

GOLF CLUB SHAFT

The present invention relates to golf club shafts, and more particularly to a golf club shaft which can exhibit vibration characteristics close to those of a steel shaft without impairing the advantageous characteristics of a so-called carbon shaft.

Golf shafts include steel shafts, carbon shafts and the like. The carbon shaft has the merit in being lighter than the steel shaft, and therefore carbon shafts are widely used. However, the carbon shaft has the problem that a sense of flexure like a steel shaft cannot be obtained.

This is shown in Fig. 6 which shows vibration attenuation characteristics. In Fig. 6, the solid line indicates the case of a carbon shaft whereas the broken line indicates the case of a steel shaft. As will be apparent from Fig. 6, in the case of the steel shaft, since the damping factor is low, it takes some time before the vibration is damped. On the other hand, in the case of the carbon shaft, since the damping factor is high, the vibration is damped more quickly.

The damping characteristic of vibration will be discussed in relation to the swinging operation of golf. The golf club swings back from the address state to the top state. Then, a down swing is effected to hit a ball.

At that time, in the case of the steel shaft, the shaft is rearwardly flexed by the back swing, and the flexed state thereof is maintained in the course of the down swing. This results from the fact that the damping factor of vibration is low as previously mentioned. The shaft is returned forwardly when it hits a ball, and therefore, a

sufficient head speed is obtained.

On the other hand, in the case of the carbon shaft, since the damping factor of vibration is high as previously mentioned, the flex state cannot be sufficiently maintained in the course of the down swing and the shaft becomes returned. Therefore, the "sense of flexure" is not sufficiently secured and the head speed becomes slow.

One previously proposed golf club shaft is shown in Fig. 7 in which metal fibre (for example, amorphous fibre, stainless fibre, etc.) is spirally wound about an inner layer or an outer layer of a carbon shaft.

However, this shaft is designed principally to prevent torsion of the shaft but not to improve its flexing characteristics.

It is an object of the present invention to provide a golf shaft which can improve the flexing characteristics, i.e. the vibration characteristics, without impairing at all the characteristics possessed by a carbon shaft.

According to the present invention there is provided a golf club shaft comprising an axially inner region and an axially outer region, wherein the inner region includes a reinforcing layer of a synthetic resin impregnated in a reinforcing fibre material principally composed of carbon, and the outer region includes metal fibres extending in a direction substantially parallel to the axis of the shaft.

Preferred characteristics of the shaft are as follows:

- (1) Diameter of fibre: 30 to 150 μm
- (2) Tensile strength: 80 to 500 kgf/mm^2

(3) Modulus of elasticity: 10 to 25 tonf/mm²

The metal fibre may be extended in the range of $\pm 5^\circ$ with respect to an axis of the shaft.

5 The metal fibre may be arranged at intervals of 0.2 to 0.3 mm.

In a golf shaft according to the invention, the metal fibre is provided on the surface of the outer layer of the shaft.

10 By the provision of the metal fibre as described above, it is possible to obtain vibration characteristics extremely close to the vibration characteristics of steel shafts without impairing at all the characteristics of shafts principally comprised of carbon fibres.

15 Embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a cross-sectional view of a golf club shaft;

20 Fig. 2 is a plan view showing a part of a prepreg (pre-impregnated material) of metal fibre and carbon fibre;

Fig. 3 is a sectional view taken on line III-III of Fig. 2;

25 Fig. 4 shows characteristics of various metal fibres;

Figs. 5(a) to (f) show the steps of a method of manufacturing a golf shaft;

30 Fig. 6 shows vibration characteristics; and

Fig. 7 is a side view showing part of a previously proposed golf shaft.

35 One embodiment of the present invention will be described hereinafter with reference to Figs. 1 to 5.

Fig. 1 is a cross-sectional view of a golf club shaft according to the present embodiment. The shaft comprises an inner layer 1 and an outer layer 3.

5 The inner layer 1 has a prepreg 5 of carbon fibre, a hybrid prepreg 7 of boron fibre and carbon fibre and a prepreg 9 of carbon fibre laminated in order from the inner side. On the other hand, the outer layer 3 is composed of a hybrid prepreg 11 of
10 metal fibre and carbon fibre.

