(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 470 634 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.12.2024 Bulletin 2024/49

(21) Application number: **24173137.1**

(22) Date of filing: **29.04.2024**

(51) International Patent Classification (IPC):
A63B 37/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A63B 37/0075; A63B 37/0017; A63B 37/0031; A63B 37/0033; A63B 37/0043; A63B 37/0045; A63B 37/00621; A63B 37/00622; A63B 37/0092

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **31.05.2023 JP 2023001874 U**

(71) Applicant: **Sumitomo Rubber Industries, Ltd.**
Kobe-shi, Hyogo 651-0072 (JP)

(72) Inventors:
- **INOUE, Hidetaka**
  Kobe-shi, 651-0072 (JP)
- **SAJIMA, Takahiro**
  Kobe-shi, 651-0072 (JP)
- **FUKAO, Kaita**
  Kobe-shi, 651-0072 (JP)

(74) Representative: **Manitz Finsterwald**
Patent- und Rechtsanwaltspartnerschaft mbB
Martin-Greif-Strasse 1
80336 München (DE)

(54) **GOLF BALL**

(57) An object of the present disclosure is to provide a golf ball having a small difference in the flight distance on a driver shot when hit at a high head speed and when hit at a low head speed. The present disclosure provides a golf ball comprising a spherical core, an intermediate layer and an outermost cover, wherein when a center hardness Ho (Shore C hardness) of the spherical core, a surface hardness Hs (Shore C hardness) of the spherical core, a hardness difference S=Hs-Ho, a material hardness Hm (Shore D hardness) of the intermediate layer, a material hardness He (Shore D hardness) of the outermost cover, a thickness Tc (mm) of the outermost cover, and a total lower volume Vi (mm^3) of a plurality of dimples satisfy Vi>365 and (Hc/Tc)×(SxHm/Vi)≤130.

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Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to a golf ball, and particularly relates to a golf ball comprising a spherical core, an intermediate layer, an outermost cover and dimples.

DESCRIPTION OF THE RELATED ART

[0002] One of the pleasures of a golf is hitting a golf ball farther on a driver shot. A head speed when hitting a golf ball with a driver is higher, the golf ball travels a greater flight distance. In recent years, the number of people who enjoy the golf, for example, athlete golfers, average golfers, senior golfers, and female golfers, is increasing. As the number of people enjoying the golf increases, there are more opportunities for golfers with different head speeds to play together.

[0003] On a golf course, different tee positions are provided for golfers with various ages or genders, and efforts have been made to avoid a large difference in the flight distance. For example, golfers between 60 years old and 65 years old can use a senior tee. It is common for men under 60 years old to hit from the same tee, but if golfers with significantly different head speeds (e.g., a golfer of 20-30 years old and a golfer of 50-60 years old) play together, there is a problem that the difference in the flight distance is very large.

[0004] For example, JP 2023-45218 A, JP 2017-29382 A and JP 2016-10564 A disclose golf balls having improved flight performance at a slow head speed.

[0005] JP 2023-45218 A discloses a golf ball comprising a spherical core and at least two cover layers covering the spherical core, wherein the spherical core is formed from a core rubber composition containing (a) a base rubber, (b) an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or a metal salt thereof as a co-crosslinking agent, and (c) a crosslinking initiator, a difference (core surface crosslinking density - core center crosslinking density) between a surface crosslinking density of the spherical core and a center crosslinking density of the spherical core is more than 1.0×10^2 mol/m^3 and less than 9.0×10^2 mol/m^3, a hardness difference (Cs-Co) between a surface hardness Cs (Shore C hardness) of the spherical core and a center hardness Co (Shore C hardness) of the spherical core is 13.0 or more and 30.0 or less, a compression deformation amount of the spherical core when applying a load from an initial load of 98 N to a final load of 1275 N to the spherical core is 3.8 mm or more, the at least two cover layers include a first cover layer and a second cover layer positioned closer to the core than the first cover layer, and an average hardness Dave = (TixHi+ToxHo)/(Ti+To) of the first cover layer and the second cover layer is 55 or more where To (mm) is a thickness of the first cover layer, Ho (Shore D) is a slab hardness of the first cover layer, Ti (mm) is a thickness of the second cover layer, and Hi (Shore D) is a slab hardness of the second cover layer.

[0006] JP 2017-29382 A discloses a golf ball comprising a spherical core and at least one cover layer covering the spherical core, wherein the spherical core is formed from a core rubber composition containing (a) a base rubber, (b) a co-crosslinking agent, (c) a crosslinking initiator and (x) a crosslinked rubber powder, and (x) the crosslinked rubber powder is formed from a rubber composition containing (a1) a base rubber, (b1) a co-crosslinking agent, (c1) a crosslinking initiator and (r) a resin component.

[0007] JP 2016-10564 A discloses a golf ball comprising a core and a cover positioned outside the core, wherein the golf ball has a large number of dimples on a surface thereof, the cover has a Shore D hardness of 30 or more and 50 or less, the golf ball has a compression deformation amount of 3.0 mm or more and 5.0 mm or less measured under conditions of an initial load of 98 N and a final load of 1274 N, and the golf ball satisfies the following mathematical formula (I):

$$0.80\leq((L1+L2)/2)\leq0.95 \quad (I)$$

in the mathematical formula (I), L1 represents a ratio (CL1/CD1) of a lift force coefficient CL1 relative to a drag force coefficient CD1, the lift force coefficient CL1 and the drag force coefficient CD1 being measured under conditions of a Reynolds number of 1.290×10^5 and a spin rate of 2820 rpm; and L2 represents a ratio (CL2/CD2) of a lift force coefficient CL2 relative to a drag force coefficient CD2, the lift force coefficient CL2 and the drag force coefficient CD2 being measured under conditions of a Reynolds number of 1.771×10^5 and a spin rate of 2940 rpm.

SUMMARY OF THE DISCLOSURE

[0008] The present disclosure has been made in view of the above circumstances, and an object of the present disclosure is to provide a golf ball having a small difference in the flight distance on a driver shot between hit at a high head speed and hit at a low head speed.

[0009] The present disclosure that has solved the above problem provides a golf ball comprising a spherical core, an intermediate layer positioned outside the spherical core, and an outermost cover positioned outside the intermediate layer and having a plurality of dimples formed thereon, wherein

a center hardness Ho (Shore C hardness) of the spherical core,
a surface hardness Hs (Shore C hardness) of the spherical core,
a hardness difference S=Hs-Ho,
a material hardness Hm (Shore D hardness) of the intermediate layer,
a material hardness Hc (Shore D hardness) of the outermost cover,
a thickness Tc (mm) of the outermost cover, and
a total lower volume Vi (mm^3) of the plurality of dimples satisfy $Vi>365$ and $(Hc/Tc)\times(S\times Hm/Vi)\leq 130$.

