STRING FOR A RACKET, PARTICULARLY FOR A TENNIS RACKET

The invention relates to a string for a racket, particularly for a tennis racket, which includes: a central core (2) and a peripheral protective layer (6). Additionally, the string includes an intermediate reinforcing layer (4) made of a composite material and placed between the central core (2) and the peripheral protective layer (6), the hardness of the reinforcing layer (4; 14; 24; 34) being greater than the hardness of the protective layer (6; 16; 26; 36), the reinforcing layer providing a function of increasing the resistance to wear and tear, while the protective layer provides a function of increasing sliding.
STRING FOR A RACKET, PARTICULARLY FOR A TENNIS RACKET

[0001] The present invention relates to a string for a racket, in particular a string for a tennis racket.

[0002] In sports described as racket sports, a racket is used that comprises a handle and also a frame. A string is stretched longitudinally and transversely through the frame, the string being intended to be subjected to the impact of the ball.

[0003] It is known to use a string that has a composite structure, the string comprising a central core covered by a peripheral layer over the entire length of the core.

[0004] However, the presence of the peripheral layer is not sufficient to provide satisfactory abrasion resistance and degradation resistance of the central core. The service life of the string is thus limited.

[0005] Strings are also known, especially from EP-A-1 574 134 or WO-A-2008/061229, which have a reinforced peripheral layer. For this purpose, this outer layer includes fillers, which are for example carbon nanoparticles or else glass beads.

[0006] This alternative solution does not however prove to be sufficient. Indeed, this type of string is subject to breakage phenomena in particular at the crossings of the strands of string on the racket face. The peripheral layers create abrasion and are cut into very rapidly leading to premature breakage of the string.

[0007] The objective of the present invention is to provide a string with sufficient wear resistance and that does not significantly lose its string tension value during use.

[0008] For this purpose, one subject of the invention is a string for a racket, in particular for a tennis racket, comprising:

- a central core, and
- a peripheral protective layer,

characterized in that the string comprises, in addition, an intermediate reinforcing layer made of a composite material, positioned between the central core and the peripheral protective layer, the hardness of the reinforcing layer being greater than the hardness of the protective layer, the reinforcing layer carrying out a role of increasing the wear resistance, whereas the protective layer carries out a role of increasing slip.

[0012] According to other advantageous features of the racket string in accordance with the invention, taken separately or according to all the technically possible combinations:

- the intermediate reinforcing layer is a composite sheet,
- the intermediate reinforcing layer comprises a matrix and reinforcing fillers, the fillers representing between 10% and 60% by weight of the reinforcing layer, preferably between 25% and 35%;
- the fillers are glass beads;
- the glass beads have a larger dimension, in particular a diameter, between 1 μm and 50 μm, preferably between 5 μm and 20 μm;
- the fillers are carbon fibers or ceramic particles;
- the matrix comprises polyamide;
- the central core is constituted of a monofilament;
- the central core comprises multifilaments positioned in a binding material,

[0021] the central core comprises at least three helically twisted yarns;
[0022] the central core comprises a central filament of diameter d₁ around which filaments of diameter d₂ are positioned helically, so that d₂ is greater than d₁;
[0023] the central core is composed of polyamide;
[0024] the peripheral protective layer comprises a base polymer, and also at least one additive intended to increase slip;
[0025] the base polymer is a plastic, in particular polyamide, polyurethane, polyester or polypropylene, whereas the slip additive is silicone or PTFE;
[0026] the slip additive is present, in the peripheral protective layer, between 10% and 60% by weight, preferably between 25% and 35%;
[0027] the central core has a diameter d₃ between 0.5 mm and 1.5 mm;
[0028] the reinforcing layer has a radial thickness e₁, between 0.01 mm and 0.5 mm;
[0029] the peripheral protective layer has a radial thickness e₂, between 0.01 mm and 0.5 mm;
[0030] the reinforcing layer is extruded around the central core;
[0031] the protective layer is extruded around the reinforcing layer.

