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(54) Four piece golf ball

(57) A golf ball comprising:

a core comprising a high cis-1,4 content polybutadiene, 20 to 28 parts by weight of a co-crosslinking agent comprised primarily of a zinc salt of an unsaturated acrylate, 3 to 5 parts by weight of a metal oxide activator, an 0.8 to 1.5 parts per hundred resin of a free radical initiator;

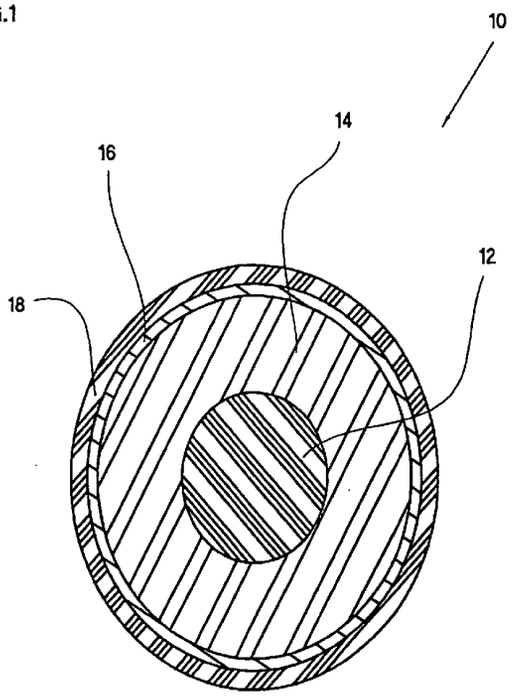
a mantle comprising a terpolymer consisting of 70 to 80% ethylene, 8 to 10.5% acrylic acid and 12 to 20% n-butyl acrylate;

a cover having an inner cover and an outer cover;

the inner cover layer comprises a blend of ionomers; and

the outer layer comprising a thermoplastic polyurethane.

FIG.1



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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. Patent Application No. 10/226,032, entitled "Multilayered Balanced Golf Ball" filed on August 22, 2002 by Simonutti and Bradley and incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to the field of golf balls.

BACKGROUND OF THE INVENTION

[0003] The golf club/ball impact can best be described as a violent collision. The typical professional can swing a 200 to 300 gram (7.06 to 10.6 ounce) driver and attain club speeds at the moment of impact of 105 mph (169 km/h) to 115 mph (185 km/h) striking a 46 gram (1.62 ounces) golf ball resting on a tee. One side of the golf ball is smashed against the face of the club which can result in the balls of the prior art compressing nearly 20% before the golf ball leaves the tee. The golf ball then accelerates from rest to speeds of approximately 155 mph (249 km/h) to 170 mph (274 km/h) and spin rates of 2000 to 4000 rpm's in less than half a millisecond, experiencing 50,000 times the force of gravity.

[0004] For a great number of years, golf balls were molded using wound cores, which comprised a soft rubber center surrounded by a layer of thread rubber windings. In the late 1960s to early 1970s, balls with ionomer covers (produced by E.I. du Pont de Nemours and Company, 1007 Market ST Wilmington, Delaware 19898 ("DuPont") under the trade name Surlyn®) were introduced. Balls molded with Surlyn® covers were produced with both thread wound cores and solid rubber cores. The balls molded using initial grades of Surlyn® and solid cores (hereafter referred to as "two-piece balls") were significantly less expensive to produce; however, the initial two-piece golf balls were hard, having an unpleasant feel to the golfer.

[0005] Recently, the introduction of the multi-piece solid ball has been a success with products such as the Titleist® Pro V1(produced by Fortune Brands, Inc. 300 Tower Parkway, Lincolnshire, Illinois 60069), and the Precept® Tour Premium (produced by Bridgestone Sports Co., LTD., Omori Bellport E Bldg. 6-22-7, Minami-oi Shinagawa-ku, Tokyo 140-0013 Japan). These golf balls, while being solid and not wound, have polyurethane covers that lend themselves to the shot making qualities that are possessed by the balls preferred by the better golfers. The golf balls are also less expensive to produce.

[0006] Existing golf balls, however, have some drawbacks. Prior art golf balls are generally manufactured with a core made primarily from polybutadiene rubber, which is covered with a fairly hard, thin, ionomer inner cover, which is subsequently covered by a polyurethane or balata/polybutadiene outer cover. While providing adequate playing characteristics at a less expensive production cost, these solid balls typically exhibit lower velocities at driver impact than wound balls using like cover materials. Prior art golf balls have used in their cores, mantles, and cover layers, either thermoset materials or thermoplastic materials. The prior art thermoplastic material allows for greater ease in manufacturing, but reduces resilience. Conversely, thermoset material is difficult to work with, but provides the needed resilience.

[0007] In addition, all of the various materials used in the construction of golf balls, from wound core constructions to multi-layer solid core constructions, have varying densities. Accordingly, the mass per unit volume of these materials varies. For example, typically the materials used to produce the cover layer possess a low mass per unit volume than the materials used to produce the core. If a golf ball is manufactured perfectly, that is if the core or center of a ball is perfectly spherical, and if the cover layer thickness and intermediate layer thickness (if applicable) are constant throughout the entire ball, the ball will be "balanced", and should fly true when struck with a golf club, or should roll true when putted.

[0008] However, in manufacturing of a golf ball, it is very difficult to ensure that the core of the golf ball is exactly and perfectly spherical and centered within the ball. Moreover, it is also very difficult to ensure that the thickness of the cover layer, and the thickness of the intermediate layer(s) of multi-piece balls, are uniform and consistent about the periphery of the core. Further, it is difficult to ensure that the materials comprising the cover layer and the intermediate layer (if applicable) are properly and sufficiently mixed or homogenized such that the composition and density of the cover layer or intermediate layer is consistent throughout the ball.

[0009] Thus, there is a need for a golf ball that is economical to produce with known manufacturing equipment and provides spin control, durability, and feel while conforming to regulations. More particularly, there is a need for four-piece golf ball that performs well and is made of highly workable material.