[0010] According to the present disclosure, a golf ball having a small difference in the flight distance on a driver shot between hit at a high head speed and hit at a low head speed is obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a partially cutaway cross-sectional view showing a golf ball according to one embodiment of the present disclosure;
Fig. 2 is a front view of a dimple pattern formed on an outermost cover;
Fig. 3 is a plane view of a dimple pattern formed on an outermost cover; and
Fig. 4 is an enlarged sectional view of dimples formed on an outermost cover.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] The present disclosure provides a golf ball comprising a spherical core, an intermediate layer positioned outside the spherical core, and an outermost cover positioned outside the intermediate layer and having a plurality of dimples formed thereon, wherein

a center hardness Ho (Shore C hardness) of the spherical core,
a surface hardness Hs (Shore C hardness) of the spherical core,
a hardness difference S=Hs-Ho,
a material hardness Hm (Shore D hardness) of the intermediate layer,
a material hardness Hc (Shore D hardness) of the outermost cover,
a thickness Tc (mm) of the outermost cover, and
a total lower volume Vi (mm^3) of the plurality of dimples satisfy $Vi>365$ and $(Hc/Tc)\times(S\times Hm/Vi)\leq 130$.

(Construction of golf ball)

[0013] The golf ball according to the present disclosure comprises a spherical core, an intermediate layer positioned outside of the spherical core, and an outermost cover positioned outside of the intermediate layer and having a plurality of dimples formed thereon.

[0014] Examples of the construction of the golf ball include a three-piece golf ball composed of a single-layered spherical core, an intermediate layer covering the spherical core, and an outermost cover covering the intermediate layer; and a multi-piece golf ball (a four-piece golf ball, a five-piece golf ball, or the like) composed of a single-layered spherical core, two or more intermediate layers covering the spherical core, and an outermost cover covering the intermediate layers.

[0015] The construction of the spherical core may be a single-layered construction, or a multi-layered construction, and the single-layered construction is preferable. The construction of the intermediate layer may be a single-layered construction, or a multi-layered construction composed of at least two layers.

[0016] The diameter of the spherical core is preferably 34.8 mm or more, more preferably 36.8 mm or more, and even more preferably 38.8 mm or more, and is preferably 42.2 mm or less, more preferably 41.8 mm or less, even more preferably 41.2 mm or less, and most preferably 40.8 mm or less. If the diameter of the spherical core falls within the above range, the golf ball has better flight distance performance or shot feeling.

[0017] When the spherical core has a diameter in the range from 34.8 mm to 42.2 mm, the compression deformation amount of the spherical core (shrinking amount of the spherical core along the compression direction) when applying a

load from an initial load of 98 N to a final load of 1275 N to the spherical core is preferably 2.0 mm or more, more preferably 2.5 mm or more, and even more preferably 3.0 mm or more, and is preferably 5.0 mm or less, more preferably 4.5 mm or less, and even more preferably 4.0 mm or less. If the compression deformation amount falls within the above range, the shot feeling is better.

[0018] The surface hardness (Hs) of the spherical core is not particularly limited, but the surface hardness (Hs) is preferably 60 or more, more preferably 65 or more, and even more preferably 70 or more, and is preferably 95 or less, more preferably 90 or less, and even more preferably 85 or less in Shore C hardness. If the surface hardness (Hs) falls within the above range, better shot feeling is obtained.

[0019] The center hardness (Ho) of the spherical core is not particularly limited, but the center hardness (Ho) is preferably 45 or more, more preferably 47 or more, and even more preferably 49 or more, and is preferably 74 or less, more preferably 72 or less, and even more preferably 70 or less in Shore C hardness. If the center hardness (Ho) falls within the above range, better shot feeling is obtained.

[0020] The hardness difference S (=Hs-Ho) between the surface hardness (Hs) and the center hardness (Ho) of the spherical core is preferably 3 or more, more preferably 5 or more, and even more preferably 7 or more, and is preferably less than 20, more preferably 18 or less, and even more preferably 16 or less in Shore C hardness. If the hardness difference S is less than 20, the spin rate becomes higher and thus the controllability on various iron shots is better. If the hardness difference S is 3 or more, the flight distance on a driver shot is greater.

[0021] The hardness (H10) at 10 mm point from the center of the spherical core in the radius direction is not particularly limited, but the hardness (H10) is preferably 60 or more, more preferably 62 or more, and even more preferably 64 or more, and is preferably 84 or less, more preferably 82 or less, and even more preferably 80 or less in Shore C hardness. If the hardness (H10) falls within the above range, better shot feeling is obtained.

[0022] In the spherical core of the present disclosure, the value (H10-Ho)/S is preferably more than 0.35, more preferably 0.38 or more, and even more preferably 0.40 or more, and is preferably less than 0.6, more preferably 0.58 or less, and even more preferably 0.56 or less. If the value (H10-Ho)/S falls within the above range, it indicates that the hardness of the core changes linearly. When the hardness of the core increases linearly, the core deforms smoothly at shotting, resulting in a better shot feeling on a driver shot.

[0023] The material hardness Hm of the intermediate layer composition constituting the intermediate layer is preferably 50 or more, more preferably 52 or more, and even more preferably 54 or more, and is preferably 73 or less, more preferably 72 or less, and even more preferably 70 or less in Shore D hardness. If the material hardness Hm is 50 or more, the flight distance is better due to the low spin rate on a driver shot, and if the material hardness Hm is 73 or less, better shot feeling is obtained when the golf ball is hit. It is noted that in the case of comprising a plurality of intermediate layers, the material hardness of the intermediate layer composition constituting the outermost intermediate layer is adopted as the material hardness Hm.

[0024] The thickness Tm of the intermediate layer is preferably 0.8 mm or more, more preferably 0.9 mm or more, and even more preferably 1.0 mm or more, and is preferably 3.0 mm or less, more preferably 2.7 mm or less, and even more preferably 2.5 mm or less. If the thickness Tm is 0.8 mm or more, the durability is better, and if the thickness Tm is 3.0 mm or less, better shot feeling is obtained. It is noted that in the case of comprising a plurality of intermediate layers, the total thickness of all the intermediate layers is adopted as the thickness Tm of the intermediate layer.

[0025] The material hardness Hc of the cover composition constituting the outermost cover is preferably 20 or more, more preferably 22 or more, and even more preferably 24 or more, and is preferably 40 or less, more preferably 39 or less, and even more preferably 38 or less in Shore D hardness. If the material hardness Hc is 20 or more, the spin rate on a driver shot is not excessively high and thus the flight distance performance is better, and if the material hardness Hc is 40 or less, the spin performance on an approach shot is better.

