STUDY OF THE MANUFACTURE AND PROPERTIES OF C/C COMPOSITES FROM CARBON CLOTH

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1 INTRODUCTION

C/C composites have many outstanding properties, such as low density, high tensile strength, high temperature resistance, excellent thermal shock behavior, high thermal and electric conductivity and good wearability[1]. They are widely used as non-structural materials in aircraft brakes, thermal protection parts and rocket nozzle, while they are used as structural parts only in space aviation, satellite, flywheel and hipbone replacement[2-6]. Although C/C composites for aircraft brakes application have been industrialized, complicated equipment, long production cycle, and high production expense limit their extensive uses.

The are two main ways to dentisify C/C composites: CVD or CVI and impregnant methods[7,8]. In order to decrease the cost of C/C composites, in this paper, the process and properties of C/C composites with rapid densification from carbon cloth by impregnate method were studied.

2 EXPERIMENT

2.1 Raw Materials:

Reinforcement:

PAN-based Carbon cloth(7.5×7.5Tows/cm^2)

Single filament properties of warp:

Tensile strength: 2.22GPa;

Tensile Modulus: 235GPa;

Elongation: 0.95%;

Diameter: 6.51μ

Single filament properties of weft:

Tensile strength: 2.76GPa;

Tensile Modulus: 248GPa;

Elongation: 1.15%;

Diameter: 5.48μ

Properties of carbon cloth:

Longitudinal Tensile Strength: 85.2MPa;

latitudinal Tensile Strength: 110.8MPa;

Matrix: modified pitch: MP(S.P.= 83□, Carbon Yield: 65.4%)

impregnant: Mesophase Pitch, MP-1(AC>90%, S.P.: 268□, Carbon Yield: 87.5%), MP-2 (AC≈50%, SP.: 251□,Carbon Yield: 86.3%)

2.2 Process and condition of Technology:

The schematic process of manufacture C/C composites is shown as Fig.1.

2.3 Test method and apparatus

2.3.1 Fracture morphology of C/C composites testament: SEM 250III

2.3.2 Mechanical performance testament

1) Testament standards: China National Standards: GB1447-83; GB1448-83; GB1449-83

2) Apparatus: Instron 1185 materials testament apparatus

3 RESULTS AND DISCUSSION

3.1 Effect of impregnant on the density of C/C composites

Impregnant are very important for the densification of C/C composites. Mesophase pitch has the advantage of high carbon yield and excellent mechanical properties, so it was considered to be an excellent impregnant recently.

Tab.1 show the results of the density change of C/C

composites by using different impregnant. The density of C/C composites reached about 1.50 g/cm^3 after 4 cycles, increased around 0.7 g/cm^3. In those cycles high softening point mesophase pitch (MP-1) was used as impregnant. The results show that use this kind of impregnant is a quickly densification method. Due to the size of pore and crack decreased with the increasing of the density of C/C composites during densification process, MP-1 was no longer good impregnant, so lower molecule weigh impregnant was needed. In the experiment lower softening point mesophase pitch (MP-2) was used at the fifth cycle, then modified pitch (MP). Density of C/C composites increased to 1.70g/cm^3 after next 3 cycles. This result showed that it is better to change impregnant for fast densification.

3.2.2 Fracture morphology of C/C composites from carbon cloth

Fracture morphology C/C composites was studied by SEM. It is found that there is a little binder between fibers and lots of pore when density is 1.55 g/cm^3 (Fig.2 a). When density came to 1.60 g/cm^3, binder between fibers increased(Fig2 b), but quite a few pores remained. Pore decreased greatly at density of 1.67 g/cm^3(Fig.2 c) and became the least when density of C/C composites reached 1.76 g/cm^3(Fig.2 d).

3.3 Mechanical properties of C/C composites from carbon cloth

The results of the mechanical properties of C/C composites are shown in Tab2.

Form Tab.2, It is seen that when its density reached 1.55 g/cm^3, C/C composites from carbon cloth had good mechanical properties. In addition, it had lower density which is a wonderful performance for aircraft and space shuttle.