SUMMARY OF THE INVENTION

[0010] A golf ball in accordance with the principles of the present invention is economical to produce with known manufacturing equipment and provides spin control, durability, and feel while conforming to regulations. One aspect of the present invention relates to a four-piece golf ball that performs well and is made of highly workable material. In accordance with the present invention, the golf ball has a core, a mantle, an inner cover layer, and an outer cover layer. The core provides spin control and a solid resilient structure to which the mantle can be molded. The mantle provides high resilience. The cover is comprised of two layers to provide adequate resilience and performance while still being able to accept dimples.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The Figure illustrates a cross-section of a golf ball in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] One aspect of the present invention relates to a four-piece golf ball that performs well and is made of highly workable material. Referring to the Figure, a golf ball in accordance with the principles of the present invention comprises a four-piece solid golf ball 10, wherein the four layers consist of (1) a center layer or core 12 comprising a first composition, (2) a middle layer or mantle 14 comprising a second composition, (3) an inner cover layer 16 comprising a third composition, and (4) a outer cover layer 18 on which the dimples are molded comprising a fourth composition. In accordance with the principles of the present invention, the core 12 provides some control of spin as well as a solid resilient structure to which the second layer is molded; the mantle 14 provides high resilience for the ball and increases spin; the inner cover 16 provides a suitable material for durability, control, and spin; and the outer cover 18 provides a suitable material for durability, control, spin, and dimple molding.

[0013] In an embodiment of the present invention, the core 12 is a solid comprised of a diene rubber, has a diameter of between about 1.00 (25.4 mm) and about 1.40 inches (35.6 mm), and has a defection under a 200 Ib. (90.7 kg) static load of between about 0.100 inches (2.5 mm) and about 0.180 inches (4.6 mm). In a preferred embodiment of the present invention, the core has a diameter of 1.20 inches (30.5 mm) to 1.38 inches (35.1 mm) and comprises a high cis-1,4 content (94% or greater) polybutadiene, 20 to 28 parts by weight of a co-crosslinking agent comprised primarily of a zinc salt of an unsaturated acrylate; 3 to 5 parts by weight of a metal oxide activator, preferably zinc oxide; and 0.8 to 1.5 parts per hundred resin of a free radical initiator.

[0014] The mantle material requires a trade-off to achieve the desired results: the more material used, the more resilient the ball; however, this results in an increased spin rate for driver shots. In a preferred embodiment of the present invention, the mantle 14 is a thermoplastic material having a thickness of between about 0.050 inches (1.27 mm) and about 0.27 inches (6.9 mm); a Shore D hardness of 62 or below; and comprises about 7% to 12% by weight of a carboxylic acid, preferably acrylic acid, about 12% to 20% by weight of an acrylate salt, preferably n-butyl acrylate, and about 71% to 80% by weight of ethylene. The carboxylic acid in the mantle is 100% neutralized with metal ions, preferably magnesium ions. If the material used in the mantle is not 100% neutralized, the resultant resilience properties such as coefficient of restitution (C.O.R.) and initial velocity will not be sufficient to produce the performance required for a premium golf ball. The C.O.R is a measurement of the amount of energy returned in an inelastic collision, such as the impact between the golf ball and the club face. It is expressed as a ratio of energy present in the system before the impact to energy present in the system just after impact. This relates to the energy present in the ball and clubhead velocity just after the ball/club impact.

[0015] In a preferred embodiment of the present invention, the inner cover layer 16 comprises a blend of ionomers having a Shore D hardness of 65 or more and a thickness of about 0.020 inches (0.51 mm) to about 0.050 inches (1.27 mm).

[0016] In a preferred embodiment, the outer cover layer 18 comprises thermoplastic polyurethane or thermoset material having a Shore D hardness of greater than 53 and a thickness of greater than 0.040 inches (1.02 mm).

[0017] In a preferred embodiment a ball made in accordance with the principles of the present invention has a core with a deflection of between about 0.100 inches (2.5 mm) and 0.180 inches (4.6 mm) under an applied load of 200 Ib (90.7 kg). The mantle 14 has a thickness of about 0.065 inches (1.65 mm) to 0.140 inches (3.6 mm), and a Shore D hardness of 55 to 62, and comprises a terpolymer consisting of approximately 70% to 80% ethylene; approximately 8% to 10.5% acrylic acid; and approximately 12% to 20% n-butyl acrylate, where 100% of the carboxylic acid groups are neutralized with magnesium ions. The inner cover layer 16 comprises a blend of ionomers with a Shore D hardness of between 68 and 73, and a thickness of 0.025 inches (0.635 mm) to 0.045 inches (1.14 mm). The outer cover layer 18 comprises a thermoplastic polyurethane or a thermoset material having a Shore D hardness of between 56 and 62, and a thickness of approximately 0.040 inches (1.02 mm) to 0.055 inches (1.40 mm).

[0018] In one embodiment, the ball may be balanced. A balanced ball does not depart from its intended flight or roll path due to an off-center core or outer layers of inconsistent thickness. In accordance with the principles of the present invention the ball would have a core, mantle, inner and outer cover layer that are of uniform density without any uneven areas of distribution. This can be accomplished by blending essentially nonreactive materials with the particular components of the golf ball. Thus, a truly balanced ball in accordance with the principles of the present invention has a uniform density. Materials suitable for use in adjusting the density of the component parts can be chosen from the group consisting of inorganic materials, organic materials, and combinations thereof. Preferred inorganic fillers comprise zinc oxide, barium sulfate, titanium dioxide, or a combination thereof.