[0026] The thickness Tc of the outermost cover is preferably 0.4 mm or more, more preferably 0.5 mm or more, and even more preferably 0.6 mm or more, and is preferably 1.0 mm or less, more preferably 0.9 mm or less, and even more preferably 0.8 mm or less. If the thickness Tc is 0.4 mm or more, the spin performance on an approach shot is better, and if the thickness Tc is 1.0 mm or less, the spin rate on a driver shot is not excessively high and thus the flight distance performance is better.

[0027] The value (Hc/Tc) of the slab hardness Hc (Shore D) to the thickness Tc (mm) of the outermost cover is preferably 30 or more, more preferably 33 or more, and even more preferably 35 or more, and is preferably 75 or less, more preferably 72 or less, and even more preferably 70 or less. If the value (Hc/Tc) is 30 or more, the resilience performance is better, and if the value (Hc/Tc) is 75 or less, better shot feeling is obtained when the golf ball is hit.

(Dimples)

[0028] The golf ball according to the present disclosure comprises an outermost cover having a plurality of dimples formed thereon. The dimples are concaves formed on the outermost cover. Next, the dimples formed on the outermost cover of the golf ball according to the present disclosure will be described with reference to the figures.

[0029] A golf ball 2 shown in Fig. 1 comprises a spherical core 4, an intermediate layer 6 covering the core 4, and an outermost cover 8 positioned outside the intermediate layer 6. The golf ball 2 has a plurality of dimples 10 on the surface. Other portions than the dimples 10 on the surface of the golf ball 2 are lands 12. The golf ball 2 is provided with a paint layer and a mark layer on an outer side of the outermost cover 8, but these layers are not depicted.

[0030] As shown in Fig. 2 and Fig. 3, the outermost cover of the golf ball 2 has a plurality of dimples 10 formed on the surface. Each of the dimples 10 has a circle contour.

[0031] Fig. 4 shows a cross section of the golf ball 2 along a plane passing through the central point of the dimple 10 and the central point of the golf ball 2. The top-to-bottom direction in Fig. 4 is the depth direction of the dimple 10. In Fig. 4, a chain double-dashed line 14 indicates a virtual sphere. The surface of the virtual sphere 14 is the surface of the golf ball 2 when it is virtualized that no dimple 10 exists. The diameter of the virtual sphere 14 is equal to the diameter of the golf ball 2. The dimple 10 is recessed from the surface of the virtual sphere 14. The land 12 coincides with the surface of the virtual sphere 14. In the present embodiment, the cross-sectional shape of the dimple 10 is substantially a circular arc. The curvature radius of this circular arc is shown by a reference sign CR in Fig. 4.

[0032] In Fig. 4, an arrow Dm indicates the diameter of the dimple 10. The diameter Dm is a distance between one tangent point Ed and another tangent point Ed when a tangent line Tg traversing two sides of the dimple 10 is drawn. The tangent point Ed is also the edge of the dimple 10. The edge Ed defines the contour of the dimple 10.

[0033] In the present disclosure, the "volume of the dimple" means the volume of the portion surrounded by the surface of the dimple 10 and the surface of the virtual sphere including the contour of the dimple 10. The "volume of the dimple" is divided by a plane connecting intersection points Ed-Ed of the surface of the virtual sphere 14 with the surface of the dimple. The "upper volume of the dimple" is the volume of the dimple upper part surrounded by the surface of the virtual sphere 14 and the plane connecting the intersection points Ed-Ed of the surface of the dimple. The "lower volume of the dimple" is the volume of the dimple lower part surrounded by the plane connecting the intersection points Ed-Ed of the surface of the dimple and the surface of the dimple 10. The volume of the dimple is the sum of the upper volume and the lower volume. The "total volume V of the dimples" in the present disclosure is the sum of the volume of all the dimples. The "total upper volume Vo of the dimples" is the sum of the upper volume of all the dimples. The "total lower volume Vi of the dimples" is the sum of the lower volume of all the dimples. When the total upper volume of the dimples is Vo, and the total lower volume of the dimples is Vi, so V=Vo+Vi.

[0034] The total lower volume Vi of the plurality of dimples of the golf ball is more than 365 mm^3, preferably 380 mm^3 or more, more preferably 400 mm^3 or more. If the total lower volume Vi is more than 365 mm^3, the lift force that acts upon the golf ball is suppressed due to the backspin, and the excess lift on a driver shot is suppressed. The total lower volume Vi is preferably 500 mm^3 or less, more preferably 495 mm^3 or less, and even more preferably 490 mm^3 or less. If the total lower volume Vi is 500 mm^3 or less, the lift force that acts upon the golf ball on a driver shot is fully obtained, and the flight distance performance is better.

[0035] The diameter Dm of the dimple 10 is preferably 2.0 mm or more, more preferably 2.5 mm or more, and even more preferably 2.8 mm or more, and is preferably 6.0 mm or less, more preferably 5.5 mm or less, and even more preferably 5.0 mm or less. If the diameter Dm is 2.0 mm or more, the dimples easily contribute to the turbulent air flow, and if the diameter Dm is 6.0 mm or less, the nature of the golf ball that is substantially a spherical body can be kept.

[0036] The plurality of dimples may be a plurality of dimples with a single diameter, or a combination of dimples with various types of diameters. The golf ball 2 shown in Fig. 2 and Fig. 3 has five types of dimples, i.e. a dimple A with a diameter of 4.400 mm, a dimple B with a diameter of 4.285 mm, a dimple C with a diameter of 4.150 mm, a dimple D with a diameter of 3.875 mm, and a dimple E with a diameter of 3.000 mm.

[0037] In Fig. 4, a double ended arrow Dp1 indicates a first depth of the dimple 10. The first depth Dp1 is the distance between the deepest part of the dimple 10 and the surface of the virtual sphere 14.

[0038] The first depth Dp1 is preferably 0.15 mm or more, more preferably 0.17 mm or more, and even more preferably 0.20 mm or more, and is preferably 0.45 mm or less, more preferably 0.43 mm or less, and even more preferably 0.40 mm or less. If the first depth Dp1 is 0.15 mm or more, the lift force obtained by the dimples fully occurs, and if the first depth Dp1 is 0.45 mm or less, the nature of the golf ball that is substantially a spherical body can be kept.

[0039] In Fig. 4, a double ended arrow Dp2 indicates a second depth of the dimple 10. The second depth Dp2 is the distance between the deepest part of the dimple 10 and the tangent line Tg.

[0040] The second depth Dp2 is preferably 0.08 mm or more, more preferably 0.10 mm or more, and even more preferably 0.12 mm or more, and is preferably 0.30 mm or less, more preferably 0.28 mm or less, and even more preferably 0.26 mm or less. If the second depth Dp2 is 0.08 mm or more, the dimples easily contribute to the turbulent air flow, and if the second depth Dp2 is 0.30 mm or less, the lift force obtained by the dimples is not excessively great, and the flight distance performance on a driver shot is better.

