US 20110053707A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2011/0053707 A1**

(43) **Pub. Date: Mar. 3, 2011**

Ishii et al.

(54) **MULTILAYER SOLID GOLF BALL**

(75) Inventors: **Hideyuki Ishii**, Portland, OR (US); **Yutaka Kabeshita**, Portland, OR (US); **Yasushi Ichikawa**, Tualatin, OR (US); **Hsin Cheng**, Taipei (TW); **Chien-Hsin Chou**, Yun-lin Hsien (TW); **Chen-Tai Liu**, Yun-lin Hsien (TW)

(73) Assignee: **NIKE, INC.**, Beaverton, OR (US)

(21) Appl. No.: **12/708,800**

(22) Filed: **Feb. 19, 2010**

Related U.S. Application Data

(60) Provisional application No. 61/153,952, filed on Feb. 19, 2009.

Publication Classification

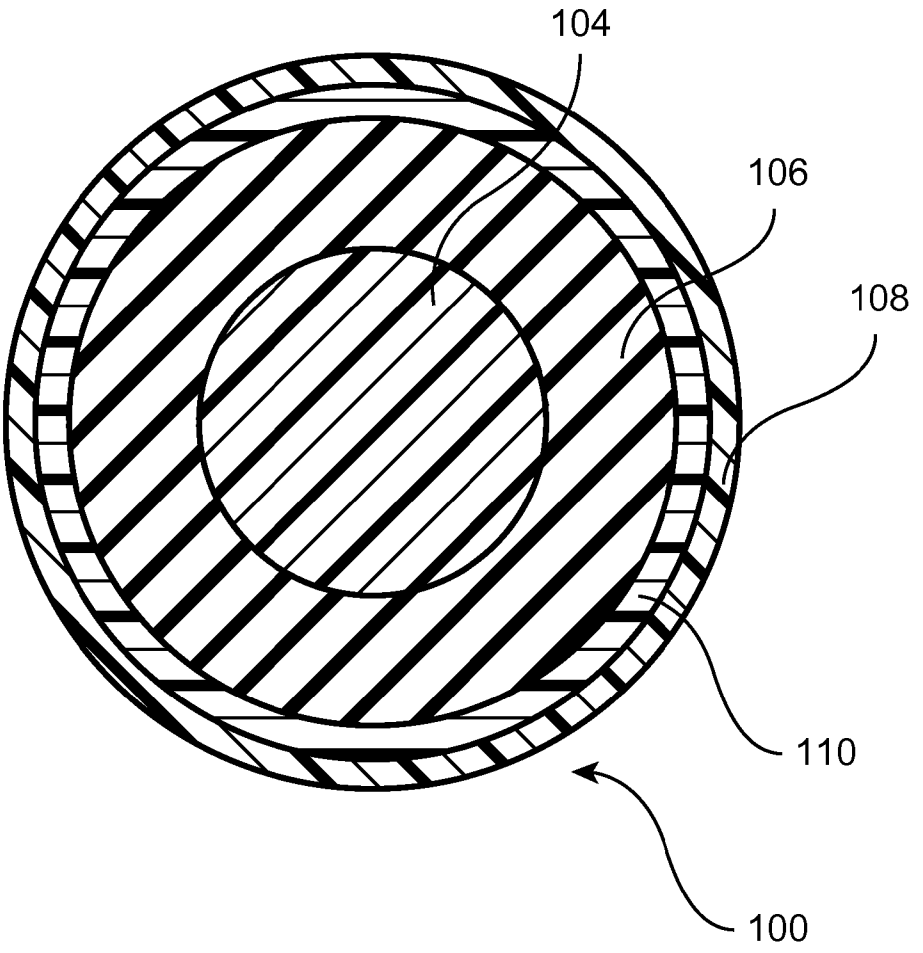
(51) **Int. Cl.**

A63B 37/02	(2006.01)
A63B 37/12	(2006.01)
A63B 37/14	(2006.01)

(52) **U.S. Cl.** **473/376**; 473/374; 473/383; 473/378

(57) **ABSTRACT**

A multilayer solid golf ball maintains performance characteristics after exposure to high ambient temperatures. A core includes a thermoplastic material. The core is surrounded by an intermediate layer comprising a peroxide cross-linked polybutadiene. A single layer or double layer cover with dimples is also provided.



