INFLUENCE OF RESIN-DERIVED CARBON ON WEAR PERFORMANCE OF CARBON CARBON COMPOSITES

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Introduction

C/C composites have been widely used as aircraft brake materials. The performance of C/C composites is decided by microstructure and mechanical properties of carbon fiber and matrix concurrently. Nowadays, matrix carbon of C/C composites used in aircraft brake disc is mainly rough laminar (RL) pyrolytic carbon or RL pyrolytic carbon adding resin or pitch-based carbon. C/C composites with pure RL pyrolytic carbon usually have excellent friction and wear performance, however the high preparation cost limits their industrial applications [1-4]. Although mixing process of CVI and impregnation can effectively reduce the cost of material preparation, resin-derived carbon, or pitch-derived carbon affects the friction and wear behaviors of the composites. Xiong et al. [5] reported that the C/C composites with a high textured RL pyrolytic carbon can form a more compacted and continuous friction film, and have a more appropriate and stable friction coefficient and a lower wear rate under various conditions. In this presentation, the microstructure and wear properties of the C/C composites with different resin-derived carbon content have been investigated.

Experimental

Three kinds of C/C composites were made from a three-dimensional needled carbon fiber preform. The preform of sample A was densified by CVD; the preform of sample B was impregnated with furan resin only; the preform of sample C was first densified by CVI to 1.60g/cm^3, and then impregnated with furan resin. The densities of the C/C composites were 1.80~1.82g/cm^3. Braking tests at different braking speeds were performed in the MM-1000. The values of braking speeds were 5, 10, 15, 20, and 25m/s, respectively, while the braking pressure and the inertia were maintained at 0.6Mpa and 0.3 kg m^2, respectively. Metallographic observation was performed on POL YVAR2 MET. Friction surface and debris without any treatment were observed on JSM-6360LV.

Results and Discussion

Fig. 1 shows the microstructures of the three samples under polarized light. It can be seen that pyrolytic carbon in sample A exhibited extinction angle, Ae =18° which is a characteristic of RL pyrolytic carbon [6]. The carbon fibers in sample B are surrounded by two lamellae, the first resin-derived carbon obviously shows extinction phenomena. In contrast, the resin-derived carbon far from the carbon fiber does not show extinction phenomena. Pyrolytic carbon in sample C exhibited extinction angle, Ae =20°, resin-derived carbon exists in the gap of pyrolytic carbon.

Fig. 2a shows the friction coefficients of the three composites changed with braking speeds as a similar trend, which all have the lowest value at 5m/s condition, with the brake speed increases, the friction coefficient reached the peak value at the medium braking speed.

As shown in Fig. 3, friction coefficient curves of different samples have the similar shape, which consistent with the typical characteristics of the friction coefficient curve of C/C composite as brake material.

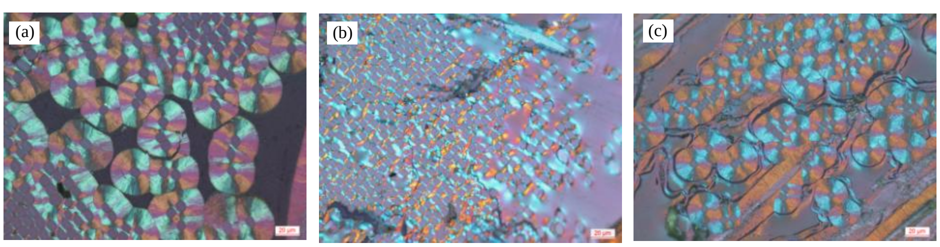

Fig. 1 Characteristic microstructures of C/C composites in PLM.
Sampl A (a), sample B (b), and sample C (c).