[0041] The area A of the dimple 10 is the area of a region surrounded by the contour of the dimple 10 when the central point of the golf ball 2 is viewed at infinity. In the case that the dimple 10 has a circular shape, the area A is calculated by the following mathematical formula.

$$A=\pi\times(Dm/2)^2$$

[0042] In the golf ball 2 shown in Fig. 2 and Fig. 3, the area of the dimple A is 15.21 mm^2, the area of the dimple B is 14.42 mm^2, the area of the dimple C is 13.53 mm^2, the area of the dimple D is 11.79 mm^2, and the area of the dimple E is 7.07 mm^2.

[0043] The ratio (total areas of dimples/surface area of virtual sphere) of the sum of the areas A of all the dimples 10 to the surface area of the virtual sphere 14 is referred to as an occupation ratio So. The occupation ratio So is preferably 70% or more, more preferably 75% or more, and even more preferably 80% or more, and is preferably 95% or less, more preferably 92% or less, and even more preferably 90% or less. If the occupation ratio So falls within the above range, the effect of the turbulence by the dimples is greater.

[0044] The number of the dimples can be appropriately adjusted depending on the diameter or occupation ratio of the dimples. It is noted that from the viewpoint of the occupation ratio or the function of the respective dimple, the total number of the dimples 10 is preferably 250 or more, more preferably 280 or more, and even more preferably 300 or more, and is preferably 450 or less, more preferably 410 or less, and even more preferably 390 or less.

[0045] The golf ball according to the present disclosure satisfies $(Hc/Tc)\times(S\times Hm/Vi)\leq 130$. Here, S is the hardness difference between the surface hardness Hs and the center hardness Ho of the spherical core, Hm is the material hardness of the intermediate layer, Hc is the material hardness of the outermost cover, Tc is the thickness of the outermost cover, and Vi is the total lower volume of the dimples. The value $(Hc/Tc)\times(S\times Hm/Vi)$ is preferably 55 or more, more preferably 57 or more, and even more preferably 60 or more, and is preferably 130 or less, more preferably 125 or less, and even more preferably 120 or less. If the value $(Hc/Tc)\times(S\times Hm/Vi)$ falls within the above range, the difference in the flight distance on a driver shot between hit at a high head speed and hit at a low head speed is small.

[0046] The value (Hm/Vi) is preferably 0.08 or more, more preferably 0.09 or more, and even more preferably 0.10 or more, and is preferably 0.22 or less, more preferably 0.20 or less, and even more preferably 0.18 or less. If the value (Hm/Vi) falls within the above range, lowering in the spin rate on a driver shot and the turbulent air flow by the dimples fully occur, and thus the flight distance performance is better.

[0047] The golf ball according to the present disclosure preferably satisfies the surface hardness Hs (Shore C hardness) of the spherical core < the surface hardness Hms (Shore C hardness) of the intermediate layer > the surface hardness Hcs (Shore C hardness) of the golf ball.

[0048] The difference (Hms-Hcs) between the surface hardness Hms of the intermediate layer and the surface hardness Hcs of the golf ball is preferably more than 0, more preferably 2 or more, and even more preferably 4 or more in Shore C hardness. If the difference (Hms-Hcs) is more than 0, the spin performance on an approach shot is better since the deformation of the cover when the golf ball is hit is greater. It is noted that the upper limit of the difference (Hms-Hcs) is not particularly limited, but it is about 20 in Shore C hardness.

[0049] The difference (Hms-Hs) between the surface hardness Hms of the intermediate layer and the surface hardness Hs of the spherical core is preferably more than 0, more preferably 2 or more, and even more preferably 4 or more in Shore C hardness. If the difference (Hms-Hs) is more than 0, the whole intermediate layer-covering spherical body having the intermediate layer formed on the surface of the spherical core has a greater degree of an outer-hard and inner-soft structure, and the spin rate on a driver shot can be suppressed.

[0050] The golf ball according to the present disclosure preferably has a diameter ranging from 40 mm to 45 mm. In light of satisfying the regulation of US Golf Association (USGA), the diameter is particularly preferably 42.67 mm or more. In light of prevention of air resistance, the diameter is more preferably 44 mm or less, and particularly preferably 42.80 mm or less. In addition, the golf ball according to the present disclosure preferably has a mass of 40 g or more and 50 g or less. In light of obtaining greater inertia, the mass is more preferably 44 g or more, and particularly preferably 45.00 g or more. In light of satisfying the regulation of USGA, the mass is particularly preferably 45.93 g or less.

[0051] When the golf ball has a diameter in the range of from 40 mm to 45 mm, the compression deformation amount (shrinking amount along the compression direction) of the golf ball when applying a load from an initial load of 98 N to a final load of 1275 N to the golf ball is preferably 2.0 mm or more, more preferably 2.1 mm or more, and even more preferably 2.2 mm or more, and is preferably 3.0 mm or less, more preferably 2.9 mm or less, and even more preferably 2.8 mm or less. If the compression deformation amount falls within the above range, the golf ball has better shot feeling.

[0052] Next, the materials for forming the constituent members of the golf ball according to the present disclosure will be explained.

(Core composition)

[0053] The spherical core of the golf ball according to the present disclosure is preferably formed from a rubber composition (hereinafter sometimes referred to as "core rubber composition") containing (a) a base rubber, (b) an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or a metal salt thereof as a co-crosslinking agent, and (c)

a crosslinking initiator.

[0054] As (a) the base rubber, a natural rubber and/or a synthetic rubber can be used. For example, a polybutadiene rubber, a natural rubber, a polyisoprene rubber, a styrene polybutadiene rubber, or an ethylene-propylene-diene rubber (EPDM) can be used. These rubbers may be used solely, or at least two of these rubbers may be used in combination.

[0055] (b) The α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or the metal salt thereof is blended as a co-crosslinking agent in the rubber composition, and has an action of crosslinking a rubber molecule by graft polymerization to a base rubber molecular chain.

[0056] Examples of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms include acrylic acid, methacrylic acid, fumaric acid, maleic acid and crotonic acid.

[0057] Examples of the metal ion constituting the metal salt of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms include a monovalent metal ion such as sodium, potassium and lithium; a divalent metal ion such as magnesium, calcium, zinc, barium and cadmium; a trivalent metal ion such as aluminum; and other metal ions such as tin and zirconium. The above metal component may be used solely or as a mixture of at least two of them. Among them, the divalent metal ion such as magnesium, calcium, zinc, barium and cadmium is preferably used as the metal component. This is because if the divalent metal salt of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms is used, a metal crosslinking easily generates between the rubber molecules. Especially, as the divalent metal salt, zinc acrylate is preferable, because zinc acrylate enhances the resilience of the obtained golf ball. It is noted that the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or the metal salt thereof may be used solely or as a mixture of at least two of them.