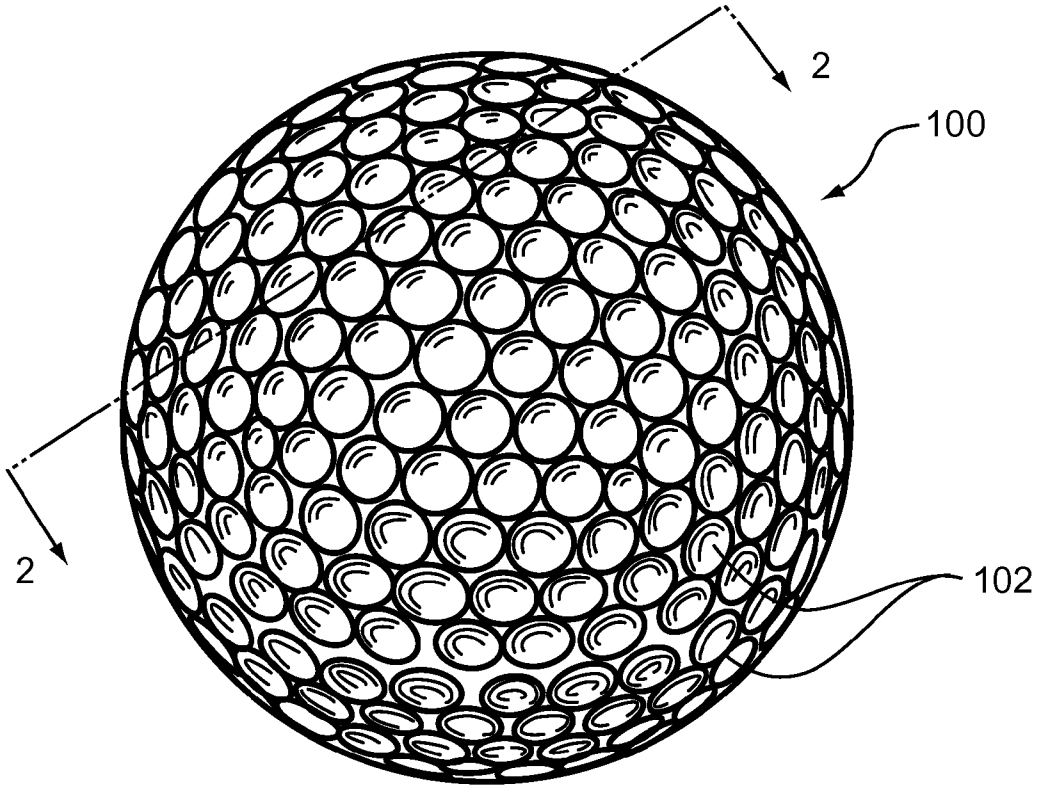


Figure 1

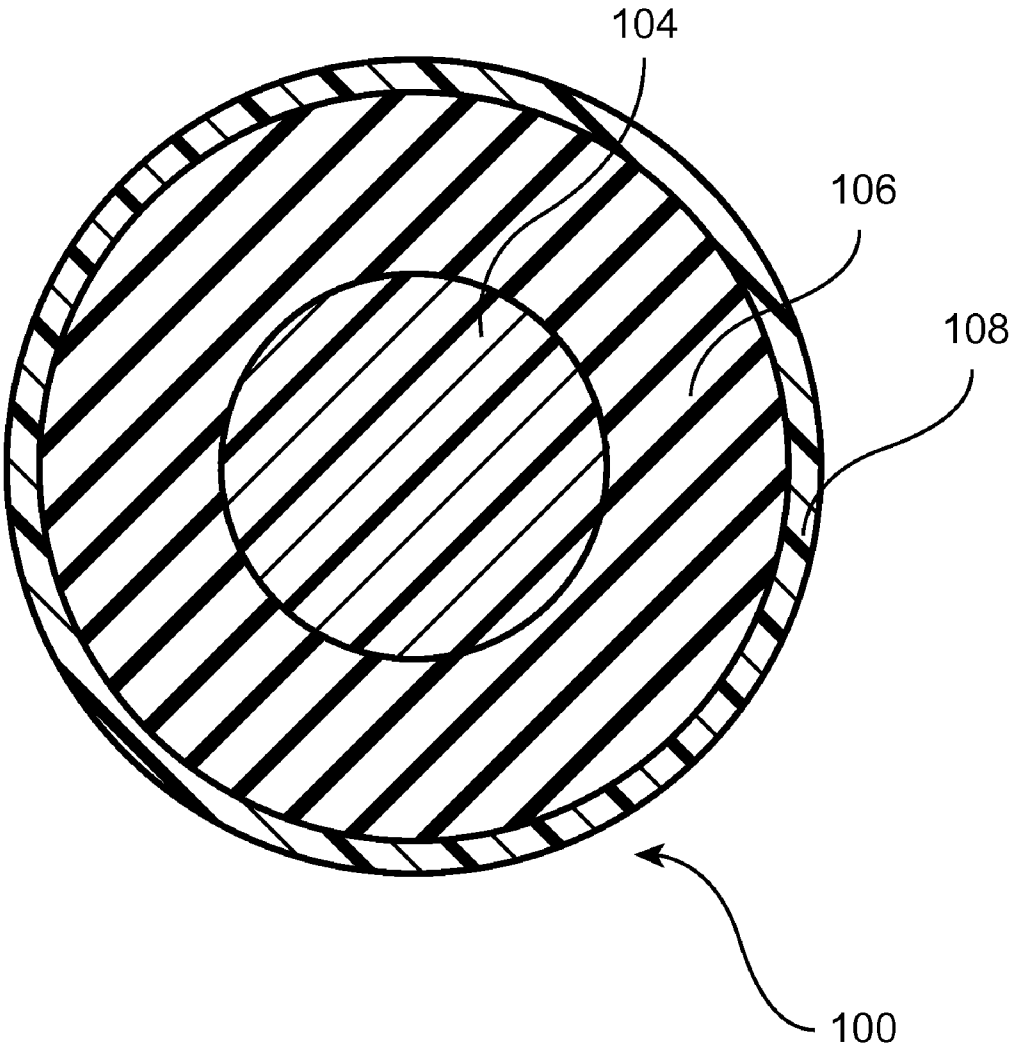


Figure 2

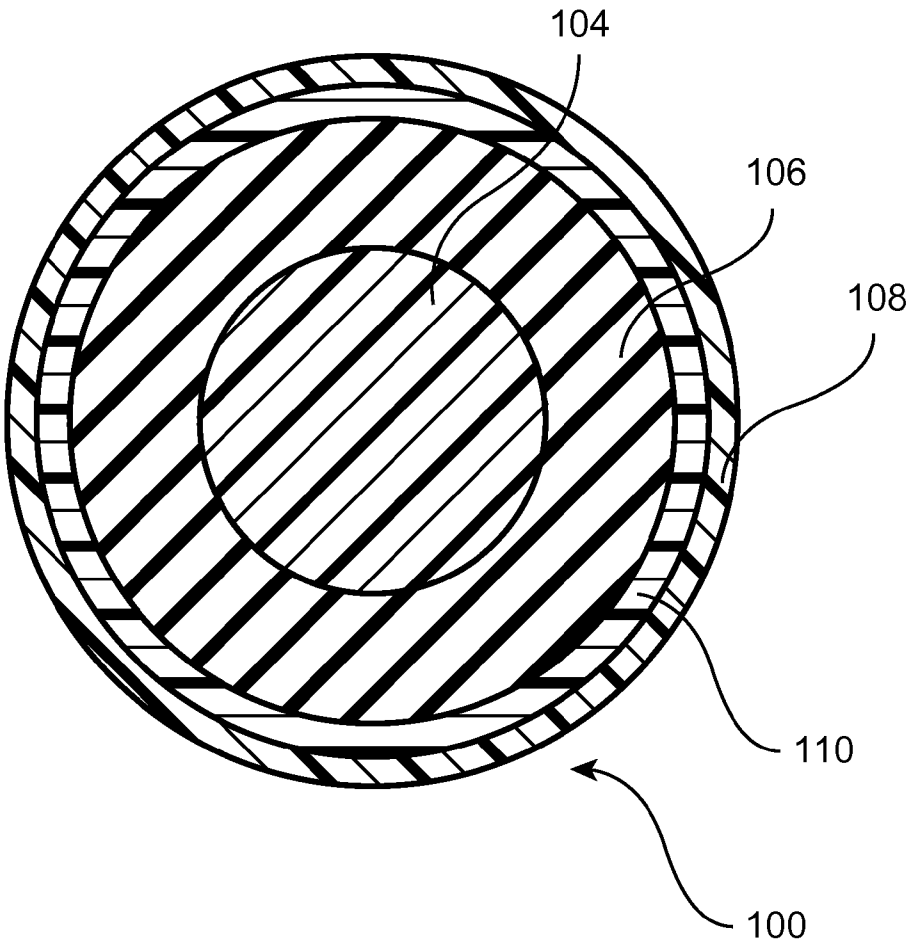


Figure 3

MULTILAYER SOLID GOLF BALL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 61/153,952, entitled "Multilayer Solid Golf Ball", and filed on Feb. 19, 2009, which application is hereby incorporated by reference.

BACKGROUND

[0002] The present invention relates generally to a golf ball and, more particularly, to a multilayer solid golf ball having a core that retains its performance characteristics after exposure to high temperature.

[0003] The history of golf ball development had gone very far from wound golf balls to solid two piece golf balls and multilayer golf balls. Rubber cores gradually replaced wound cores because of quality consistency and performance benefit such as reducing of driver spin for longer distance.

[0004] Multilayer golf balls with layers comprising a thermoplastic material such as ionomer materials brought golf ball technology to the next level. Typically, thin layers of different materials fused together added extra features such as lower spin off the tee but increasing spin around the green. For example, one of the layers may be a hard ionomer in a mantle layer while a soft elastomer material forms the layer for