 The prepreg will be described. The prepreg (pre-impregnated material) herein is a material in which a matrix resin is impregnated in a reinforcing fibre material to have a shape which can be moulded
15 easily. The reinforcing fibres have the following forms:

- (1) Unidirectional prepreg
- (2) Fabric prepreg
- (3) Yarn prepreg
- 20 (4) Mat prepreg

 The prepreg of carbon fibre mainly includes unidirectional prepreg and fabric prepreg. The yarn prepreg and the mat prepreg are often used minorly in a combination of unidirectional prepreg and fabric
25 prepreg.

 There are two methods for manufacturing a prepreg, i.e. a wet method and a dry method. The wet method is to melt a resin into a solvent to have a low viscosity before impregnation. The dry method is
30 to heat material to have a low viscosity before impregnation.

 The aforementioned prepreg 5 of carbon fibre, the hybrid prepreg 7 of boron fibre and carbon fibre and the prepreg 9 of carbon fibre use the
35 carbon fibre, boron fibre and carbon fibre as the

reinforcing fibre material and are manufactured by the above-described dry method and wet method.

5 In the hybrid prepreg 11 of metal fibre and carbon fibre, as shown in Fig. 2, metal fibres 15 are extended approximately in an axial direction of the shaft on the surface of a sheet 13 with glass cloth impregnated. The hybrid prepreg has a cross-sectional section as shown in Fig. 3. Actually, a sheet of carbon fibre is pressed on the metal fibre 10 15, but the carbon fibre sheet is not shown.

The hybrid prepreg 11 of metal fibre and carbon fibre is basically manufactured by the dry method or the wet method, but is different from conventional prepreps in that the prepreg 11 is 15 provided on its surface with the metal fibre 15. The method for the manufacture of the prepreg will be described hereinafter.

First, a hot melt type thermosetting resin is coated on a plain weave glass cloth having a 20 weight of 30 to 50 g/m², or the glass cloth is passed through the thermosetting resin so that resin is impregnated in the glass cloth to prepare a sheet 13. The ratio between the glass cloth and the thermosetting resin is that the glass cloth is 40 to 25 65 in weight %.

Next, the sheet 13 is dried to the extent that the tip of a finger sticks thereto when depressed. After drying, the sheet is wound in a state in which a polyethylene film (PE film, not 30 shown) having a thickness of approximately 20 μ m is sandwiched as a separator.

The PE film is pasted on the outer peripheral surface of the drum in a state in which the PE film is positioned on the side of the drum. 35 At this time, care is given so as not to produce

wrinkles.

In this state, the metal fibres 15 are mounted to the sheet 13 at intervals of 0.2 to 0.8 mm while rotating the drum. The tension of the metal fibre 15 is preferably in the order of 30 to 250 g.

Next the metal fibre 15 and the glass cloth sheet 13 with the resin impregnated are pressed by pressing a roller.

Then, the material in which the metal fibre 15 and the glass cloth sheet 13 with the resin impregnated are pressed is removed from the drum, the carbon fibre sheet is pressed on the metal fibre 15, and the PE film is peeled off. The hybrid prepreg 11 of metal fibre and carbon fibre is now prepared. Thereafter the material is cut into a predetermined shape.

The metal fibre 15 will be described hereinafter. The metal fibre 15 used should preferably fulfil the following conditions (1) to (3):

- (1) Diameter of fibre: 30 to 150 μm
- (2) Tensile strength: 80 to 500 kgf/mm^2
- (3) Modulus of elasticity: 10 to 25 tonf/m^2

Material fulfilling the conditions (1) to (3) are as shown in Fig. 4. In the preferred embodiments SUPER-FINE METAL (trade mark, manufactured by K K Kobe Seikosho) is used.

SUPER-FINE METAL is a superfine-diameter wire having a superhigh strength having superfine particles of 20 $\text{\AA}$, which is excellent in mechanical properties such as bending, shearing and torsional deformation resistances, and high toughness.