[0058] The amount of (b) the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or the metal salt thereof may be appropriately adjusted depending on the desired hardness of the spherical core. For example, the amount of the component (b) is preferably 15 parts by mass or more, more preferably 20 parts by mass or more, and is preferably 50 parts by mass or less, more preferably 40 parts by mass or less, with respect to 100 parts by mass of (a) the base rubber.

[0059] (c) The crosslinking initiator is blended to crosslink (a) the base rubber component. As (c) the crosslinking initiator, an organic peroxide is suitable. Specific examples of the organic peroxide include dicumyl peroxide, 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane, 2,5-dimethyl-2,5-di(t-butylperoxy) hexane and di-t-butyl peroxide. These organic peroxides may be used solely or as a mixture of at least two of them. Among them, dicumyl peroxide is preferably used.

[0060] The amount of (c) the crosslinking initiator may be appropriately adjusted depending on the desired hardness of the spherical core. For example, the amount of (c) the crosslinking initiator is preferably 0.2 part by mass or more, more preferably 0.4 part by mass or more, and is preferably 5.0 parts by mass or less, more preferably 2.5 parts by mass or less, and even more preferably 1.0 part by mass or less, with respect to 100 parts by mass of (a) the base rubber.

[0061] In the case that the co-crosslinking agent of the rubber composition consists of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms, the rubber composition preferably further contains (d) a metal compound. This is because if the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms is neutralized with the metal compound in the rubber composition, substantially the same effect as using the metal salt of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms as the co-crosslinking agent is provided. In addition, in the case that the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and the metal salt thereof are used in combination as the co-crosslinking agent, (d) the metal compound may be used.

[0062] (d) The metal compound is not particularly limited, as long as it can neutralize (b) the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms in the rubber composition. Examples of (d) the metal compound include a metal hydroxide such as magnesium hydroxide, zinc hydroxide, calcium hydroxide, sodium hydroxide, lithium hydroxide, potassium hydroxide, and copper hydroxide; a metal oxide such as magnesium oxide, calcium oxide, zinc oxide, and copper oxide; and a metal carbonate such as magnesium carbonate, zinc carbonate, calcium carbonate, sodium carbonate, lithium carbonate, and potassium carbonate. As (d) the metal compound, the divalent metal compound is preferable, the zinc compound is more preferable. This is because the divalent metal compound reacts with the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms to form a metal crosslinking. (d) The metal compound may be used solely, or at least two of them may be used in combination.

[0063] The rubber composition may further contain (e) an organic sulfur compound. (e) The organic sulfur compound enhances the resilience of the spherical core. (e) The organic sulfur compound is not particularly limited, as long as it is an organic compound having a sulfur atom in the molecule thereof. Examples of (e) the organic sulfur compound include an organic compound having a thiol group (-SH) or a polysulfide bond having 2 to 4 sulfur atoms (-S-S-, -S-S-S-, or -S-S-S-S-), and a metal salt thereof (-SM, -S-M-S- or the like; M is a metal atom). (e) The organic sulfur compound may be used solely or as a mixture of at least two of them.

[0064] Examples of (e) the organic sulfur compound include thiophenols, thionaphthols, polysulfides, thiurams, thiocarboxylic acids, dithiocarboxylic acids, sulfenamides, dithiocarbamates, and thiazoles. As the organic sulfur compound, diphenyl disulfides (e.g. diphenyl disulfide, bis(pentabromophenyl) disulfide), thiophenols, and thionaphthols (e.g. 2-thionaphthol) can be suitably used.

[0065] The amount of (e) the organic sulfur compound may be appropriately adjusted depending on the desired resilience performance of the spherical core. For example, the amount of (e) the organic sulfur compound is preferably 0.05 part by mass or more, more preferably 0.1 part by mass or more, and is preferably 5.0 parts by mass or less, more preferably 3.0 parts by mass or less, with respect to 100 parts by mass of (a) the base rubber.

[0066] The rubber composition may further contain (f) a carboxylic acid and/or a metal salt thereof. As (f) the carboxylic acid and/or the metal salt thereof, a carboxylic acid having 1 to 30 carbon atoms and/or a metal salt thereof is preferable. As the carboxylic acid, an aliphatic carboxylic acid (a saturated fatty acid or an unsaturated fatty acid), or an aromatic carboxylic acid (e.g. benzoic acid) can be used. The amount of (f) the carboxylic acid and/or the metal salt thereof is preferably 1 part by mass or more and 40 parts by mass or less with respect to 100 parts by mass of the base rubber.

[0067] The rubber composition may further contain an additive such as a filler for adjusting weight or the like, an antioxidant, a peptizing agent, and a softener, where necessary.

[0068] The filler blended in the rubber composition is mainly used as a weight adjusting agent for adjusting the weight of the golf ball obtained as a final product, and may be blended where necessary. Examples of the filler include an inorganic filler such as barium sulfate, calcium carbonate, magnesium oxide, tungsten powder, and molybdenum powder.

[0069] The rubber composition can be obtained by kneading (a) the base rubber, (b) the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and/or the metal salt thereof, (c) the crosslinking initiator, and the other optional components. The kneading method is not particularly limited. For example, the kneading can be conducted with a conventional kneading machine such as a kneading roll, a banbury mixer and a kneader.

[0070] The spherical core can be molded, for example, by heat pressing the core rubber composition. The molding conditions for heat pressing the core rubber composition may be determined appropriately depending on the rubber composition. Generally, the heat pressing is preferably carried out at a temperature of 130 °C to 200 °C for 10 to 60 minutes, or carried out in a two-step heating of heating at a temperature of 130 °C to 150 °C for 20 to 40 minutes followed by heating at a temperature of 160 °C to 180 °C for 5 to 15 minutes.

(Cover composition and intermediate layer composition)

[0071] The golf ball according to the present disclosure has an intermediate layer covering the spherical core. The intermediate layer is preferably formed from an intermediate layer composition containing a resin component.

[0072] The golf ball according to the present disclosure has an outermost cover positioned outside of the intermediate layer. The outermost cover is preferably formed from a cover composition containing a resin component.

[0073] Examples of the resin component used in the resin composition forming the outermost cover and the intermediate layer include an ionomer resin, a urethane resin (a thermoplastic polyurethane elastomer or a thermosetting polyurethane elastomer), a thermoplastic styrene elastomer, a thermoplastic polyamide elastomer, and a thermoplastic polyester elastomer.