outer cover. Thin layers of ionomer layers were typically used because ionomer has relatively low resilience, particularly when compared to the rubbers typically used to form the core or the layers of the core.

[0005] However, highly neutralized ionomers, such as those developed by DuPont®, have resilience comparable to or even better than the resilience of rubber materials. These highly neutralized ionomers may represent the next step in innovation for golf ball cores. Golf ball cores comprising a thermoplastic material are more consistent in quality than thermoset rubber cores. One limitation on the use of thermoplastic resins, such as a highly neutralized ionomer, for a golf ball core is the effect that ambient temperature has on the shape and performance of the golf ball core.

[0006] Flying distance is an important index used to evaluate the performance of a golf ball. Flying distance is affected by three main factors: "initial velocity", "spin rate", and "launch angle". Initial velocity is one of the primary physical properties affecting the flying distance of the golf ball. The coefficient of restitution (COR) is an alternate parameter of initial velocity of the golf ball, and the temperature will affect the COR. The COR is generally defined as the ratio of velocity of an object before and after an impact. A COR of 1 is a perfect elastic collision where no energy is lost due to the collision, and a COR of 0 is a perfect inelastic collision, where all of the energy is dissipated during the collision. Taking 24 degrees Celsius as the standard temperature at which the United States Golf Association (USGA) sets as a standard temperature for measuring golf ball physical properties and performance characteristics for adherence to USGA rules and regulations, the physical properties, including the COR, of the golf ball will be affected when the temperature is lower or higher than 24 degrees Celsius. For example, the COR is significantly positive relative to the ambient temperature, so the golf ball usually flies shorter in a cold weather.

[0007] Similarly, performance is affected by long-term exposure to high temperatures. Due to the habits of many golfers, golf balls may be routinely subjected to long-term exposure to high temperatures. For example, many golfers tend to leave their golf balls in their golf bags and in their car trunks. Golfers may live in areas where daytime, or even nighttime temperatures regularly exceed 30 degrees Celsius, particularly during daylight hours during the summer. Inside a car trunk, the temperature may reach 50 degrees Celsius for extended periods of time.