[0032] The invention will be better understood on reading the description which follows, given solely by way of non-limiting examples and with reference to the drawings in which:

[0033] FIG. 1 is a perspective view of a strand of string according to a first embodiment of the invention;
[0034] FIG. 2 is a front view of the strand of string represented in FIG. 1, along the arrow II;
[0035] FIG. 3 is a perspective view of a strand of string according to a second embodiment of the invention;
[0036] FIG. 4 is a front view of the strand of string represented in FIG. 3, along the arrow IV;
[0037] FIG. 5 is a perspective view of a strand of string according to a third embodiment of the invention;
[0038] FIG. 6 is a front view of the strand of string represented in FIG. 5, along the arrow VI;
[0039] FIG. 7 is a perspective view of a strand of string according to a fourth embodiment of the invention; and
[0040] FIG. 8 is a front view of the strand of string represented in FIG. 7, along the arrow VIII.

[0041] FIGS. 1 and 2 represent a strand of string 1 comprising a central core 2, covered by an intermediate reinforcing layer 4, itself covered by a peripheral protective layer 6.

[0042] The central core 2 constituting a substantially homogeneous central body of the strand of string 1 is a monofilament made of a thermoplastic. This monofilament is homogeneous from its periphery to its center.

[0043] The protective layer 6 is positioned uniformly over the periphery of the strand of string 1. This protective layer 6 is therefore positioned around the reinforcing layer 4. The protective layer 6 advantageously comprises a base polymer, to which at least one additive intended to increase slip is added. Such an additive for increasing slip is intended to lower the friction coefficient of this peripheral layer 6, in comparison with the case where it is constituted solely of the base polymer.

[0044] By way of example, the base polymer may be, for example, polyamide, polyurethane, polyester or polypropy-
lene. Furthermore, the additive intended to increase slip is, for example, silicone or PTFE (TEFLON).

The first role of the protective material 6 is to protect the reinforcing layer 4 against premature wear of this layer, leading to breakage of the string.

The second role of the protective layer 6 is linked to the way in which the stringing of a racket frame is carried out. Numerous intersections appear between two strands of string over the entire surface of the racket face. The two strands of string are positioned one top of the other and are substantially perpendicular. After the player has hit a tennis ball, the two strands of string have a tendency to move relative to one another. It is especially important to ensure that the two strands of string can, at the same time, be mobile and return to their initial position without them breaking in the vicinity of their point of contact. The protective layer 6 enables sliding movements of the strands of string relative to one another.

The reinforcing layer 4, positioned between the central core 2 and the protective layer 6, is made of a composite material. The reinforcing layer 4 comprises a matrix and also fillers embedded in the matrix.

The fillers have a reinforcing role, the purpose of which is to contribute to the hardness of the reinforcing layer 4. The matrix provides, at the same time, the cohesion of the structure of the reinforcing layer 4 and the transmission of the forces exerted by the ball to the fillers. The fillers increase the mechanical strength of the reinforcing layer 4. In other words, the role of the reinforcing layer 4 is to protect the central core 2 effectively from abrasion or premature degradation of the strings of the racket.

Furthermore, the protective layer makes it possible to avoid an abrasion phenomenon, due to direct contact between two adjacent hard layers. Under these conditions, the invention makes it possible to overcome the drawbacks of the prior art, represented for example by WO-A-2008/061229. In this solution that requires a peripheral reinforcing layer, there is a substantial abrasion phenomenon, due to the contact between these two adjacent hard layers, which results in premature wear of the string.

The reinforcing fillers may be, besides glass beads, carbon fibers or ceramic particles. The matrix of the reinforcing layer is a thermoplastic material which may be, by way of non-limiting examples, polyamide, polyurethane, polyester or polypropylene.

FIGS. 3 and 4, which differ from FIGS. 1 and 2 due to the nature of the core, represent a strand of string 10 comprising a central core 12 surrounded uniformly by the intermediate reinforcing layer 14, itself uniformly surrounded by the peripheral protective layer 16.

The central core 12 comprises multifilaments of a first type of material which are positioned in a matrix constituted of a second type of material. By way of example, the multifilaments may be constituted of polyamide and arranged in a polyurethane matrix. This type of flexible and comfortable string is capable of having a satisfactory service life due to the integration of the reinforcing layer 14 between the central core 12 and the protective layer 16.

FIGS. 5 and 6 differ from FIGS. 1 to 4 due to the nature of the central core. They represent a strand of string 20 comprising a central core 22 reinforced by the reinforcing layer 24 positioned around its entire periphery. The peripheral protective layer 26 is positioned around the reinforcing layer 24.