[0074] Examples of the ionomer resin include a binary ionomer resin prepared by neutralizing at least a part of carboxyl groups in a binary copolymer composed of an olefin and an α, β-unsaturated carboxylic acid having 3 to 8 carbon atoms with a metal ion, a ternary ionomer resin prepared by neutralizing at least a part of carboxyl groups in a ternary copolymer composed of an olefin, an α, β-unsaturated carboxylic acid having 3 to 8 carbon atoms and an α, β-unsaturated carboxylic acid ester with a metal ion, and a mixture of those.

[0075] Examples of the binary ionomer resin include Himilan (registered trademark) 1555 (Na), 1557 (Zn), 1605 (Na), 1706 (Zn), 1707 (Na), AM7311 (Mg), AM7329 (Zn), AM7337 (available from Dow-Mitsui Polychemicals Co., Ltd.); Surlyn (registered trademark) 8945 (Na), 9945 (Zn), 8140 (Na), 8150 (Na), 9120 (Zn), 9150 (Zn), 6910 (Mg), 6120 (Mg), 7930 (Li), 7940 (Li), AD8546 (Li) (available from E.I. du Pont de Nemours and Company); and Iotek (registered trademark) 8000 (Na), 8030 (Na), 7010 (Zn), 7030 (Zn) (available from ExxonMobil Chemical Corporation).

[0076] Examples of the ternary ionomer resin include Himilan AM7327 (Zn), 1855 (Zn), 1856 (Na), AM7331 (Na) (available from Dow-Mitsui Polychemicals Co., Ltd.); Surlyn 6320 (Mg), 8120 (Na), 8320 (Na), 9320 (Zn), 9320W (Zn), HPF1000 (Mg), HPF2000 (Mg) (available from E.I. du Pont de Nemours and Company); and Iotek7510 (Zn), 7520 (Zn) (available from ExxonMobil Chemical Corporation). It is noted that Na, Zn, Li, Mg or the like described in the parentheses after the trade names of the ionomer resin indicate metal ion type for neutralizing the ionomer resin.

[0077] The thermoplastic polyurethane elastomer has a urethane bond in the molecule. The urethane bond may be formed by a reaction between a polyol and a polyisocyanate. The polyol which is the raw material for the urethane bond has a plurality of hydroxy groups, and a low molecular weight polyol or a high molecular weight polyol may be used.

[0078] Specific examples of the thermoplastic polyurethane elastomer include Elastollan (registered trademark) NY80A, NY84A, NY88A, NY95A, ET885, ET890 (available from BASF Japan Ltd.).

[0079] As the thermoplastic styrene based elastomer, a styrene block-containing thermoplastic elastomer can be suitably used. The styrene block-containing thermoplastic elastomer has a polystyrene block as a hard segment, and a soft segment.

[0080] The styrene block-containing thermoplastic elastomer includes a styrenebutadiene-styrene block copolymer

(SBS), a styrene-isoprene-styrene block copolymer (SIS), a styrene-isoprene-butadiene-styrene block copolymer (SIBS), a hydrogenated product of SBS, a hydrogenated product of SIS, and a hydrogenated product of SIBS. Examples of the hydrogenated product of SBS include a styrene-ethylene-butylene-styrene block copolymer (SEBS). Examples of the hydrogenated product of SIS include a styrene-ethylene-propylene-styrene block copolymer (SEPS). Examples of the hydrogenated product of SIBS include a styrene-ethylene-ethylene-propylene-styrene block copolymer (SEEPS).

[0081] Examples of the thermoplastic styrene based elastomer include TEFABLOC T3221C, T3339C, SJ4400N, SJ5400N, SJ6400N, SJ7400N, SJ8400N, SJ9400N, SR04 (available from Mitsubishi Chemical Corporation).

[0082] The cover composition constituting the outermost cover preferably contains the polyurethane and/or the ionomer resin as the resin component, and particularly preferably contains the polyurethane as the resin component. If the outermost cover contains the polyurethane as the resin component, the bite of the outermost cover into the club face on a driver shot is greater, and thus the spin rate is easily increased.

[0083] In the case that the cover composition contains the polyurethane as the resin component, the amount of the polyurethane in the resin component is preferably 50 mass % or more, more preferably 60 mass % or more, and even more preferably 70 mass % or more. The resin component of the cover composition may consist of the polyurethane (preferably the thermoplastic polyurethane elastomer).

[0084] In the case that the cover composition contains the ionomer resin as the resin component, the amount of the ionomer resin in the resin component is preferably 50 mass % or more, more preferably 60 mass % or more, and even more preferably 70 mass % or more. When the ionomer resin is contained, it is also preferable that the thermoplastic styrene elastomer is used in combination.

[0085] The intermediate layer composition preferably contains the ionomer resin as the resin component. When the ionomer resin is contained, it is also preferable that the thermoplastic styrene elastomer is used in combination. The amount of the ionomer resin in the resin component of the intermediate layer composition is preferably 50 mass % or more, more preferably 60 mass % or more, and even more preferably 70 mass % or more.

[0086] The outermost cover composition and the intermediate layer composition may contain a pigment component such as a white pigment (e.g. titanium oxide), a blue pigment and a red pigment, a weight adjusting agent such as zinc oxide, calcium carbonate and barium sulfate, a dispersant, an antioxidant, an ultraviolet absorber, a light stabilizer, a fluorescent material or fluorescent brightener, or the like, in addition to the above resin component.

[0087] The amount of the white pigment (e.g. titanium oxide) is preferably 0.5 part by mass or more, more preferably 1 part by mass or more, and is preferably 10 parts by mass or less, more preferably 8 parts by mass or less, with respect to 100 parts by mass of the base resin constituting the outermost cover. If the amount of the white pigment is 0.5 part by mass or more, it is possible to impart the opacity to the cover. In addition, if the amount of the white pigment is 10 parts by mass or less, the obtained cover has better durability.

[0088] The method for forming the intermediate layer is not particularly limited, and examples thereof include a method which comprises molding the intermediate layer composition into a hemispherical half-shell in advance, covering the spherical core with two of the half-shells, and performing compression molding; and a method which comprises injection molding the intermediate layer composition directly onto the spherical core to cover the spherical core.

[0089] Examples of the method for molding the cover include a method which comprises molding the cover composition into a hollow shell, covering the spherical body (the spherical body having the spherical core and the intermediate layer) with a plurality of the hollow shells, and performing compression molding (preferably a method which comprises molding the cover composition into a hollow half-shell, covering the spherical body with two of the half-shells, and performing compression molding); and a method which comprises injection molding the cover composition directly onto the spherical body.

[0090] The golf ball body having the cover formed thereon is ejected from the mold, and is preferably subjected to surface treatments such as deburring, cleaning and sandblast where necessary.