[0008] When exposed to relatively high ambient temperatures for extended periods, golf balls tend to lose their original performance characteristics. The material of the core or the cover layers may distort or lose their shape, particularly when the temperature cycles between relatively high ambient temperatures and relatively low ambient temperatures, such as the ambient temperature changes over the course of a day. This results in loss of distance and feel.

[0009] Therefore, there exists a need in the art for a golf ball that maintains its performance characteristics even after exposure to relatively high ambient temperatures.

SUMMARY

[0010] In one aspect, the invention provides a golf ball comprising a core, said core comprising a thermoplastic material; an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and a cover enclosing said inner ball, wherein said golf ball satisfies the following requirements: (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about eight hours, (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of about 50 degrees Celsius for at least about 8 hours, and wherein the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and (3) said core has a coefficient of restitution at 40 meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball.

[0011] In another aspect the invention provides a golf ball comprising a core, said core comprising a thermoplastic material; an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and a cover enclosing said inner ball and having a plurality of dimples on its outer surface, wherein said golf ball satisfies the following requirements: (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about 8 hours, (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 50 degrees Celsius for at least about 8 hours, and the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, (3) said core has a coefficient of restitution at forty (40) meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball, and (4) said dimples have a total volume of 550 cubic millimeters to 800 cubic millimeters.

[0012] Other systems, methods, features and advantages of the invention will be, or will become, apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such

additional systems, methods, features and advantages be included within this description and this summary, be within the scope of the invention, and be protected by the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views.

[0014] FIG. **1** is a perspective view of a golf ball;

[0015] FIG. **2** is a cross-sectional view of a first embodiment of the golf ball shown in FIG. **1**; and

[0016] FIG. **3** is a cross-sectional view of a second embodiment of the golf ball shown in FIG. **1**.

DETAILED DESCRIPTION

[0017] FIG. **1** shows a perspective view of a solid golf ball **100** according to the invention. Golf ball **100** is generally spherical in shape with a plurality of dimples **102** disposed on the surface of golf ball **100**. Any number of dimples **102** may be provided on the surface of golf ball **100**. In some embodiments, the number of dimples **102** may range from about 250 to about 500. In some embodiments, the number of dimples **102** may range from about 300 to about 400. Dimples **102** may be arranged on the surface of golf ball **100** in any pattern.

[0018] Though shown as substantially hemispherical, dimples **102** may have any shape known in the art, such as elliptical, polygonal, or the like. While in some embodiments dimples **102** may be protrusions extending away from the surface of golf ball **100**, dimples **102** are typically indentations in the surface of golf ball **100**. Each indentation defines a volume. For example, if a dimple is a hemispherical indentation in the surface, the space carved out by the dimple and bounded by an imaginary line representing where the surface of golf ball **100** would be if no dimple were present has a volume of a hemisphere, or $2/3\pi r^3$, where r is the radius of the hemisphere. In some embodiments, all dimples **102** may have the same diameter or radius. In other embodiments, dimples **102** may be provided with different diameters or radii. In some embodiments, each dimples may have a diameter or radius selected from a preselected group of diameters/radii. In some embodiments, the number of different diameters/radii in the preselected group of diameters/radii ranges from three (3) to six (6). In some embodiments, the number of dimples **102** with the greatest diameter/radius is greater than the number of dimples with any other diameter/radius. In other words, in such an embodiment, there are more of the largest dimples than dimples of any other size.

[0019] The aggregate of the volumes of all of dimples **102** on the surface of golf ball **100** is a total dimple volume. In one embodiment, the total dimple volume is about 550 cubic millimeters to about 800 cubic millimeters. In some embodiments, the total dimple volume may range from about 600 cubic millimeters to about 800 cubic millimeters.

[0020] Internally, golf ball **100** is generally constructed as a multilayer solid golf ball. In other words, multiple layers of material are fused or compressed together to form the ball. As shown in FIG. **2**, one embodiment of golf ball **100** includes a core **104**, a cover **108**, and an intermediate layer **106** sandwiched between core **104** and intermediate layer **106**. Together, core **104** and intermediate layer **106** may be considered to be an "inner ball".

