magnetic field has the highest relative density of 95.85% and lowest apparent porosity of 1.31%. The increasing content of sintering aids promotes the densification process of SiC ceramics by increasing the amount of liquid phase during sintering [28]. In this paper, some pores cannot be eliminated completely and still remain in sintered ceramics owing to that the low solid loading (30%) is used for gel-casting of SiC ceramics. It is obtained that the relative densities of SiC green bodies are only 31.9%, 32.3%, 32.5%, and 32.6%, respectively. As a result, the density of sintered SiC ceramics with high sintering temperature and high sintering aids content is a bit low.

The XRD patterns of α-SiC ceramics with different contents of sintering aids prepared by gel-casting with and without a magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h are shown in Figure 6. It is seen that the $Y_2Al_2O_3$ secondary phase is formed in all samples during sintering. In the SiC ceramic with 10 wt% sintering aids prepared by gel-casting in 0 T and subsequent sintering, as shown in Figure 6(a), the peak intensities of SiC have no difference between the top and side surface, showing that no orientation forms for the sample prepared in 0 T even through sintering. Oppositely, it is observed from Figure 6(b–e) that the peak intensities exist evident change between the top and side surface in the samples with different content of sintering aids prepared by gel-casting in 6 T and subsequent sintering. Similarly, the peak intensity of (006) on the top surface is very high; however, the peak intensity of (110) is highest on the side surface. These show that the oriented polycrystalline structure still exists after the textured green bodies are sintered at 1950 °C. By comparing the peaks intensities on the top surface in the textured SiC samples with different content of sintering aids, it is found that the other peak intensities such as (110), (109), and (116) except (006) peak increase gradually with the increasing content of sintering aids. This illustrates that the degree of texture in sintered SiC ceramic has a decreasing trend with the increasing content of sintering aids, which shows the same tendency of green bodies in Figure 3.

The Lotgering orientation factor of textured SiC ceramics after sintering is shown in Figure 7. For the samples prepared without the magnetic field, the degree of texture is approximately 0, which is irrelevant to the sintering process compared with that of the green body in 0 T. It is found from Figure 7 that with the increasing content of the sintering aids, the degree of texture in sintered samples decreases from 0.83 with 5 wt% sintering aids to 0.63 with 12.5 wt% sintering aids. The increasing sintering aids increase the densification of the samples but decrease the degree of texture in the samples. By comparison, the degree of texture in the sintered sample with the same sintering aids content shows a lower value than that of the green body, which meaning that the sintering process inhibits the texture development of the samples. According to relative reports regarding other systems, the sintering process can promote the degree of texture by the grain growth [5,6,29]. However, abnormal outcome occurs in this study. Base on the grain size distribution of the raw SiC powders in Figure 1(b), it is seen that a few particles with the diameter size (>10 μm) exist in the raw powders. And these extremely big particles may

![Figure 5](attachment:figure5.png)

**Figure 5.** Relative density and apparent porosity of α-SiC ceramics prepared by gel-casting without and with a strong magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h. (RD: relative density; AP: apparent porosity).
quickly settle due to the gravity force before their rotation is finished by the magnetic force, leading to the existence of the unoriented grains in the green body. During sintering, the unoriented particles with an extremely big size will experience the grain growth by consuming the oriented particles with a relatively small size around them though the solution re-precipitation process [21]. Therefore, the degree of texture in the SiC ceramics decreases after sintering. And the decreasing magnitude of the degree of texture in the samples increases with the increasing content of sintering aids by comparing the degree of texture in Figures 4(a) and 7. This is mainly because that the increasing sintering aids promote the sintering process by accelerating the growth of unoriented grains in the samples. Some oriented grains with relatively small sizes are consumed by these grains with extremely big sizes owing to the formation of a large number of the liquid phase, leading to the large decrease of the degree of texture in the samples after sintering.

The SEM micrographs of textured SiC ceramics with different sintering aids contents after sintering at 1950 °C are shown in Figure 8. Figure 8(a,c,e,g)