[0019] An unbalanced ball will generally have a light spot and a heavy spot. When an unbalanced ball is repeatedly spun in a salt water solution of the float test described below, the ball will tend to consistently orient itself in the solution with its light spot up and its heavy spot down. The "float" test is performed by filling a container with warm water. A salt, such as sodium chloride, is then added to the solution in sufficient amount to enable one or more golf balls to float in the solution. Preferably, a few drops of detergent are added to the container. The ball is spun and when the ball stops spinning in water, then the top is marked. The spinning is repeated to determine if the same portion will again be at the top when the ball stops. A balanced ball would exhibit no orientational preference when placed in a salt bath of equivalent density. In a preferred embodiment, the cover layer is adjusted to a target specific gravity of about 1.125 using inert fillers. In a preferred embodiment of the present invention, the core, mantle, inner cover layer and outer cover layer all have a specific gravity of between about 1.118 and about 1.132, with the golf ball preferably having a specific gravity of about 1.125.

Examples of the Invention

[0020] The following are non-limiting illustrative examples of golf balls in accordance with the principles of the present invention, wherein certain teachings in each example can be combined and mixed in other embodiments thereby more fully illustrating the scope of the inventions. The four-piece construction in accordance with the principles of the present invention results in greater distance and performance than the prior art three-piece golf balls as exhibited by the following non-limiting examples.

[0021] A golf ball in accordance with the principles of the present invention was made having a core as set forth below in the master batch formulas:

Table 1:

Master Batch Formula	
Material	Phr
Polybutadiene Rubber	97.56
Millable Polyurethane	2.44
Zinc Diacrylate	90.28
Zinc Oxide	4.88
Titanium Dioxide	18.3
Colorant	.16

[0022] The material used for molding the mantle was a terpolymer of ~ 76% ethylene, ~ 8.5% acrylic acid, and ~ 15.5% by weight n-butyl acrylate, wherein 100% of the acrylic acid groups was neutralized with magnesium ions. This material is available from DuPont, under product number AD1016. The terpolymer was compounded with barium sulfate and titanium dioxide to a specific gravity of 1.125.

[0023] The inner cover layer of the example balls was molded using ionomers produced and provided by DuPont under the product name Surlyn™, in the following blend: Surlyn™ 6120 - 40 phr and Surlyn™ 8140 - 60 phr. The blend was compounded with barium sulfate and titanium dioxide to a specific gravity of 1.125. The outer cover layer, for the balls of examples 1 and 2, was molded using the thermoset material formula outlined below using the second pass batch, with 432 dimples in an icosadodecahedron pattern consistent through all examples, as well as in the control ball:

Table 2:

Second Pass Formula	
Material	Phr
Trans-polyisoprene	59.00
Peroxide	2.00
Master Batch Compound	87.57

The compound was mixed in two parts. First a master batch was mixed as described in Table 1, followed by a second pass procedure to mix the peroxide and balata into the compound as described in Table 2. Mixing was performed using techniques well known to those in the golf ball industry.

[0024] All example balls were buffed, finished and painted using methods known in the art. Balls were tested for performance properties compared to a premium performance golf ball, specifically the Staff® True Tour™, produced by Wilson Sporting Goods Company, 8700 West Bryn Mawr Avenue, Chicago, Illinois 60631.

Example 1

[0025] Balls of Example 1 were molded using layers as described above. Specifically, the layers were as follows:

- Core - 1.25 inches diameter, 0.150 deflection under an applied load of 200 lb.
- Mantle - 0.135 inches thickness.
- Inner cover layer - 0.0325 inches thickness, Shore D hardness 72.
- Outer cover layer - 0.0475 inches thickness, Shore D hardness 60.

Table 3:

Example 1 Physical Properties				
Ball	Size	Defl.	Weight	Shore D
Example 1	1.681	.085	45.52	61
Wilson Staff® True Tour™	1.679	.087	45.42	62

Shore D Hardness was measured using a Shore D durometer (manufactured by Instron Corporation, 100 Royall Street, Canton, Massachusetts, 02021) with the hardness reading taken at the surface of the ball. Deflection was measured under a 200 lb. applied load, using Wilson Dead Weight Deflection testing machine. The deflection of a test subject golf ball is taken by placing the ball between two round plates, which are supported from below by round shafts. A force is then applied forcing the bottom plate to compress the ball into the upper plate, using a lever mechanism. The force applied is a nominal 200 lbs. The deflection is determined by taking the measured distance between the inside of the two plates at contact and the measured distance between the inside of the two plates at some time after the force is applied. The deflection is calculated as the simple difference between the two measurements.

[0026] The flight performance properties of the Example 1 ball were tested:

Table 4:

Example 1 Flight Performance Properties					
Ball	Ball Speed (fps)	Spin Rate (RPM)	Apogee	Carry Dist. (yds)	Total Dist. (yds)
Example 1	233.1	2840	9.6	252.8	273.4
Wilson Staff® True Tour™	231.8	3370	9.7	251.9	267.1
Driver test results are an average of 3 tests at the following conditions: (1) club head velocity of 160 ft/s and (2) launch angle of 9.5°.					

Example 2

[0027] Balls of Example 2 were molded using layers as described above. Specifically the layers were as follows:

- Core - 1.375 inches diameter, 0.135 deflection under an applied load of 200 lb.
- Mantle - 0.0725 inches thickness.
- Inner cover layer- 0.0325 inches thickness, Shore D hardness 72.
- Outer cover layer - 0.0475 inches thickness, Shore D hardness 60.

Table 5:

Example 2 Physical Properties				
Ball	Size	Defl.	Weight	Shore D
Example 2	1.678	.080	45.02	61
Wilson Staff® True Tour™	1.680	.090	45.46	61

Shore D Hardness was measured using a Shore D durometer with the hardness reading taken at surface of ball. Deflection was measured under 200 lb. applied load, using Wilson Dead Weight Deflection testing machine.

[0028] The flight performance properties of the Example 2 ball were tested:

Table 6:

Example 2 Flight Performance Properties					
Ball	Ball Speed (fps)	Spin Rate (RPM)	Apogee	Carry Dist. (yds)	Total Dist. (yds)
Example 2	233.6	3000	9.6	252.0	277.1
Wilson Staff® True Tour™	231.2	3420	9.8	252.8	272.3

Driver test results are an average of 3 tests at the following conditions: (1) club head velocity of 160 ft/s and (2) launch angle of 9.5°.