[0021] Core **104** may include any number of materials. In some embodiments, core **104** may include a thermoplastic material or a thermoset material. The thermoplastic material of core **104** may be an ionomer resin, a highly neutralized acid polymer composition, a polyamide resin, a polyester resin, a polyurethane resin, and combinations thereof. In one embodiment, core **104** comprises an ionomer resin. For example, core **104** may include HPF and Surlyn®, both commercially available from E.I. Dupont de Nemours and Company, and IOTEK®, commercially available from Exxon Corporation. To increase COR, one composition of core **104** includes HPF as the main composition with Surlyn® and/or IOTEK® as optional sub-compositions. Any sub-composition of core **104** may be in an amount of 0 to 40 parts by weight, or in some embodiments, 0 to 10 parts by weight, based on 100 parts by weight of the main composition of core **104**.

[0022] Core **104** may be made using any method known in the art, such as hot-press molding or injection molding. Core **104** of the present invention may be single layer or multilayer construction, and except for the aforementioned materials, any other materials may be also used to make core **104**. In some embodiments, the material of core **104** is selected to provide core **104** with a COR greater than 0.750. In some embodiments, core **104** has a COR at 40 meters per second ranging between about 0.79 and 0.89. In some embodiments, core **104** has a higher COR than that of golf ball **100** taken as a whole.

[0023] In some embodiments, a diameter of core **104** may be in a range between about 19.0 millimeters and about 37.0 millimeters. In some embodiments, the diameter of core **104** may range from about 19.0 millimeters and about 32 millimeters. In some embodiments, the diameter of core **104** may range between about 21.0 millimeters and about 35.0 millimeters. In some embodiments, the diameter of core **104** may range between about 23.0 millimeters and 32.0 millimeters.

[0024] In the embodiment shown in FIG. **2**, intermediate layer **106** covers and substantially encloses core **104**. Intermediate layer **106** has an interior surface facing an exterior surface of core **104**. In the embodiment shown in FIG. **2**, the exterior surface of intermediate layer **106** faces an interior surface of cover **108**. Intermediate layer **106** may have any thickness. In one embodiment, the thickness of intermediate layer **106** may range from about 3 millimeters to about 11 millimeters. In one embodiment, the thickness of intermediate layer **106** may range from about 4 millimeters to about 10 millimeters.

[0025] Intermediate layer **106** may include a thermoset material. In some embodiments, the thermoset material may be a rubber composition. In some embodiments, the base rubber of the rubber composition may include 1,4-cis-polybutadiene, polyisoprene, styrene-butadiene copolymers, natural rubber, and combinations thereof. To increase the resiliency of the inner ball, 1,4-cis-polybutadiene may be used as the base rubber of the rubber composition. Alternatively, 1,4-cis-polybutadiene can be used as the base material for intermediate layer **106**, with additional materials added to the base material. In some embodiments, the amount of 1,4-cis-polybutadiene is at least 50 parts by weight, based on 100 parts by weight of the rubber composition.

[0026] Additives, such as a crosslinking agent and a filler with a greater specific gravity may be added to the rubber

composition. The suitable crosslinking agent can be selected from the group consisting of peroxide, zinc diacrylate, magnesium acrylate, zinc methacrylate, and magnesium methacrylate. To increase the resiliency of the rubber composition, zinc acrylate may be used. However, to increase the resistance to long-term exposure to relatively high ambient temperatures, peroxide may be used as the cross-linking agent. In particular, when core **104** is formed from a high resilient thermoplastic material, the performance of golf ball **100** is maintained in spite of long-term exposure to relatively high ambient temperatures when intermediate layer **106** is formed from a peroxide cross-linked polybutadiene material.

[0027] For example, when intermediate layer **106** is formed from a peroxide cross-linked polybutadiene material and core **104** may include a high resilient thermoplastic material, golf ball **100** may be stored at 24 degrees Celsius for at least about 8 hours. The inner ball (core **104** and intermediate layer **106**) may have a first deflection amount of 2.2 millimeters to about 3.2 millimeters under a load of about 10 kilograms to about 130 kilograms when golf ball **100** is stored in an environment of about 24 degrees Celsius for at least about 8 hours. When the same ball is stored in an environment of about 50 degrees Celsius for at least about 8 hours, golf ball **100** may have a different deflection, the second deflection amount. The ratio of the second deflection amount to the first deflection amount is between about 1.5 and about 1.15.