[0091] In addition, if desired, a paint film or a mark may be formed. The thickness of the paint film is not particularly limited, and is preferably 5 μm or more, more preferably 6 μm or more, and even more preferably 7 μm or more, and is preferably 50 μm or less, more preferably 40 μm or less, and even more preferably 30 μm or less. If the thickness of the paint film is 5 μm or more, the paint film is hard to wear off even if the golf ball is used continuously, and if the thickness of the paint film is 50 μm or less, the dimple effect is fully obtained. It is noted that the effect of the present disclosure is not impaired since the paint film is very thin.

EXAMPLES

[0092] Next, the present disclosure will be described in detail by way of examples. However, the present disclosure is not limited to the examples described below. Various changes and modifications without departing from the spirit of the present disclosure are included in the scope of the present disclosure.

[Evaluation method]

(1) Material (slab) hardness (Shore D hardness)

[0093] Sheets with a thickness of about 2 mm were produced by injection molding the intermediate layer composition or the cover composition. The sheets were stored at a temperature of 23 °C for two weeks. At least three of these sheets were stacked on one another so as not to be affected by the measuring substrate on which the sheets were placed, and the hardness of the stack was measured with an automatic hardness tester (Digitest II, available from Bareiss company) using a testing device of "Shore D".

(2) Compression deformation amount (mm)

[0094] The compression deformation amount was measured with a YAMADA type compression tester "SCH". The golf ball or spherical core was placed on a metal rigid plate of the tester. A metal cylinder slowly fell toward the golf ball or spherical core. The golf ball or spherical core sandwiched between the bottom of the cylinder and the rigid plate deformed. The travelling distance of the cylinder when applying a load from an initial load of 98 N to a final load of 1275 N to the golf ball or spherical core was measured. The compression deformation amount (mm) is the travelling distance. The travelling speed of the cylinder before applying the initial load was 0.83 mm/s. The travelling speed of the cylinder when applying the load from the initial load to the final load was 1.67 mm/s.

(3) Core hardness distribution (Shore C hardness)

[0095] The hardness measured at the surface portion of the core was adopted as the surface hardness of the core. In addition, the core was cut into two hemispheres to obtain a cut plane, and the hardness at the central point of the cut plane and the hardness at the predetermined distance from the central point in the radius direction were measured. It is noted that the core hardness was measured at four points at the predetermined distance from the central point of the core cut plane, and the average value thereof was calculated. The hardness was measured with an automatic hardness tester (Digitest II, available from Bareiss company) using a testing device of "Shore C".

(4) Surface hardness of golf ball and surface hardness of intermediate layer

[0096] The hardness measured at the land on the surface portion of the golf ball was adopted as the surface hardness of the golf ball. In addition, the hardness measured at the surface portion of the intermediate layer-covering spherical body having the intermediate layer formed on the surface of the spherical core was adopted as the surface hardness of the intermediate layer. Each hardness was measured at four points and the average value thereof was calculated. The hardness was measured with an automatic hardness tester (Digitest II, available from Bareiss company) using a testing device of "Shore C".

(5) Flight distance (m) on a driver shot by a golfer with a high head speed

[0097] A driver (trade name "SRIXON ZX7", Shaft hardness: S, Loft angle: 10.5°, available from Sumitomo Rubber Industries, Ltd.) was installed on a swing machine available from Golf Laboratories, Inc. The hitting point was set at the face center. The golf ball was hit at a head speed of 45 m/sec, and the ball speed (m/s) and spin rate (rpm) right after hitting the golf ball and the flight distance (the distance from the launch point to the stop point) were measured. The measurement was conducted twelve times for each golf ball, and the average value of the obtained data was adopted as the measurement value for that golf ball.

(6) Flight distance (m) on a driver shot by a golfer with a low head speed

[0098] A driver (trade name "XXIO12", Shaft hardness: R, Loft angle: 10.5°, available from Sumitomo Rubber Industries, Ltd.) was installed on a swing machine available from Golf Laboratories, Inc. The hitting point was set at the face center. The golf ball was hit at a head speed of 35 m/sec, and the ball speed (m/s) and spin rate (rpm) right after hitting the golf ball and the flight distance (the distance from the launch point to the stop point) were measured. The measurement was conducted twelve times for each golf ball, and the average value of the obtained data was adopted as the measurement value for that golf ball.

[Production of golf ball]

(1) Preparation of core composition

[0099] According to the formulations shown in Table 1, the materials were kneaded with a kneading roll to obtain the core compositions.

Table 1

Core No.		A	B	C
Core formulation (parts by mass)	Polybutadiene	100	100	100
	Zinc acrylate	31.9	35.3	35.3
	Zinc oxide	10	5	5
	Barium sulfate	Appropriate amount*1)	Appropriate amount*1)	Appropriate amount*1)
	Benzoic acid	2	-	-
	Bis(pentabromophenyl) disulfide	0.4	-	-
	Diphenyl disulfide	-	0.4	0.4
	Dicumyl peroxide	0.7	0.7	0.7
Core vulcanizing temperature (°C)		150	160	160
Core vulcanizing time (min)		20	17	17
Core diameter (mm)		39.5	39.5	39.1
Core compression deformation amount (mm)		3.21	3.20	3.24
Core hardness distribution (Shore C)	Hardness at 0 mm point from center (center hardness)	56.1	68.3	67.9
	Hardness at 2.5 mm point from center	62.4	72.9	72.7
	Hardness at 5 mm point from center	66.1	73.3	73.1
	Hardness at 7.5 mm point from center	67.0	73.9	73.5
	Hardness at 10 mm point from center	67.3	74.8	74.6
	Hardness at 12.5 mm point from center	70.9	75.6	75.3
	Hardness at 15 mm point from center	77.6	78.1	77.9
	Surface hardness	81.8	82.3	81.9
	Hardness difference (surface hardness – center hardness)	25.7	14.0	14.0

*1) The amount of barium sulfate was adjusted such that the golf balls had a mass of 45.3 g.

Core No.		D	E	F
Core formulation (parts by mass)	Polybutadiene	100	100	100
	Zinc acrylate	34.3	30.6	33.2
	Zinc oxide	5	5	10
	Barium sulfate	Appropriate amount*1)	Appropriate amount*1)	Appropriate amount*1)
	Benzoic acid	-	-	2
	Bis(pentabromophenyl) disulfide	-	0.4	0.4
	Diphenyl disulfide	0.4	-	-
	Dicumyl peroxide	0.7	0.7	0.7
Core vulcanizing temperature (°C)		150	155	170
Core vulcanizing time (min)		20	20	15
Core diameter (mm)		39.5	39.5	39.5
Core compression deformation amount (mm)		3.18	3.16	3.20
Core hardness distribution (Shore C)	Hardness at 0 mm point from center (center hardness)	70.7	64.8	55.4
	Hardness at 2.5 mm point from center	71.9	67.7	65.1
	Hardness at 5 mm point from center	72.5	69.3	69.6
	Hardness at 7.5 mm point from center	73.0	69.9	70.2
	Hardness at 10 mm point from center	75.5	72.6	70.6
	Hardness at 12.5 mm point from center	77.1	75.1	71.0
	Hardness at 15 mm point from center	77.7	79.8	76.7
	Surface hardness	79.3	82.2	86.2
	Hardness difference (surface hardness – center hardness)	8.6	17.4	30.8

*1) The amount of barium sulfate was adjusted such that the golf balls had a mass of 45.3 g.