Example 3

[0029] Balls of Example 3 were molded using layers as described above. Specifically the layers were as follows:

- Core - 1.130 inches diameter, 0.135 deflection under an applied load of 200 lb.
- Mantle - 0.0725 inches thickness.
- Inner cover layer - 0.0325 inches thickness, Shore D hardness 72.
- Outer cover layer - 0.0475 inches thickness, Shore D hardness 60.

Table 5:

Example 3 Physical Properties				
Ball	Size (in)	Defl. (in)	Weight (g)	Shore D
Example 3	1.684	0.083	45.93	59
Wilson Staff® True Tour™	1.680	0.081	45.43	59

Shore D Hardness was measured using a Shore D durometer with the hardness reading taken at surface of ball. Deflection was measured under 200 lb. applied load, using Wilson Dead Weight Deflection testing machine.

[0030] The flight performance properties of the Example 3 ball were tested:

Table 6:

Example 3 Flight Performance Properties					
Ball	Ball Speed (fps)	Spin Rate (RPM)	Apogee	Carry Dist. (yds)	Total Dist. (yds)
Example 3	243.5	3138	10.5	270.2	275.6
Wilson Staff® True Tour™	241.4	3227	10.1	258.4	265.1

Driver test results are an average of 3 tests at the following conditions: (1) club head velocity of 167 ft/s and (2) launch angle of 9.5°.

Test Results

[0031] A test of various golf balls was performed, with the course fairway spotty with a variable 6-12 mph right to left crosswind and the temperature was 62° F. The golf balls in accordance with the principles of the present invention are designated "Example 3" in the test results, below:

Table 7

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Staff® True Tour™										
Average	161.5	231.4	3453	9.0	9.8	238.2	-4.0	6.3	244.5	199
Trim50%	161.4	231.5	3514	9.0	9.8	237.5	-4.3	5.5	243.7	
StDev	0.3	1.0	260	0.1	0.2	3.9	4.1	3.4	5.9	
Max	161.9	233.1	3711	9.2	10.1	246.0	3.0	13.0	259.0	
Min	161.2	229.6	2894	8.6	9.2	234.0	-9.0	3.0	238.0	
Example 3										
Average	161.3	234.2	2915	9.3	9.9	249.9	-3.2	6.3	256.2	365
Trim50%	161.3	234.1	2850	9.3	9.9	249.7	-3.3	5.5	256.0	
StDev	0.4	0.9	331	0.1	0.1	5.0	5.8	3.0	6.0	
Max	161.9	235.9	3590	9.6	10.1	259.0	9.0	12.0	269.0	
Min	160.9	232.8	2531	9.1	9.8	241.0	-14.0	3.0	245.0	
Titleist Pro V1										
Average	161.3	229.8	3240	9.2	10.1	245.1	-4.7	5.4	250.5	136
Trim50%	161.3	229.8	3202	9.1	10.1	244.5	-4.3	5.0	249.5	
StDev	0.2	0.9	196	0.2	0.1	3.9	2.8	3.5	5.3	
Max	161.6	231.3	3763	9.6	10.3	255.0	0.0	11.0	266.0	
Min	160.9	228.3	3053	9.0	9.9	241.0	-10.0	1.0	246.0	
Titleist Pro V1*										
Average	161.3	230.0	3088	9.2	9.8	239.8	-2.7	11.7	251.4	113

Table 7 (continued)

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Titleist Pro V1*										
Trim50%	161.2	230.0	3084	9.2	9.9	240.0	-2.8	11.3	251.3	
StDev	0.3	0.7	274	0.1	0.1	2.5	3.7	5.8	5.6	
Max	161.9	231.0	3484	9.4	10.0	245.0	5.0	19.0	260.0	
Min	160.9	228.8	2427	8.9	9.6	235.0	-7.0	4.0	244.0	
Maxfli M3										
Average	161.4	230.8	3298	9.1	9.9	242.6	-4.0	7.0	249.6	148
Trim50%	161.3	230.8	3283	9.0	9.9	241.7	-4.0	7.2	249.2	
StDev	0.3	1.0	228	0.2	0.2	2.6	4.5	2.6	3.9	
Max	161.9	232.1	3769	9.3	10.2	248.0	4.0	11.0	258.0	
Min	161.2	229.0	3018	8.8	9.8	239.0	-11.0	2.0	244.0	
Maxfli A10										
Average	161.2	231.0	3366	8.9	10.1	243.8	-5.3	4.6	248.3	173
Trim50%	161.2	231.0	3389	8.9	10.0	243.3	-5.7	3.5	248.5	
StDev	0.2	0.7	190	0.2	0.2	3.3	4.2	3.3	4.2	
Max	161.6	232.2	3620	9.3	10.7	250.0	1.0	11.0	254.0	
Min	160.9	229.9	3013	8.7	9.9	240.0	-10.0	1.0	242.0	
Precept U Tri Extra Spin										
Average	161.2	233.8	3030	9.3	10.3	250.2	-7.0	2.7	252.8	128
Trim50%	161.2	233.9	3041	9.3	10.2	249.8	-6.8	2.8	252.2	
StDev	0.2	1.0	234	0.2	0.3	3.5	2.9	2.0	4.4	
Max	161.6	235.0	3325	9.6	10.8	256.0	-2.0	5.0	260.0	

Table 7 (continued)