[0028] In Table 1, various COR and deflection measurements are provided for various golf balls. An Example ball is made according to the invention. In the Example, core **104** includes HPF2000, a DuPont ionomer resin in which the MAA acid groups have been fully neutralized with magnesium ions. Intermediate layer **106** includes BR compound, a peroxide cross-linked polybutadiene material, the specific composition of which is shown in Table 2. The performance of the Example is compared with two conventional balls:

Comparative 1, where the entire inner ball includes HPF2000 and Comparative 2, where the entire inner ball comprises Surlyn8940, a Dupont ionomer resin-Ethylene/methacrylic acid (E/MAA) copolymer, in which the MAA acid groups have been partially neutralized with sodium ions.

TABLE 1

Comparison of Example Ball Performance with Conventional Balls

	Example	Comparative 1	Comparative 2
Core	HPF2000	HPF2000	Surlyn8940
Intermediate layer	BR		
Core diameter (mm)	28.0		
Inner ball diameter (mm)	39.3	39.3	39.3
Compression Test (10-130 kg)			
Second Deflection Amount after storage at 50 degrees C. for 8 hrs (mm)	3.13	3.27	2.21
First Deflection Amount after storage at 24 degrees C. for 8 hrs (mm)	2.84	2.66	1.54
Ratio of Second Deflection Amount to First Deflection Amount	1.10	1.23	1.44
COR			
	0.838	0.825	0.726

TABLE 2

BR Compound Composition

TAIPOL ™ BR0150	100
Zinc diacrylate	28
Zinc oxide	6
Barium sulfate	39.5
Peroxide	1

[0029] As shown in Table 1, the deflection performance of the Example ball is greater than that of Comparative 1 and Comparative 2 after exposure to high ambient temperatures. The ratio of the second deflection amount to the first deflection amount of the Example ball is about 1.1, while the other balls have a ratio of 1.23 and 1.44, respectively. This means that the Comparative balls are less capable of holding their shape and resisting compression after long exposure to high temperatures than the Example ball. Further the COR of the Example ball is greater than either of the Comparative balls.

[0030] To increase the specific gravity of intermediate layer **106**, a suitable filler may be added in the rubber composition, such as zinc oxide, barium sulfate, calcium carbonate, and magnesium carbonate, and in the present invention, zinc oxide is preferred. In addition, a metal powder with a greater specific gravity may also be used as the filler, such as tungsten. By means of adjusting the added amount of the filler, the specific gravity of intermediate layer **106** can reach the desired level.

[0031] In the embodiment shown in FIG. **2**, an exterior surface of intermediate layer **106** faces an interior surface of cover **108**. The exterior surface of cover **108** is the exterior surface of golf ball **100**, which is shown in FIG. **1**. Cover **108** may include any material known in the art. In some embodiments, cover **108** may include an ionomer resin, a highly neutralized ionomer resin, a polyamide resin, a polyester resin, a thermoplastic polyurethane resin, a thermoset polyurethane resin, or combinations of these compounds.

[0032] In the embodiment shown in FIG. **3**, an additional cover layer is provided: inner cover layer **110**. In such an embodiment cover **108** may be considered to be an outer cover layer. Inner cover layer **110** may comprise the same material as that of outer cover layer **108**.

[0033] The thickness of inner cover layer **110** may range between about 0.5 millimeters and 11.0 millimeters. In some embodiments, the thickness of inner cover layer **110** may range between about 0.5 millimeters and about 8.5 millimeters. In some embodiments, the thickness of inner cover layer **110** may range between about 0.5 millimeters and about 3.0 millimeters.

[0034] Inner cover layer **110** has an interior surface that faces an exterior surface of intermediate layer **106**. Inner cover layer **110** covers and encloses intermediate layer **106**. Inner cover layer **110** has an exterior surface that faces an interior surface of outer cover layer **108**.

[0035] In some embodiments, the exterior surface of inner cover layer **110** has a higher hardness than the exterior surface of cover **108**. In some embodiments, an exterior surface of inner cover layer **110** may have a Shore D hardness of 45 to 65, while the exterior surface of outer cover layer **108** may have a Shore D hardness of 40 to 60. In some embodiments, the entirety of inner cover layer **110** has a higher hardness than the entirety of cover **108**.

