THE INVESTIGATION ON MOLDED CARBON-CARBON COMPOSITE IN SUPER HIGH TEMPERATURE

Su Junming, Su Zhean, Cui Hong, Guo Chen, Li Ruizhen, Li Yadi
The 43rd Institute of the 4th Academy of CASC,China

Introduction

Since 90s, many developed countries have invested much money in the research work of fast fabricating C/C composite, in order to reduce its cost and enlarge its application range.[1.2.3] Such as the MER corporation in USA, its single step method is making C/C composite of 1.6g/cm^3 density by thermal molding the perform (2D or fiber bundles),phenolic resin and carbon filler.[4] The technology of this study is making C/C composite of 1.70 ~ 1.80g/cm^3 by super high temperature(2200 ~ 2500℃) molding the chopped carbon fiber, petroleum coke and high softening point pitch pro rata in the graphite mold. It is an integrate process of preformation, densification and graphitization.

Experimental

1. Raw materials

Short-cut carbon fiber: PAN based, 6K
diameter 7 μ m
length 6mm
density 1.76/cm^3
σ b ≥ 2500Mpa; E ≥ 196Gpa
petroleum coke: particle size ≤ 10 μ m
coal pitch powder: softening point ≥ 140℃
particle size 75mesh
B_4 C powder: purity ≥ 90%

2. Mixing ratio

The content of short-cut carbon fiber is 35 ~ 50%, petroleum coke 10 ~ 25%, coal pitch powder 25 ~ 40% and a little B_4 C powder.

3. The integrate process of super high temperature molding

Mix the raw materials in proportion, which is short-cut carbon fiber being used as reinforcement, petroleum coke as partical matrix carbon,a little B_4 C as catalyst and high softening point coal pitch as adhesive,then put them in the graphite mold. While carbonizing at 350 ~ 550℃,the pressure is 5 ~ 8Mpa, and while at the super high temperature 2200 ~ 2500℃, the pressure is about 15 ~ 25Mpa, so the final C/C composite, of which the density is 1.70 ~ 1.80g/cm^3 ,will be made whithin 8 ~ 10 hours.

Results and discussion

1. Thermal press condition

At the preliminary stage, just 0.5Mpa of pressure is enough to keep the press system contact well and be heated by electric power.

While the temperature up to 380 ~ 550℃, the pressure is about 5 ~ 8Mpa. The press will promote the discomposition-polymerization reaction of adhesive pitch vapour-phase to move to the direction of polymerization, and improve the carbon yield remarkably. The carbon yield of this study is 86%,it is 26% more than that of the ordinary pressure carbonization(60%). In addition, both of the volumetric expansion as carbonization and the volatiles escaping are inhibited by the pressure, so that the fast temperature-rise will help to inhibite the cracking. In the carbonization stage of this study, the temperature-rise rate is 200 ~ 250℃/hr.

At the super high temperature stage of 2200℃ ~ 2500℃, the enlongation rate of C /C can get to3 ~ 8%. On account of the creep characteristic at high temperature, the pressure of 15 ~ 20Mpa will make the C/C composite compress along the altitude, the density increase, the graphitation rate and the thermal conductivity increase.

2. The compressional deformation and the mass loss

Table 1 shows the axial compressional deformation and the mass loss in the thermal press procedure.

Table 1. Compressional deformation and the mass loss of C/C

No.	axial compressional deformation (mm)			mass loss (g)		
	production	reality	difference	raw material	product	loss (%)
1	58	61	3	1203	1078	10.4
2	51	55	4	1195	1080	9.6
3	68	72	5	1360	1220	10.3
4	66	69	3	1390	1280	7.9
5	74	75	1	1380	1260	8.7
6	72	74	2	1475	1300	11.9

While thermal pressed at super high temperature, the

C/C composite will expand slightly in radial direction, its axial compressional deformability rate can be controlled within 4mm, so that the density vibration of C/C products is in very little scale. That is because the press end material graphite T704, which has high strength and high density, doesn't deform during the thermal press procedure.

The mass loss of the raw material is because of the volatiles escaping of the adhesive pitch decompositing, and the 7 ~ 8% of volaties of petroleum coke and carbon fiber at super high temperature. The total loss of the C/C products is 8 ~ 12%.

3. Density and graphitization rate

According to different technical requirements, the density of this study system is in the scale of 1.70 ~ 1.85g/cm^3 ,and its vibration can be controlled within ± 0.03g/cm^3 . The value of d_{002} is 0.3375 ~ 0.3376,that is the 74 ~ 76% of the graphitization rate.

Conclusions

The integrate technology of preformation, densification and graphitization by super high temperature press is feasible to fabricate the low-cost, short-period C/C composite. It can be used to make little scale SRM throat and the carbon brake of high speed train and automobile.

References

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