4 CONCLUSION

4.1 C/C composites from laid-up carbon cloth reinforced in Z direction have good Mechanical properties.

4.2 Using different impregnant, after 8 times cycle, C/C composites with lower density 1.76 g/cm^3 were obtained.

Acknowledgment:

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Reference

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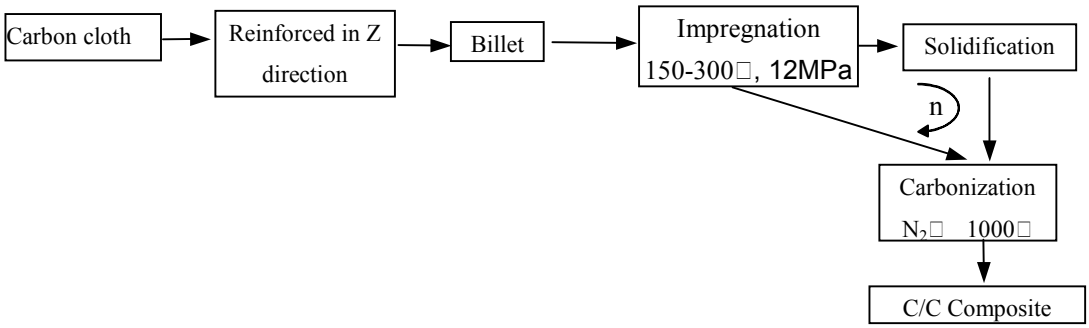
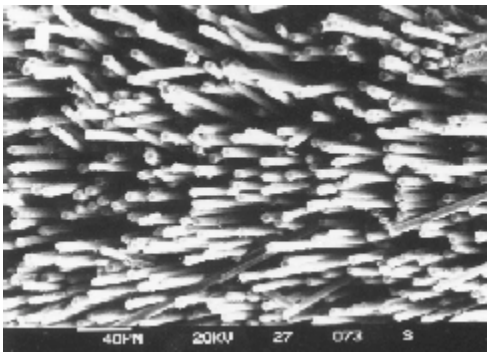
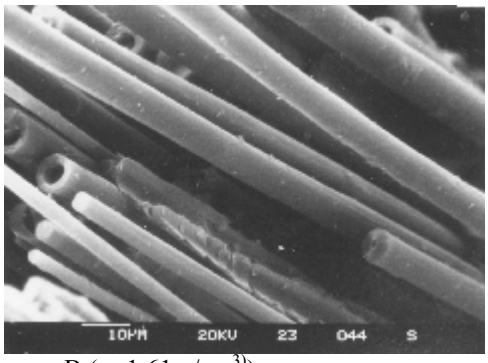


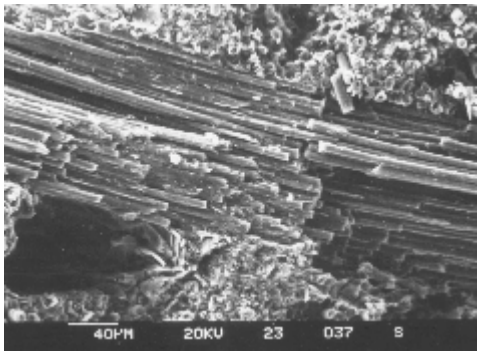
Fig. 1 Schematic of manufacture C/C composites from carbon cloth



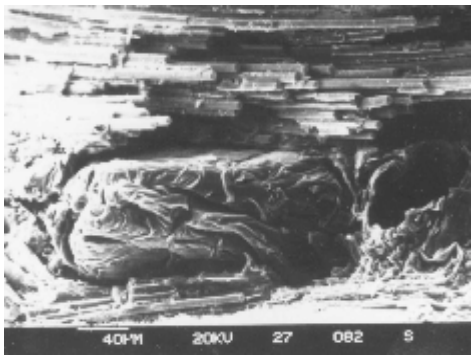
A (ρ=1.55 g/cm^3)



B (ρ=1.61 g/cm$^{3)}$)



C (ρ=1.69 g/cm^3)



D (ρ=1.76 g/cm^3)

Fig2 SEM images of Fracture morphology of C/C Composites from carbon cloth

Tab.1 Density change of C/C composites with different impregnation agent

Sample	Density(g/cm^3)	Cycle Times							
		1	2	3	4	5	6	7	8
1	0.81	1.09	1.26	1.46	1.55				
2	0.73	1.12	1.28	1.34	1.48	1.52	1.61		
3	0.80	1.15	1.24	1.36	1.48	1.56	1.61	1.68	
4	0.84	1.18	1.33	1.41	1.57	1.65	1.69	1.70	1.76

impregnant: 1-4cycle: MP-1, 5cycle: MP-2 ; 6-8cycle: modified pitch.

Tab. 2 Mechanical properties of C/C composites

Sample Number	Density (g/cm^3)	Tensile Strength (MPa)	Flexural Strength (MPa)	Compressive Strength (MPa)
1	1.55	40.85	105.73	104.33
2	1.61	--	106.00	148.00
3	1.68	--	115.30	226.00
4	1.76	87.03	113.56	199.49