[0036] While the balls described herein have compositions and layers selected to improve the performance of balls after exposure to high ambient temperatures, balls may also be designed to improve or maintain performance in other types of environments. For example, some types of golf balls may have reduced performance when cold. This problem is addressed in U.S. Pat. No. _____, currently U.S. patent application Ser. No. 12/230,272, entitled "Multilayer Solid Golf Ball", and filed on Aug. 27, 2008, the entirety of which is incorporated herein by reference.

[0037] While various embodiments of the invention have been described, the description is intended to be exemplary, rather than limiting and it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible that are within the scope of the invention. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents. Also, various modifications and changes may be made within the scope of the attached claims.

What is claimed is:

1. A golf ball comprising:

a core, said core comprising a thermoplastic material;

an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and

a cover enclosing said inner ball, wherein said golf ball satisfies the following requirements:

(1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about eight hours,

(2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of about 50 degrees Celsius for at least about 8 hours, and wherein the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and

(3) said core has a coefficient of restitution at 40 meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball.

2. The golf ball of claim **1**, wherein said core has a diameter of 19 millimeters to 32 millimeters.

3. The golf ball of claim **1**, wherein said intermediate layer has a thickness of 3 millimeters to 11 millimeters.

4. The golf ball of claim **1**, wherein said intermediate layer has a thickness of 4 millimeters to 10 millimeters.

5. The golf ball of claim **1**, wherein said thermoplastic material is selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, polyurethane resin, and any combinations thereof.

6. The golf ball of claim **1**, wherein said cover comprises an inner cover layer enclosing said inner ball and an outer cover layer enclosing said inner cover layer; said outer cover layer having a Shore D hardness lower than that of the inner cover layer.

7. The golf ball of claim **6**, wherein said inner cover layer comprises an external surface having a Shore D hardness of 45 to 65; said outer cover layer comprises an external surface having a Shore D hardness of 40 to 60.

8. A golf ball comprising:

a core, said core comprising a thermoplastic material;

an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and

a cover enclosing said inner ball and having a plurality of dimples on its outer surface, wherein said golf ball satisfies the following requirements:

(1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about 8 hours,

(2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 50 degrees Celsius for at least about 8 hours, and the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and

(3) said core has a coefficient of restitution at forty (40) meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball, and

(4) said dimples have a total volume of 550 cubic millimeters to 800 cubic millimeters.

9. The golf ball of claim **8**, wherein said dimples have a total number of 250 to 500.

10. The golf ball of claim **8**, wherein said dimples have a total number of 300 to 450.

11. The golf ball of claim **8**, wherein said dimples have a total volume of 600 cubic millimeters to 800 cubic millimeters.

12. The golf ball of claim **8**, wherein said dimples are provided with 3 to 6 kinds of different diameters.

13. The golf ball of claim **12**, wherein the number of dimples with the largest diameter is greater than the respective number of any other dimples with smaller diameters.

14. The golf ball of claim **8**, wherein said core has a diameter of 19 millimeters to 32 millimeters.

15. The golf ball of claim **8**, wherein said intermediate layer has a thickness of 3 millimeters to 11 millimeters.

16. The golf ball of claim **8**, wherein said intermediate layer has a thickness of 4 millimeters to 10 millimeters.

17. The golf ball of claim **8**, wherein said thermoplastic material is selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, polyurethane resin, and any combinations thereof.

18. The golf ball of claim **8**, wherein said cover comprises an inner cover layer enclosing said inner ball and an outer cover layer enclosing said inner cover layer; said outer cover layer having a Shore D hardness lower than that of the inner cover layer.

19. The golf ball of claim **18**, wherein said inner cover layer or outer cover layer comprises a material selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, thermoplastic polyurethane resin, thermoset polyurethane resin, and any combinations thereof.

20. The golf ball of claim **18**, wherein said inner cover layer comprises an external surface having a Shore D hardness of 45 to 65; said outer cover layer comprises an external surface having a Shore D hardness of 40 to 60.

* * * * *