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C/C コンポジットと炭化ホウ素のぬれ性の評価

Evaluation of wettability of C/C composites and boron carbide

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1. Introduction

Wetting is the phenomenon at the interface between liquid and solid materials, which depend on the interaction between each material. The contact angle is the angle between the tangent line of liquid surface on solid and solid surface at the point of contact. The magnitude of contact angle indicates the degree of wetting. So far, sintered graphite has been used for crucible materials at high temperatures in microgravity experiments. However, graphite is quite fragile and cannot be completely sealed, therefore samples must be sealed by fused silica or metallic capsules. Carbon Fiber Reinforced Carbon Composite (C/C composites) have much higher strength. If it can be welded, the encapsulation will be simplified.

In this study, we focused on the wetting between molten boron carbide with C/C composite substrate and discuss the feasibility of welding of C/C composite.

2. Methods

Experiments were performed in a grove box filled with argon gas. A small piece of boron carbide was placed on graphite substrates and C/C composite ones, whose dimension is 5 mm thick and 10 mm × 12 mm in size, and an arc discharge was applied directly above them. A TIG welding machine (RILAND/TIG 200P) with a φ1.6 YWCe-2 electrode was used for arc discharge. The output current was 100 [A] DC with positive polarity. The duration of the arc discharge was varied, and the wettability behavior was investigated based on the contact angle between boron carbide and the specimen.

3. Result and Discussion

The temperature of the specimen and boron carbide is increased higher than the melting point of boron carbide due to the arc discharge, the boron carbide was melted and adhere to the substrate. Since molten boron carbide was quite high temperature, it was difficult to measure the contact angle directly. Therefore,

wettability was estimated by measuring the contact angle between the boron carbide and the specimen after the boron carbide solidified.

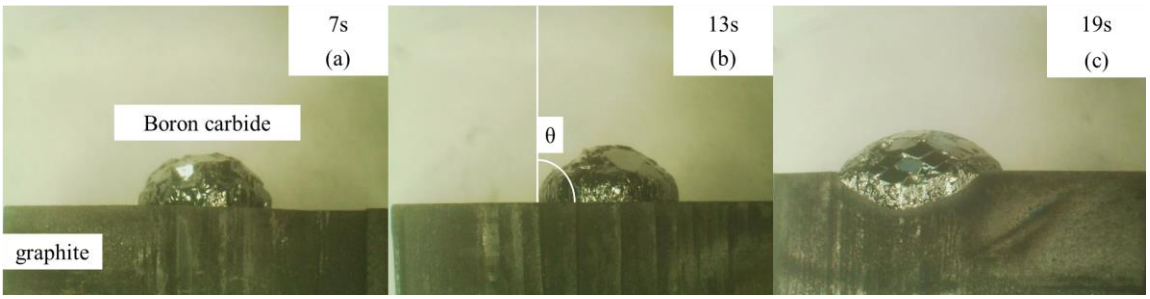

Figure 1. Boron carbide and graphite substrate after melt solidification (a) Melting time 7s (b) Melting time 13s (c) Melting time 19s

Figure 1 shows the results for boron carbide and graphite. The hemispherical solid is the solidified boron carbide. For the measurement of the contact angle, the angle between the solid boron carbide and the surface of the substrate was measured from the image as shown in the figure. The contact angles were measured from four different position of contact points. The average value of contact angles was used for the discussion of wetting. Figure 1(c) shows the image after 19 seconds of melting. The boron carbide was sufficiently wetted to the graphite. The boron carbide spread to the sides of the substrate.

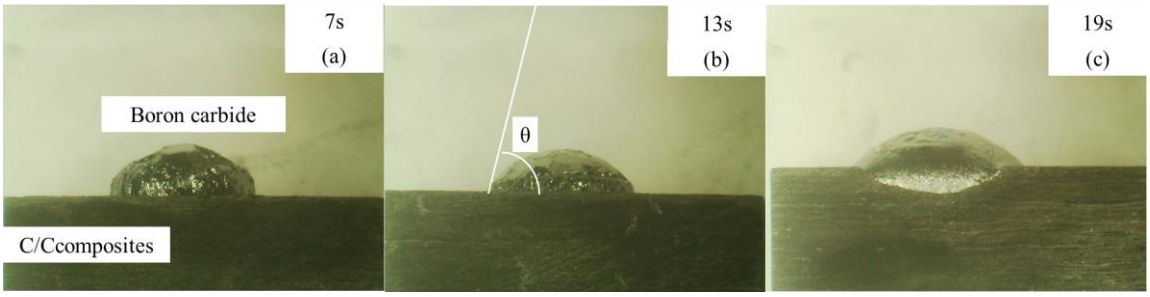

Figure 2. Boron carbide and C/Ccomposites substrate after melt solidification(a) Melting time 7s (b) Melting time 13s (c) Melting time 19s

Figure 2 shows the results for boron carbide and C/C composite, where the contact angle was measured same as graphite case. As can be seen from the comparison of Figure 1(b) and Figure 2(b), C/C composite showed high wettability in a shorter time. The relations of irradiation time and contact angle for substrates are shown in Figure 3.

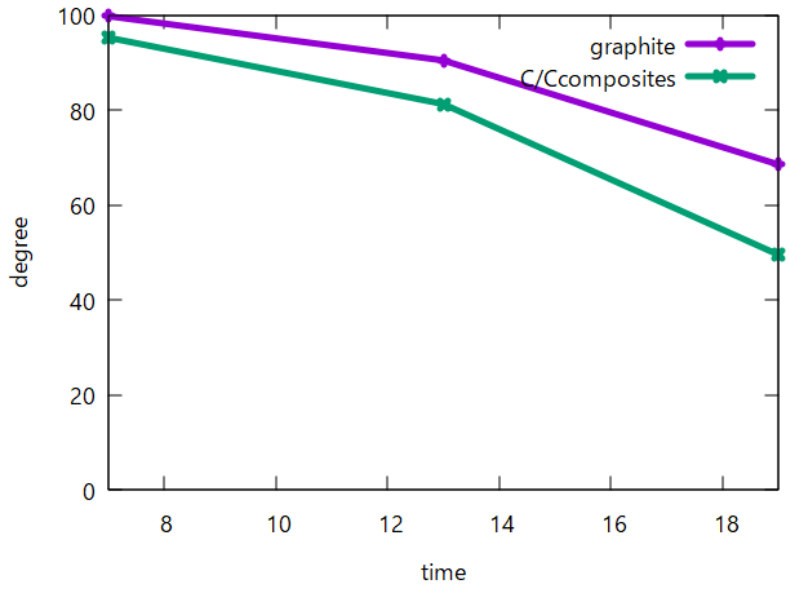

Figure 3. Wettability of boroncarbide and graphite , C/Ccomposites

We can see the wettability of boron carbide for C/C composite is higher than that of graphite for all conditions. It can also be confirmed that the wettability increases with increasing arc exposure time. These results suggest that C/C composite and boron carbide can be welded together.

4. Conclusion

Wettability for boron carbide was found to be greater for C/C composites than for graphite, suggesting that TIG welding can be used to weld boron carbide and C/C composites.