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Precept U Tri Extra Spin										
Min	160.9	232.1	2694	9.0	10.0	246.0	-11.0	0.0	247.0	
Precept U Tri Extra Distance										
Average	161.4	230.3	2891	9.4	10.0	246.3	-3.3	8.0	254.3	143
Trim50%	161.3	230.3	2908	9.3	10.0	246.2	-2.7	7.3	253.3	
StDev	0.4	1.0	159	0.1	0.2	2.9	3.9	5.4	7.5	
Max	162.3	232.4	3149	9.6	10.3	250.0	1.0	16.0	266.0	
Min	160.9	228.2	2660	9.1	9.8	241.0	-12.0	1.0	242.0	
Callaway HX Blue										
Average	161.4	230.0	3066	9.1	10.2	244.8	-2.6	4.5	249.3	172
Trim50%	161.3	230.0	3079	9.1	10.2	245.3	-2.7	3.2	248.8	
StDev	0.3	1.1	158	0.2	0.2	2.7	5.0	3.8	4.0	
Max	161.9	231.6	3325	9.8	10.8	248.0	5.0	13.0	258.0	
Min	161.2	227.6	2768	8.8	10.0	240.0	-9.0	1.0	244.0	
Callaway HX Red										
Average	161.3	232.2	3012	9.3	10.2	248.0	-3.4	3.3	251.3	195
Trim50%	161.3	232.2	3040	9.2	10.2	247.3	-3.5	3.0	250.7	
StDev	0.3	0.9	149	0.2	0.2	2.8	5.6	2.8	4.5	
Max	161.9	233.7	3244	9.8	10.7	253.0	7.0	8.0	259.0	
Min	160.9	229.8	2768	8.8	10.0	244.0	-15.0	0.0	245.0	

Table 7 (continued)

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Hogan Apex Tour										
Average	161.3	229.4	2959	9.2	9.9	240.7	-3.2	6.7	247.3	118
Trim50%	161.4	229.5	2974	9.2	9.9	241.2	-3.3	6.3	247.8	
StDev	0.3	0.7	178	0.2	0.2	2.1	4.4	3.7	4.6	
Max	161.6	230.4	3164	9.5	10.2	244.0	4.0	15.0	256.0	
Min	160.9	227.9	2527	8.9	9.4	236.0	-10.0	2.0	241.0	

[0032] As seen by comparing the ball of Example 3 and the Titleist Pro V1, the ball of Example 3 outperformed the other balls For example the ball of Example 3 had a higher initial velocity and a lower spin rate than the Titleist Pro V1. Additionally, Example 3 carried nearly 10 yards farther and had a longer total distance than the Titleist Pro V1.

[0033] A second test of various golf balls was performed, with the course fairway spotty with a variable headwind 2-10 mph with 15 mph gusts and the temperature was 59° F:

Table 8

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Staff® True Tour Control™										
Average	160.4	230.3	3301	8.8	10.0	232.1	4.6	6.5	238.7	179
Trim50%	160.4	230.5	3258	8.8	10.0	231.2	4.5	6.3	238.1	
StDev	0.4	1.0	226	0.2	0.2	3.6	4.0	1.7	3.7	
Max	160.9	231.9	3823	9.3	10.2	240.0	11.0	9.0	246.0	
Min	159.8	228.6	2986	8.4	9.5	228.0	-1.0	4.0	234.0	
Example 3										
Average	160.5	232.9	3054	9.2	10.2	240.8	1.9	4.3	245.2	268
Trim50%	160.5	232.8	3097	9.2	10.2	240.8	1.7	4.3	245.0	
StDev	0.4	1.0	263	0.2	0.1	3.1	6.8	1.2	3.9	
Max	161.2	234.5	3440	9.5	10.4	245.0	12.0	7.0	252.0	
Min	159.8	231.5	2628	8.8	9.9	236.0	-9.0	2.0	240.0	
Titleist Pro V1										
Average	160.4	228.8	3256	9.0	10.3	235.8	2.9	4.1	239.9	59
Trim50%	160.4	228.8	3299	9.0	10.2	235.7	3.2	4.2	239.5	
StDev	0.4	0.5	172	0.2	0.2	2.4	1.9	2.2	3.1	
Max	160.9	229.6	3452	9.2	10.7	240.0	5.0	8.0	246.0	
Min	159.8	227.9	2962	8.7	10.1	231.0	-1.0	1.0	235.0	
Titleist Pro V1*										

Table 8 (continued)

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Average	160.5	229.1	3212	9.2	10.0	232.9	2.8	7.8	241.0	188
Trim50%	160.6	229.1	3216	9.1	10.1	232.2	3.3	8.3	241.6	
StDev	0.3	0.5	170	0.2	0.1	3.8	3.9	2.5	4.3	
Max	160.9	230.1	3431	9.5	10.2	241.0	7.0	10.0	246.0	
Min	159.8	228.5	2991	8.9	9.9	227.0	-5.0	3.0	230.0	
Maxfli M3										
Average	160.5	230.2	3296	8.9	10.1	235.2	3.2	5.9	241.1	227
Trim50%	160.5	230.3	3297	8.9	10.1	235.0	2.7	5.8	240.7	
StDev	0.3	0.7	206	0.2	0.1	3.6	5.0	1.9	4.8	
Max	160.9	231.1	3573	9.1	10.4	243.0	11.0	9.0	250.0	
Min	160.1	229.0	2996	8.5	10.0	230.0	-3.0	3.0	233.0	
Maxfli A10										
Average	160.5	230.3	3470	8.7	10.3	234.6	1.2	3.7	238.3	110
Trim50%	160.6	230.4	3495	8.7	10.2	234.5	1.0	3.2	238.3	
StDev	0.4	1.2	144	0.2	0.3	1.7	5.2	2.1	1.6	
Max	160.9	232.1	3680	9.0	10.9	237.0	11.0	9.0	241.0	
Min	159.8	228.2	3228	8.2	10.0	232.0	-8.0	2.0	235.0	
Precept U Tri Extra Spin										
Average	160.5	232.9	3139	9.2	10.5	239.7	5.8	2.9	242.6	198
Trim50%	160.4	232.9	3185	9.2	10.5	240.5	6.3	3.0	243.8	
StDev	0.4	0.7	210	0.2	0.3	3.3	4.7	2.0	4.5	
Max	161.2	234.1	3390	9.4	11.1	243.0	12.0	6.0	247.0	
Min	160.1	231.5	2808	8.8	10.1	233.0	-4.0	0.0	233.0	
Precept U Tri Extra Distance										