The central core 22 comprises three yarns 221, 222, 223, twisted relative to one another helically about a longitudinal axis X-X that corresponds to the central axis of the strand of string 20. The yarns 221, 222, 223, have circular cross sections that each define a diameter d smaller than the diameter of the central core 22. These yarns are embedded in a matrix 25, covered by the reinforcing layer 24. The matrix 25 defines a binding material. This type of string is flexible and offers satisfactory strength due to the presence of the reinforcing layer 24.

FIGS. 7 and 8, which differ from FIGS. 1 to 6 due to the nature of the core, represent a portion of string 30 provided with a core referred to as a wrapped core 32 covered over its periphery by the reinforcing layer 34, itself covered by the protective layer 36.

The wrapped core 32 comprises a central monofilament 33 of diameter d, around which monofilaments 35 of diameter d, are positioned helically. The diameter d is substantially greater than the diameter d. The monofilaments 35 constitute wrapping fibers firmly bound by adhesive. The presence of the reinforcing layer 34 makes it possible to lengthen the service life of such a string provided with a core 32.

The cores 2, 12, 22 and 32 are made of a thermoplastic material which may be, by way of non-limiting examples, polyamide, polyurethane, polyester and/or polypropylene.

As a variant that is not represented, a composite central core may be provided that comprises a central body of a first type of material surrounded by a sheath over its entire periphery made from a second material.
Each central core 2, 12, 22 and 32 has a diameter $d_c$ substantially between 0.5 mm and 1.5 mm. Each intermediate reinforcing layer 4, 14, 24, and 34 has a radial thickness $e_1$ between 0.01 mm and 0.5 mm, in particular between 0.05 mm and 0.5 mm. Each peripheral protective layer 6, 16, 26 and 36 has a radial thickness $e_2$ between 0.01 mm and 0.5 mm, in particular between 0.05 mm and 0.5 mm.

One non-limiting example of a process for manufacturing a strand of string 1, 10, 20, 30 according to the present invention consists in using an extruder. The central core 2, 12, 22 or 32 passes into an extruder head while the material used for the reinforcing layer 4, 14, 24 or 34 is worked at pressure and at temperature in order to produce the first sheathing of the central core.

Secondly, this first sheathing then passes into the extruder head. The material used to manufacture the peripheral protective layer 6, 16, 26 or 36 is in turn worked at pressure and at temperature in order to produce the second sheathing around the first sheathing.

Such a manufacturing process makes it possible, firstly, to make the reinforcing layer 4, 14, 24 or 34 adhere around the central core in the manner of a sheathing then to make the protective layer 6, 16, 26 or 36 adhere to the periphery of the reinforcing layer also in the manner of a sheathing.

A string according to claim 23, wherein the fillers are glass beads.

A string according to claim 24, wherein the glass beads have a largest dimension, in particular a diameter, between 1 μm and 50 μm, preferably between 5 μm and 20 μm.

A string according to claim 23, wherein the fillers are carbon fibers or ceramic particles.

A string according to claim 23, wherein the matrix comprises polyamide.

A string according to claim 21, wherein the central core is constituted of a monofilament.

A string according to claim 21, wherein the central core comprises multi-filaments positioned in a binding material.

A string according to claim 21, wherein the central core comprises at least three helically twisted yarns.

A string according to claim 21, wherein the central core comprises a central filament of diameter $d_c$, around which filaments of diameter $d_s$ are positioned helically, so that $d_s$ is greater than $d_c$.

A string according to claim 21, wherein the central core is composed of polyamide.

A string according to claim 21, wherein the peripheral protective layer comprises a base polymer, and also at least one additive intended to increase slip.

A string according to claim 33, wherein the base polymer is a plastic, in particular polyamide, polyurethane, polyester or polypropylene, whereas the slip additive is silicone or PTFE.

A string according to claim 33, wherein the slip additive is present in the peripheral protective layer, between 10% and 60% by weight, preferably between 25% and 35%.

A string according to claim 21, wherein the central core has a diameter $d_c$ between 0.5 mm and 1.5 mm.

A string according to claim 21, wherein the reinforcing layer has a radial thickness $e_1$ between 0.01 mm and 0.5 mm.

A string according to claim 21, wherein the peripheral protective layer has a radial thickness $e_2$ between 0.01 mm and 0.5 mm.

A string according to claim 21, wherein the reinforcing layer is extruded around the central core.

A string according to claim 21, wherein the protective layer is extruded around the reinforcing layer.