Next, a method for manufacturing a golf shaft will be described. Fig. 5 shows the method for manufacturing a golf shaft in order of steps. First, as shown in Fig. 5(a), the carbon fibre prepreg 5,

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cut into a predetermined shape, is drawn out and flattened to remove twists.

5 Subsequently, a release medium is coated on an outer surface of a core not shown, a resin is coated thereon and the carbon fibre prepreg 5 is wound thereabout. At this time, an angle of fibre is 30° to 40° with respect to the axis as shown in Fig. 5(b).

10 Then, the hybrid prepreg 7 of boron fibre and carbon fibre is wound, as shown in Fig. 5(c). An angle of fibre is $\pm 3^{\circ}$ with respect to the axis.

As shown in Fig. 5(d), the carbon fibre prepreg 9 is wound. An angle of fibre is $\pm 5^{\circ}$ with respect to the axis.

15 As shown in Fig. 5(e), the prepreg 11 of metal fibre and carbon fibre is wound. An angle of fibre is $\pm 3^{\circ}$ with respect to the axis.

20 Further, as shown in Fig. 5(f), the carbon fibre prepreg 15 cut into a predetermined shape is wound in order to strengthen a joined portion with respect to a head not shown. An angle of fibre is $\pm 3^{\circ}$ with respect to the axis.

25 After all the prepregs have been wound, a polyester tape, a cellophane tape or polypropylene tape is wound thereabout. In this state, it is heated at 130 to 145°C for 120 to 130 minutes to be hardened.

30 Upon completion of heating and hardening, the core is removed, the tape is peeled off and the surface is polished to make it smooth. Finally, a transparent coating is applied.

The characteristics of the golf club shaft according to the present embodiment will now be described.

35 First, since the golf shaft is composed

principally of carbon fibre, the golf shaft is light in weight and the characteristics of the conventional carbon shaft are maintained as they are.

5 Next, with respect to the flexure characteristic, since the metal fibre 15 is extended approximately in an axial direction of the shaft on the surface of the outer layer 3, a flexure characteristic close to that of the conventional shaft can be obtained. Accordingly, sufficient
10 "sense of flexure" is secured from the top swing to the down swing so that the head speed can be increased.

 According to the above-described embodiment, the following effects can be obtained.
15 First, it is possible to obtain vibration characteristics extremely close to those of a steel shaft without impairing at all the characteristics of the conventional carbon shaft.

 Secondly, since the metal fibre 5 is
20 arranged on the surface, the wear resistance is enhanced, high resistance to bending, shearing and twisting can be obtained, and the mechanical strength is improved.

 In addition, since the metal fibres 15
25 arranged in order are visible, the golf club shaft presents a pleasing appearance.

 While the preferred embodiment of the present invention has been described, it is evident that various changes and modifications thereof can be
30 made without departing from the principle thereof.

CLAIMS

1. A golf club shaft comprising an axially inner region and an axially outer region, wherein the inner region includes a reinforcing layer of a synthetic resin impregnated in a reinforcing fibre material principally composed of carbon, and the outer region includes metal fibres extending in a direction substantially parallel to the axis of the shaft.
 2. A golf club shaft as claimed in Claim 1 wherein the diameter of the metal fibres is in the range of 30 to 150 μm .
 3. A golf club shaft as claimed in Claim 1 or Claim 2 wherein the tensile strength of the metal fibres is in the range 80 to 500 kgf/mm^2 .
 4. A golf club shaft as claimed in any of Claims 1 to 3 wherein the modulus of elasticity of the metal fibres is in the range 10 to 25 tonf/mm^2 .
 5. A golf club shaft as claimed in any preceding claim, wherein said metal fibres are extended in the range of $\pm 5^\circ$ with respect to the axis of the shaft.
 6. The golf club shaft as claimed in any preceding claim, wherein the metal fibres are arranged at intervals of 0.2 to 0.8 mm.
 7. A golf club shaft substantially as hereinbefore described with reference to, and as illustrated by, Figs. 1 to 5 of the accompanying drawings.
 8. A method of manufacturing a golf club shaft substantially as hereinbefore described with reference to the accompanying drawings.
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