Table 8 (continued)

N = 12	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)	SAA (sq. yds)
Average	160.5	229.6	2856	9.2	10.1	237.1	5.4	3.8	240.9	210
Trim50%	160.5	229.4	2889	9.2	10.1	237.3	4.7	3.7	240.5	
StDev	0.3	0.9	183	0.1	0.0	3.2	5.2	1.6	3.7	
Max	161.2	231.6	3159	9.5	10.2	242.0	14.0	7.0	249.0	
Min	160.1	228.5	2545	9.0	10.1	230.0	-2.0	1.0	235.0	
Callaway HX Blue										
Average	160.5	229.0	3264	9.1	10.5	236.1	4.7	3.4	239.5	268
Trim50%	160.5	229.0	3245	9.1	10.5	236.0	4.5	3.0	238.8	
StDev	0.4	1.3	189	0.2	0.2	4.9	4.3	2.8	6.8	
Max	161.2	230.7	3550	9.3	10.8	245.0	12.0	11.0	256.0	
Min	160.1	225.4	2990	8.8	10.2	229.0	-3.0	0.0	232.0	
Callaway HX Red										
Average	160.5	230.9	3217	9.2	10.7	238.8	3.9	2.9	241.7	361
Trim50%	160.6	230.7	3250	9.2	10.7	239.0	3.5	2.7	241.8	
StDev	0.4	0.9	231	0.2	0.3	4.7	6.1	1.8	5.9	
Max	160.9	232.5	3560	9.5	11.0	249.0	20.0	7.0	252.0	
Min	159.8	229.9	2798	8.9	10.2	230.0	-6.0	1.0	231.0	
Hogan Apex Tour										
Average	160.7	228.4	3070	9.1	10.1	234.2	0.2	6.9	241.1	329
Trim50%	160.7	228.5	3101	9.1	10.1	234.7	0.7	6.2	241.2	
StDev	0.4	1.2	240	0.2	0.1	4.2	6.3	4.2	7.4	
Max	161.2	230.3	3458	9.5	10.2	240.0	10.0	15.0	255.0	
Min	159.8	226.3	2685	8.8	9.9	226.0	-9.0	2.0	229.0	

[0034] As seen by comparing the ball of Example 3 and the Titleist Pro V1, the ball of Example 3 outperformed the other balls For example the ball of Example 3 had a higher initial velocity and a lower spin rate than the Titleist Pro V1. Additionally, Example 3 carried nearly 5 yards farther and had a longer total distance than the Titleist Pro V1.

[0035] A third test of various golf balls was performed, with the course fairway spotty with a variable 3-10 mph right to left crosswind with a tail and the temperature was 52° F:

Table 9

Golf ball	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)
Staff® True Tour Control™									
Average	161.0	231.1	3371.6	9.0	9.9	235.6	1.3	7.3	242.9
Trim50%	160.9	231.2	3382.2	9.0	9.9	235.0	0.8	6.9	242.2
Example 3									
Average	161.0	233.8	2942.3	9.3	10.0	246.1	-0.1	5.8	251.9
Trim50%	161.0	233.8	2936.7	9.3	10.0	246.1	-0.1	5.3	251.5
Titleist Pro V1									
Average	160.9	229.5	3263.7	9.1	10.1	241.1	-0.3	4.7	245.9
Trim50%	160.9	229.5	3260.4	9.1	10.1	240.8	-0.3	4.6	245.4
Titleist Pro V1*									
Average	160.9	229.8	3156.3	9.2	9.9	237.2	0.2	8.9	246.3
Trim50%	161.0	229.8	3154.6	9.2	9.9	237.2	0.4	9.0	246.6
Maxfli M3									
Average	161.0	230.8	3323.8	9.0	10.0	240.1	0.6	6.5	246.6
Trim50%	161.0	230.9	3322.6	9.0	10.0	239.5	0.3	6.4	246.6

Table 9 (continued)

Golf ball	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)
Maxfli A10									
Average	161.0	230.8	3449.4	8.8	10.2	239.6	-0.7	4.5	244.0
Trim50%	161.0	230.9	3464.8	8.8	10.1	239.4	-0.7	3.7	244.0
Precept U-Tri Extra Spin									
Average	161.0	233.5	3124.0	9.2	10.4	245.7	0.1	3.4	249.1
Trim50%	160.9	233.5	3158.8	9.2	10.3	246.1	0.5	3.4	249.4
Precept U-Tri Extra Distance									
Average	161.0	230.1	2929.2	9.3	10.0	242.4	1.9	5.7	248.1
Trim50%	160.9	230.0	2966.3	9.3	10.0	242.3	1.7	5.4	247.4
Callaway HX Blue									
Average	161.0	229.7	3214.2	9.0	10.3	240.8	1.0	3.8	244.6
Trim50%	161.0	229.7	3214.8	9.1	10.3	240.9	0.8	3.3	244.0
Callaway HX Red									
Average	161.0	231.7	3118.7	9.2	10.5	243.4	1.8	3.3	246.6
Trim50%	161.0	231.7	3127.5	9.2	10.4	243.3	1.3	3.1	246.4

Table 9 (continued)

Golf ball Hogan Apex Tour	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)
Average	161.0	229.1	3030.7	9.2	10.0	237.7	0.6	7.3	244.9
Trim50%	161.1	229.2	3061.6	9.2	10.0	238.3	1.1	6.9	245.0

[0036] As seen by comparing the ball of Example 3 and the Titleist Pro V1, the ball of Example 3 outperformed the other balls For example the ball of Example 3 had a higher initial velocity and a lower spin rate than the Titleist Pro V1. Additionally, Example 3 carried and rolled farther and had a longer total distance than the Titleist Pro V1.

