Structural Characteristics of SiC synthesized from Organosilicon Gel by Sol-Gel Method at Low Temperature

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1. Introduction

SiC is probably the most widely used monoxide ceramic material with attractive properties such as high strength, stiffness, good wear and corrosion resistance, high thermal conductivity, good creep resistance etc.[1-3]. Recently in connection with its application studies on the synthesis of such SiC from organosilicon gel by sol-gel method at low temperature are very active[4, 5]. With the final application and the synthesizing method silicon carbide can be obtained in various forms such as powder, film, whisker etc.[6]. In this research we have tried to form sol-gel compounds using silica gel and TEOS(tetraethyl ortho-silicate) with various types of carbon and to synthesize SiC from them at low temperature, and the structural formation of these prepared SiCs have been studied with the X-ray diffractometer.

2. Experimental

In oder to synthesize SiC high purity silica gel(Junsei Chemical Co. Ltd. Japan) and TEOS(TCI. Co. Japan) have been used as the silicon source starting materials, and as the carbon source starting materials petroleum cokes, active carbon and artificial graphite have been used. As the first step to synthesize silicon carbide we have obtained organosilicon gel by mixing the above two kinds of starting materials in molar ratio and by reacting them in the solution of isopropanol and water at temperature between 180°C and 200°C. In this process a small quantity of HCl was added for the promotion of the reaction. As the second step we have heated each prepared organosilicon gel at 1450°C to synthesize SiC after drying it under 450°C.

3. Results and Discussion

The results of X-ray diffraction analysis for the SiC prepared by the above synthesizing method are shown in Figure 1 and Figure 2. Figure 1 shows the results for the case of using silica gel as a silicon source with various types of carbon. In case of petroleum cokes as a carbon source we can see from the Figure 1 that there are almost no peaks for the synthesized SiC, but mostly peaks for the original petroleum cokes. And for the case of using active carbon we can observe that there are also mainly peaks for the starting material, but with a few peaks for SiC. In case of artificial graphite, however, we can see that there are much peaks for the synthesized SiC, even if their intensities are more or less weak. From these results it seems that the degree of formation of SiC increases in the order of petroleum cokes, active carbon and artificial graphite.

Figure 2 shows the results for the case of using TEOS as a silicon source with various types of carbon. From this Figure 2 we can observe that very weak SiC peaks are formed for the case of

petroleum cokes, but SiC peaks with middle intensities are obtained for the case of active carbon and much SiC peaks with weak intensities are formed for the case of artificial graphite. From these results it seems that in case of using TEOS the degree of SiC formation increases petroleum cokes, active carbon and artificial graphite just as the case of using SiO_2. In comparison of the results of the SiC synthesis by sol-gel method using TEOS with those using SiO_2 it has been shown that the SiC peaks with relative stronger intensities generally occurred in case of SiO_2 than in case of TEOS.

4. Conclusion

From the results of SiC synthesis from organosilicon gel as a silicon source and various types of carbon as a carbon source by sol-gel method at low temperature we could observe that a small quantity of SiC has been formed, even if the formation of SiC has not been perfect. We could also suggest that carbon source starting material in powder form is less reactive than that in the form of organic compounds, but it can be taken into consideration that much SiC be synthesized at low temperature, if we control the reaction conditions so that the perfect sol-gel reaction between the silicon source starting materials could be occurred.

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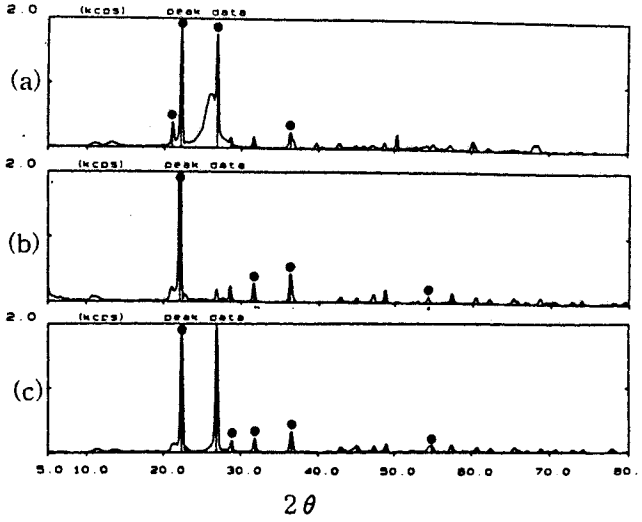

Figure 1. The results of XRD analysis for the prepared silicon carbide with SiO_2 and various carbon source (a) petroleum cokes (b) active carbon (c) artificial graphite(● : new formed peaks)

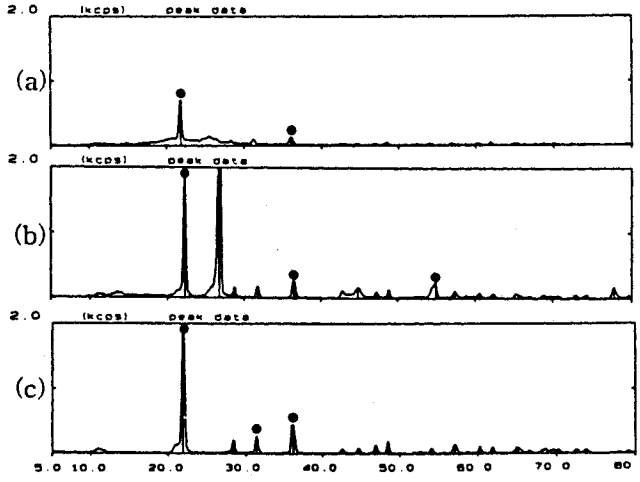

Figure 2. The results of XRD analysis for the prepared silicon carbide with TEOS and various carbon source (a) petroleum cokes (b) active carbon (c) artificial graphite(● : new formed peaks)