

# 3D COARSE WEAVE C/C COMPOSITE MOULDED AT SUPER HIGH TEMPERATURE

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## INTRODUCTION

Carbon/carbon (C/C) composite has been widely used as thermostructure and abrasion materials since 70s for it has the characteristics of low density, unique high temperature resistance and high specific strength, but the application range of C/C is limited because of its long manufacturing period and high cost. The new C/C of this study with the 3D coarse weave reinforcement, which is pre-impregnated pitch, will get the density of 1.60~1.70g/cm<sup>3</sup> after the muolding process at super high temperature (2200~2500 °C), it has better mechanical property in axial direction, and the advantages of simple technology, low cost, and more application.

## EXPERIMENTAL

1. After the 3D coarse weave reinforcement impregnated pitch, the C/C of 1.60~1.70g/cm<sup>3</sup> final density, is made by the process of moulding at 2200~2500°C.

2. The mechanism of moulding at super high temperature

C/C composite has quasi elastic-plasticity at room temperature, but its fracture strain is still very low, at the range of 0.2~0.6%. As the temperature rised, the elongation increases sharply, it can get 3~8%. According to the plasticity of creep at high temperature, C/C composite with higher density, graphite degree and thermal conductivity can be made by the process of moulded at super high temperature. This is the base mechanism of our technology. The creep property at high temperature of carbon-graphite materials is related with temperature, pressure and the kinds of material. Figure 1 shows the relation between the deformation rate and the pressure, temperature and time of high strength graphite.

## RESULTS AND DISCUSSION

1. The properties of moulded 3D coarse weave C/C

Table 1 is the comparition of 3D coarse weave C/C

and chopped fiber reinforced C/C, which has the same moulded process. Figure 2 is the machined production of 3D coarse weave moulded C/C.

Table 1. The properties of two kinds of moulded C/C

Properties	3D coarse weave C/C	Chopped fiber moulded C/C
Density, g/cm <sup>3</sup>	1.60~1.70	1.86~1.89
Tensile strength, MPa	39.2	20.3
Compress strength, MPa	x-y	66.2
	z	208
Flexure strength, MPa	55.4	57.8

Although the 3D coarse weave moulded C/C has lower density than the chopped fiber moulded C/C, it shows great increment of mechanical properties, especially the property of axial direction. During the hot press process, chopped fiber in x-y direction distribute randomly of chopped fiber moulded C/C, but it has little fibers in z direction to improve the reinforcing effective of C/C composite.

2. The effects of pressure on the carbonization

Being the adhesive of carbon materials, the pitch has 91% or more of carbon content, but its carbon yield is just about 60% at normal pressure. That is to say the 1/3 amount of pitch carbon will be losing during the carbonization at normal pressure. If there is the pressure about 2~5MPa in the carbonization procedure, the carbon yield will be 75~80%, it is 15~20 percent more that of normal pressure. Figure3 is the carbon yield of coal tar pitch at pressure hot balance.

Without pressure in carbonization, the mounts of low molecular aromatic and aliphatic compound don't polymerize at lower temperature (<300°C), and escape from the billet, and the pitch will also bleedout for its low viscosity. At the condition of pressure, the polymerization reaction can be improved to form high molecular dense-cyclo aromatic compound, on the other hand, the decomposition material is difficult to escape, and has

polymerized again effectively. So the carbon yield of pitch increases under pressure.

### Conclusions

Using pre-impregnated 3D coarse weave reinforcement, the C/C composite with improved properties can be made by the technology of moulded at super high temperature, it has the advantages of simple process, and low cost.

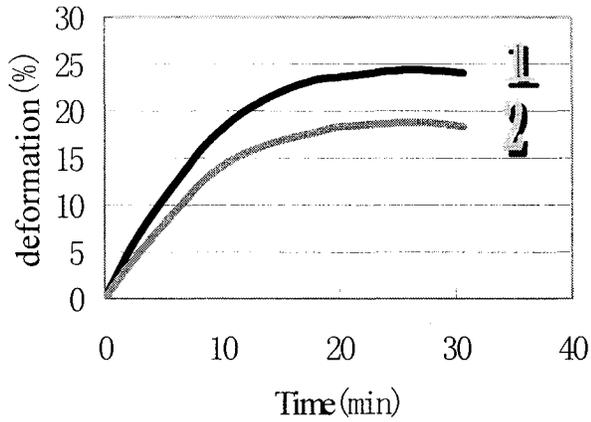


Figure 1. The effects of hot press pressure, temperature and time on the deformation rate of high strength graphite

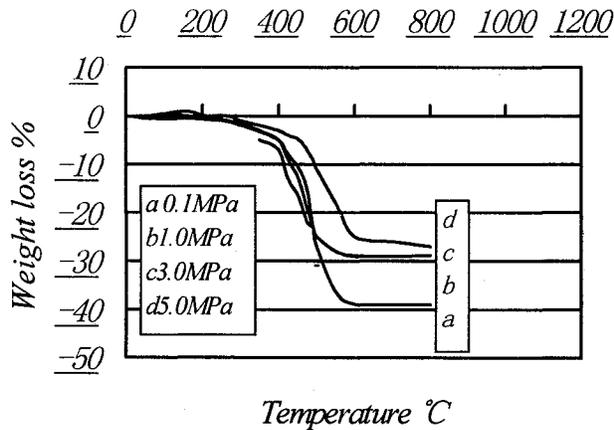


Figure 3. The carbon yield of coal tar pitch at pressure hot balance.

### References

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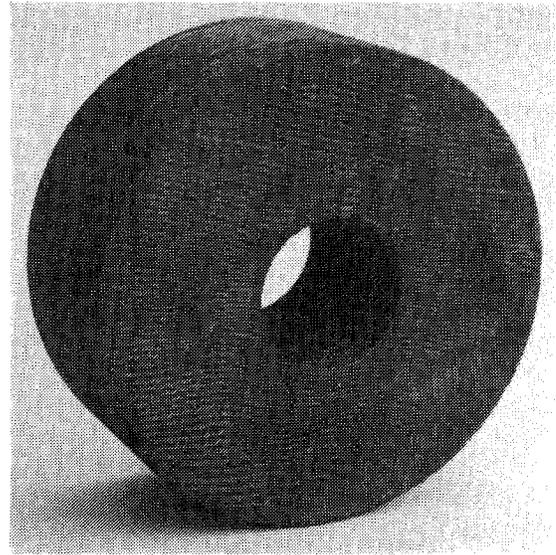


Figure 2. The machined production of 3D coarse weave molded C/C.