[0037] The three test results were averaged:

Table 10

Example Averages									
Golf Ball	Club Velocity (fps)	Ball Velocity (fps)	Ball Spin (rpm)	Launch Angle (deg)	Apogee Angle (deg)	Carry Distance (yds)	Carry Direction (yds)	Roll Distance (yds)	Total Distance (yds)
Staff ® True Tour Control™	161.0	231.1	3372	9.0	9.9	235.6	1.3	7.3	242.9
Example 3	161.0	233.8	2942	9.3	10.0	246.1	-0.1	5.8	251.9
Titleist Pro V1	160.9	229.5	3264	9.1	10.1	241.1	-0.3	4.7	245.9
Titleist Pro V1*	160.9	229.8	3156	9.2	9.9	237.2	0.2	8.9	246.3
Maxfli M3	161.0	230.8	3324	9.0	10.0	240.1	0.6	6.5	246.6
Maxfli A10	161.0	230.8	3449	8.8	10.2	239.6	-0.7	4.5	244.0
Precept U-Tri Extra Spin	161.0	233.5	3124	9.2	10.4	245.7	0.1	3.4	249.1
Precept U-Tri Extra Dist	161.0	230.1	2929	9.3	10.0	242.4	1.9	5.7	248.1
Callaway HX Blue	161.0	229.7	3214	9.0	10.3	240.8	1.0	3.8	244.6
Callaway HX Red	161.0	231.7	3119	9.2	10.5	243.4	1.8	3.3	246.6
Hogan Apex Tour	161.0	229.1	3031	9.2	10.0	237.7	0.6	7.3	244.9

[0038] As seen from the data, surprisingly both examples increase ball speed, and reduce spin rate on the driver. This results in increased distance, through both carry and roll. Also with this increased speed and lower spin, more optimum dimples can be utilized which could potentially increase distance further. The ball of the present invention exhibits the desired low spin/high velocity off of the golf tee; yet, it also exhibits the desired high spin and controllability when hit on the green with a club such as a 9-iron.

[0039] It should be understood that various changes and modifications to the preferred embodiments described herein would be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without demising its attendant advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

Claims

1. A golf ball comprising:

a core comprising a high cis-1,4 content polybutadiene, 20 to 28 parts by weight of a co-crosslinking agent comprised primarily of a zinc salt of an unsaturated acrylate, 3 to 5 parts by weight of a metal oxide activator, and 0.8 to 1.5 parts per hundred resin of a free radical initiator;
a mantle comprising a terpolymer consisting of 70 to 80% ethylene, 8 to 10.5% acrylic acid and 12 to 20% n-butyl acrylate.;
a cover having an inner cover and an outer cover;
the inner cover layer comprises a blend of ionomers; and
the outer cover layer comprising a thermoplastic polyurethane.

2. The golf ball of claim 1, wherein the core has a diameter of 1.2 inches to 1.38 inches.

3. The golf ball of claim 1, wherein the high cis-1,4 content polybutadiene is 94% or greater.

4. The golf ball of claim 3, wherein the core has a defection of between 0.100 and 0.180 inches under an applied load of 200 Ib.

5. The golf ball of claim 1, wherein the mantle has a thickness of 0.065 inches to 0.140 inches and a Shore D hardness within the range of 55 to 62.

6. The golf ball of claim 1, wherein, wherein 100% of the carboxylic acid groups are neutralized with magnesium ions.

7. The golf ball of claim 1, wherein the inner cover layer has a Shore D hardness within the range of 68 and 73 and a thickness of 0.025 inches to 0.045 inches.

8. The golf ball of claim 1, wherein the outer cover layer has a Shore D hardness within the range of 56 and 62 and a thickness of 0.040 inches to 0.055 inches.

9. The golf ball of claim 1, wherein the core, the center, the mantle, the inner cover and the outer cover have approximately the same specific gravity.

10. The golf ball of claim 1, further comprising a filler selected from the group consisting of zinc oxide, barium sulfate, titanium dioxide, and combinations thereof.

11. A golf ball comprising:

a center layer comprising a diene rubber, having a diameter of between 1.00 inch and 1.40 inches and a deflection under a 200 Ib. static load of between 0.100 inches and 0.180 inches;
a middle layer comprising a thermoplastic material having a thickness of between 0.050 inches and 0.27 inches, a Shore D hardness of 62 or below;
an inner cover layer comprising a blend of ionomers, a Shore D hardness of at least 65, and a thickness of .020 inch to .050 inch; and
an outer cover layer comprising a thermoplastic polyurethane having a Shore D hardness of greater than 53, and a thickness of greater than 0.040 inch.

12. The golf ball of claim 11, wherein the thermoplastic material comprises 7% to 12% by weight of a carboxylic acid, 12% to 20% by weight of an acrylate salt, and 71 % to 80% by weight of ethylene.

13. The golf ball of claim 12, wherein the carboxylic acid is acrylic acid and the acrylate salt is n-butyl acrylate.

14. The golf ball of claim 12, wherein 100% of the carboxylic acid groups are neutralized with a metal ion.

15. The golf ball of claim 14, wherein the metal ion is magnesium.

16. The golf ball of claim 11, wherein the center comprises:

a polybutadiene;
20 to 28 parts by weight of a co-crosslinking agent comprised primarily of a zinc a salt of an unsaturated acrylate;
3 to 5 parts by weight of a metal oxide activator; and
0.8 to 1.5 parts per hundred resin of a free radical initiator.

17. The golf ball of claim 11, wherein the cis-1,4 content of the polybutadiene is 94% or greater.

18. The golf ball of claim 11, wherein the core, the center, the mantle, the inner cover and the outer cover have approximately the same specific gravity.

19. The golf ball of claim 11, further comprising a filler selected from the group consisting of zinc oxide, barium sulfate, titanium dioxide, and combinations thereof..

20. A method of making a golf ball comprising:

forming a core with a diameter of 1.2 inches to 1.38 inches comprising a diene rubber;
forming an mantle with a thickness of 0.065 inches to 0.140 inches comprising a terpolymer;
forming an inner cover layer with a thickness of 0.025 inches to 0.045 inches comprising ionomers; and
forming an outer cover layer with a thickness of 0.040 inches to 0.055 inches comprising thermoset material.