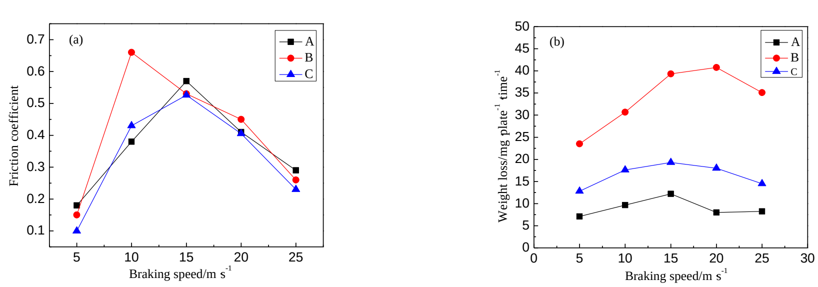

Fig. 2 Relationship between friction properties and braking speeds
(a) Friction coefficient-braking speeds curves; (b) Weight loss-braking speeds curves

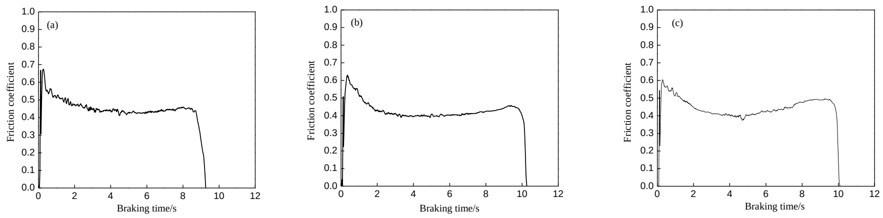

Fig. 3 Friction coefficient-time curves at 20m/s
(a) Sample A; (b) Sample B; (c) Sample C

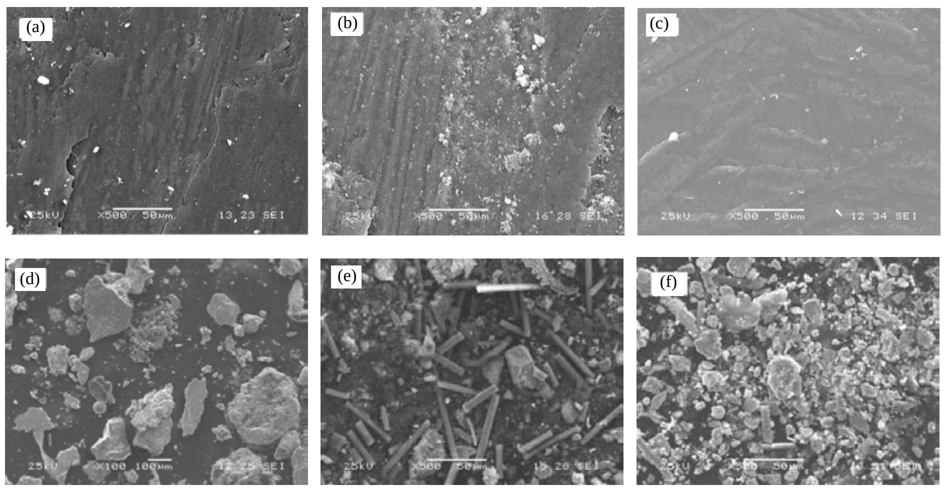

Fig. 4 Morphologies of friction surface and debris
(a)Friction surface of sample A; (b) Friction surface of sample B; (c) Friction surface of sample C
(d) Wear debris of sample A; (e) Wear debris of sample B; (f) Wear debris of sample C

Fig. 2b demonstrates that with increasing braking speed, the mass wear rates of three samples increased first and decreased afterwards. Weight loss of sample B is much higher than those of the other two samples at all braking speeds.

During the braking test, friction film is formed and then destroyed repeatedly, this will reach a friction dynamic balance. Morphologies of friction surface and debris are shown in Fig. 4. Compacted and continuous friction films are formed on the surface of three samples. On the contrary, there is very great difference among the morphologies of debris of three samples. Debris of sample A is platelet-shaped, which resulted from the splitting of the friction film. While debris of sample B is mainly composed of granular chippings and chopped carbon fibers. With resin-derived carbon content increasing, many more carbon particles are generated, as a consequent, it is more difficult to reach the friction balance, and the wear rate of materials increases rapidly.

Conclusions

The friction coefficients of three C/C composites with different resin-derived carbon content densified by CVD/CVI and impregnation have the same characteristic, and they have the similar average values, which change with braking speed as the same trend, and the friction curves are in accord with the requirement for brake disc. However, wear rates of C/C composites increase significantly with resin-derived carbon content.

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