Figure 6. XRD patterns of α-SiC ceramics with different contents of sintering aids prepared by gel-casting with and without a magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h. (a) 10 wt% sintering aids, 0 T; (b) 5 wt% sintering aids, 6 T; (c) 7.5 wt% sintering aids, 6 T; (d) 10 wt% sintering aids, 6 T; (e) 12.5 wt% sintering aids, 6 T.
shows the surface of textured SiC with 5 wt%, 7.5 wt %, 10 wt%, and 12.5 wt% sintering aids perpendicular to the magnetic field, respectively. It is seen that the SiC grains mainly show equiaxial on the surface. Figure 8(b,d,f,g) shows the surface of textured SiC with 5 wt%, 7.5 wt%, 10 wt%, and 12.5 wt% sintering aids parallel to the magnetic field, respectively. It is observed that some slightly elongated SiC grains occur and are oriented perpendicular to the magnetic field. The anisotropic microstructure occurs on different surfaces perpendicular to and parallel to the magnetic field in the textured SiC samples. Figure 9 shows the average grain size, aspect ratio, and diagonal length of textured SiC ceramics prepared with different sintering aids contents after sintering at 1950 °C. They are measured from the SEM images by using the size measure software. With the increase of sintering aids content from 5 wt% to 12.5 wt%, the average grain size of SiC ceramics mainly has an evident change. The aspect ratio of SiC ceramics increases from 1.6 to 1.8 when the sintering aids increase from 5 wt% to 7.5 wt%. However, at 10 wt% sintering aids, the aspect ratio decreases to 1.6. Up to 12.5 wt% of sintering aids, the aspect ratio increases to 2.0. As shown in Figure 9(b), the longest diagonal was 1.4 for 5 wt% sintering aids, 1.5 for 10 wt% sintering aids, 1.4 for 10 wt% sintering aids, and 1.6 for 12.5 wt% sintering aids, respectively. Among, the diagonal length slightly increases with the increase of sintering aids from 10 wt% to 12.5 wt%. On the contrary, the shortest length slightly decreases from 0.9 to 0.8. Based on the above results, it is concluded that the sintering aids content has no evident effect on the grain size of SiC ceramics.

The bending strength of SiC ceramics prepared by gel-casting without and with a strong magnetic field of 6 T and subsequent sintering are shown in Figure 10. It is seen that the bending strength of the samples without and with a strong magnetic field both shows an increasing trend owing to the densification process caused by the increasing content of sintering aids during sintering based on Figure 5. By comparison, for the sample with the same content of sintering aids, the bending strength of the sample with a strong magnetic field in all directions is both higher than that of the sample without a strong magnetic field. And the bending strength in the direction of load parallel to the magnetic field is higher than that in the direction of load perpendicular to the magnetic field. For the textured sample with 10 wt% sintering aids, the highest bending strength reaches 445.58 ± 24.87 MPa and 372.21 ± 19.98 MPa for the load parallel and perpendicular to the magnetic field, respectively. And for the unoriented sample with 10 wt% sintering aids, the bending strength is 339.89 ± 27.58 MPa. It is concluded from Figure 8 that the microstructure is composed of fine, equiaxed grains, and slightly elongated grains which are aligned perpendicular to the magnetic field. The alignment of elongated grains improves the bending strength of the textured sample. In conclusion, the crystallographic orientation in microstructure is beneficial for the bending strength of SiC ceramics. As the increase of sintering aids from 5 wt% to 12.5 wt%, the degree of the texture of SiC ceramics shows a decreasing trend, and the grain size basically has no evident change from the microstructure. However, the relative density shows an increasing trend (as shown in Figure 5). Therefore, it is believed that the densification process with the increase of sintering aids content promotes the improvement of the bending strength of textured SiC ceramics.

4. Conclusions

Textured SiC ceramics were prepared by gel-casting in the magnetic field of 6 T and subsequently pressureless sintering. The c-axis of α-SiC crystal was aligned parallel to the magnetic field. It is demonstrated that the high degree of texture in the green bodies could be obtained. The increasing content of sintering aids decreases the degree of texture in the green bodies owing to the increasing viscosity and collision force between the particles. After sintering, the degree of texture in samples showed the same variation tendency as that in the green bodies with increasing sintering aids. However, for the sample with the same content of sintering aids, the degree of texture decreased after sintering owing to the abnormal growth of the unoriented grains with extremely big size in the raw materials. The increasing content of sintering aids promoted the densification process of
the samples and improved the bending strength of the samples. The textured SiC ceramics showed an anisotropic bending strength. The bending strength in the direction of load parallel to the magnetic field was higher than that in the direction of load perpendicular to the magnetic field. This indicates that the mechanical properties of SiC ceramics can be improved by tailoring the grain orientation by the magnetic field.

**Figure 8.** SEM micrographs of textured SiC ceramics with different contents of sintering aids on different surface perpendicular to and parallel to the magnetic field. (a), (c), (e), and (g): the surface perpendicular to the magnetic field with 5 wt%, 7.5 wt%, 10 wt%, and 12.5 wt% sintering aids, respectively. (b), (d), (f), and (h): the surface parallel to the magnetic field with 5 wt%, 7.5 wt%, 10 wt%, and 12.5 wt% sintering aids, respectively.
Disclosure statement

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Figure 9. (a) Grain size and aspect ratio (b) diagonal length of textured SiC ceramics prepared with different sintering aids contents after sintering at 1950 °C.

Figure 10. Bending strength of α-SiC ceramics prepared by gel-casting without and with a strong magnetic field of 6 T and subsequent sintering at 1950 °C for 2 h.
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