21. The method of making a golf ball of claim 20 further including forming the core with a diene rubber comprising:

a high cis-1,4 content polybutadiene of 94% or greater;
20 to 28 parts by weight of a co-crosslinking agent comprised primarily of a zinc salt of an unsaturated acrylate;
3 to 5 parts by weight of a metal oxide activator; and
0.8 to 1.5 parts per hundred resin of a free radical initiator.

22. The method of making a golf ball of claim 20, further including forming the mantle with a material comprising a terpolymer consisting of 70% to 80% ethylene, 8% to 10.5% acrylic acid and 12% to 20% n-butyl acrylate.

23. The method of making a golf ball of claim 20, further including forming the inner cover layer with a Shore D hardness of between 68 and 73.

24. The method of making a golf ball of claim 20, further including forming the outer cover layer has a Shore D hardness of between 56 and 62.

25. The method of claim 20 further comprising the step of making the core, the center, the mantle, the inner cover and the outer cover have approximately the same specific gravity.

26. A golf ball comprising:

a core formed of a first composition;
an intermediate layer formed of a second composition;
a inner cover layer formed of a third composition;
a outer cover layer formed of a fourth composition, the specific gravity of each of the first, second, third, and fourth compositions being generally equal to each other, the first, second, third, and fourth compositions being

sufficiently mixed such that the ball exhibits random orientation when floated in a solution of sufficient density to support the ball.

27. The golf ball of claim 26, wherein the core has a diameter of 1.2 inches to 1.38 inches.

28. The golf ball of claim 26, wherein the core has a deflection of between 0.100 and 0.180 inches under an applied load of 200 lb.

29. The golf ball of claim 26, wherein the mantle has a thickness within the range of 0.065 inches to 0.140 inches, and a Shore D hardness within the range of 55 to 62.

30. The golf ball of claim 26, wherein, wherein 100% of the carboxylic acid groups are neutralized with magnesium ions.

31. The golf ball of claim 26, wherein the inner cover layer has a Shore D hardness within the range of 68 and 73 and a thickness within the range of 0.025 inches to 0.045 inches.

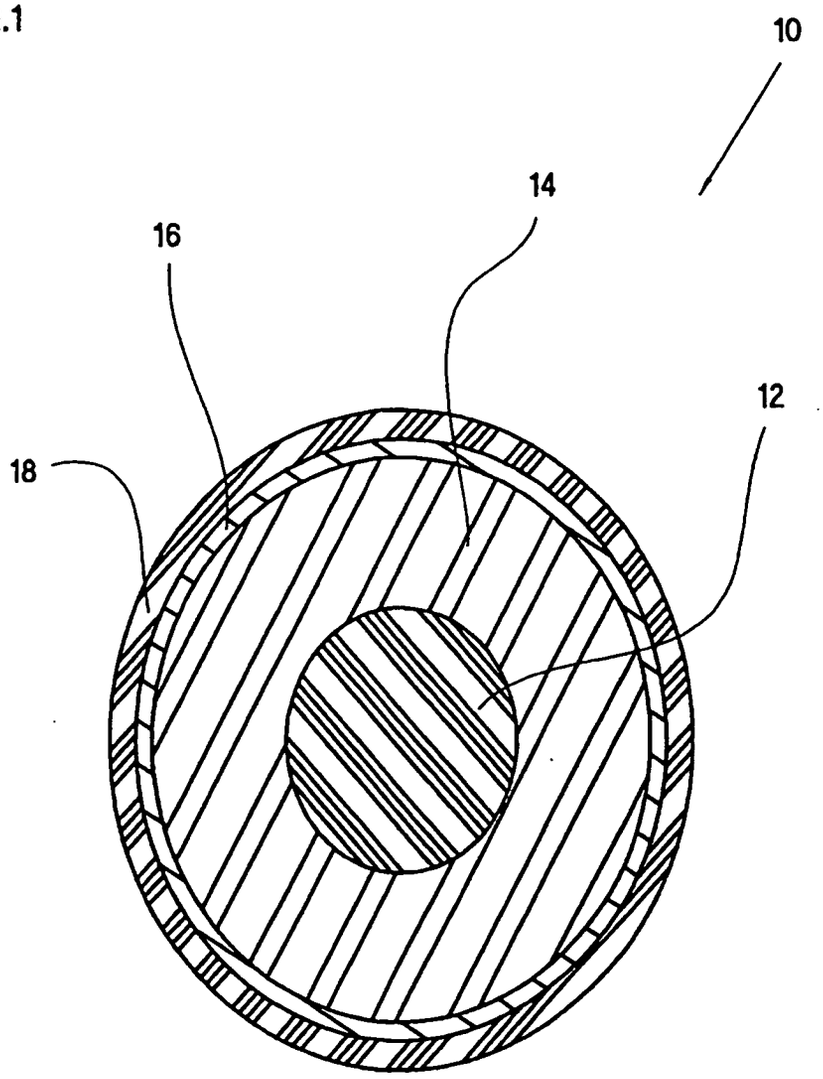
32. The golf ball of claim 26, wherein the outer cover layer has a Shore D hardness within the range of 56 and 62 and a thickness within the range of 0.040 inches to 0.055 inches.

33. The golf ball of claim 26, wherein the specific gravities of the core, intermediate layer, inner cover layer, and outer cover layer are between 1.18 and 1.32.

34. The golf ball of claim 26, wherein the specific gravities are 1.25.

35. The golf ball of claim 26, wherein the specific gravities of the core, intermediate layer, inner cover layer, and outer cover layer are within 0.07.

FIG.1



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EUROPEAN SEARCH REPORT

Application Number
EP 04 02 2199

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 2003/125480 A1 (LADD DEREK A ET AL) 3 July 2003 (2003-07-03) * paragraphs [0024], [0031], [0069]; claims 1,3,12 *	1-35	A63B37/00 C08K5/098 C08K5/14
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

A63B
C08K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 December 2004	Meulemans, R

CATEGORY OF CITED DOCUMENTS

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