[0100] The materials used in Table 1 are shown as follows.

Polybutadiene: "BR-730" available from JSR Corporation
Zinc acrylate: "ZN-DA90S" available from Nisshoku Techno Fine Chemical Co., Ltd.
Zinc oxide: "Ginrei R" available from Toho Zinc Co., Ltd.
Barium sulfate: "Barium sulfate BD" available from Sakai Chemical Industry Co., Ltd.
Benzoic acid: (purity: at least 98%) available from Tokyo Chemical Industry Co. Ltd.
Bis(pentabromophenyl) disulfide: available from Kawaguchi Chemical Industry Co., Ltd.
Diphenyl disulfide: available from Sumitomo Seika Chemicals Co., Ltd.
Dicumyl peroxide: "Percumyl (registered trademark) D" available from NOF Corporation

(2) Preparation of intermediate layer composition/cover composition

[0101] According to the formulations shown in Tables 2 and 3, the materials were extruded with a twin-screw kneading type extruder to prepare the intermediate layer compositions/cover compositions in a pellet form.

Table 2

Intermediate layer composition/cover composition No.		a	b	c	d	e
Formulation (parts by mass)	Surlyn 8150	-	50	-	-	-
	Himilan 1605	50	-	47	-	-
	Himilan AM7329	50	50	50	-	-
	Himilan 1555	-	-	-	45	41
	Himilan 1557	-	-	-	45	41
	TEFABLOC T3221C	-	-	3	10	18
	Titanium dioxide	4	4	4	4	4
Hardness (Shore D)		66	68	63	55	50

[0102] Surlyn (registered trademark) 8150: sodium ion neutralized ethylene-methacrylic acid copolymer ionomer resin available from E.I. du Pont de Nemours and Company

[0103] Himilan (registered trademark) 1605: sodium ion neutralized ethylene-methacrylic acid copolymer ionomer resin available from Dow-Mitsui Polychemicals Co., Ltd.

[0104] Himilan (registered trademark) AM7329: sodium ion neutralized ethylene-methacrylic acid copolymer ionomer resin available from Dow-Mitsui Polychemicals Co., Ltd.

[0105] Himilan (registered trademark) 1555: sodium ion neutralized ethylene-methacrylic acid copolymer ionomer resin available from Dow-Mitsui Polychemicals Co., Ltd.

[0106] Himilan (registered trademark) 1557: zinc ion neutralized ethylene-methacrylic acid copolymer ionomer resin available from Dow-Mitsui Polychemicals Co., Ltd.

[0107] TEFABLOC T3221C: thermoplastic styrene based elastomer available from Mitsubishi Chemical Corporation

[0108] Titanium dioxide: A-220 available from Ishihara Sangyou Kaisha, Ltd.

Table 3

Intermediate layer composition/cover composition No.		f	g	h
Formulation (parts by mass)	Elastollan NY80A	100	-	-
	Elastollan NY84A	-	100	-
	Elastollan NY88A	-	-	100
	Elastollan NY95A	-	-	-
	TINUVIN 770	0.2	0.2	0.2
	Titanium dioxide	4	4	4
Hardness (Shore D)		27	31	36

[0109] Elastollan (registered trademark) NY80A: thermoplastic polyurethane elastomer available from BASF Japan Ltd.

[0110] Elastollan (registered trademark) NY84A: thermoplastic polyurethane elastomer available from BASF Japan Ltd.

[0111] Elastollan (registered trademark) NY88A: thermoplastic polyurethane elastomer available from BASF Japan Ltd.

[0112] Elastollan (registered trademark) NY95A: thermoplastic polyurethane elastomer available from BASF Japan Ltd.

[0113] TINUVIN (registered trademark) 770: hindered amine based light stabilizer available from BASF Japan Ltd.

[0114] Titanium dioxide: A-220 available from Ishihara Sangyo Kaisha, Ltd.

(3) Production of core

[0115] The core compositions shown in Table 1 were heat-pressed in upper and lower molds, each having a hemi-

spherical cavity, to produce the spherical cores. It is noted that barium sulfate was added in an appropriate amount such that the obtained golf balls had a mass of 45.3 g.

(4) Formation of intermediate layer and cover

[0116] The intermediate layer composition was injection molded on the spherical core to obtain the intermediate layer-covering spherical body. The obtained intermediate layer-covering spherical body was charged into a final mold provided with a plurality of pimples on the cavity surface. Half shells were obtained from the cover composition by a compression molding method. The intermediate layer-covering spherical body charged into the final mold was covered with two of the half shells to obtain the golf balls having an outermost cover on which a plurality of dimples with an reversed shape of the pimple shape on the cavity surface were formed. The specifications of the dimples formed on the outermost cover are shown in Tables 4 to 5. The evaluation results regarding the obtained golf balls are shown in Tables 6 to 7.

Table 4

Dimple pattern	Type	Number	Diameter (mm)	Depth Dp1 (mm)	Depth Dp2 (mm)	Curvature CR (mm)	Lower volume (mm^3)	Total lower volume Vi (mm^3)
I	A	60	4.400	0.2356	0.1219	19.9	0.93	56
	B	158	4.285	0.2297	0.1219	18.9	0.88	139
	C	72	4.150	0.2230	0.1219	17.7	0.83	59
	D	36	3.875	0.2100	0.1219	15.5	0.72	26
	E	12	3.000	0.1747	0.1219	9.3	0.43	5
II	A	60	4.400	0.2526	0.1389	17.5	1.06	63
	B	158	4.285	0.2467	0.1389	16.6	1.00	158
	C	72	4.150	0.2400	0.1389	15.6	0.94	68
	D	36	3.875	0.2270	0.1389	13.6	0.82	30
	E	12	3.000	0.1917	0.1389	8.2	0.49	6
III	A	60	4.400	0.2866	0.1729	14.1	1.32	79
	B	158	4.285	0.2807	0.1729	13.4	1.25	197
	C	72	4.150	0.2740	0.1729	12.5	1.17	84
	D	36	3.875	0.2610	0.1729	10.9	1.02	37
	E	12	3.000	0.2257	0.1729	6.6	0.61	7
IV	A	60	4.400	0.3036	0.1899	12.8	1.45	87
	B	158	4.285	0.2977	0.1899	12.2	1.37	217
	C	72	4.150	0.2910	0.1899	11.4	1.29	93
	D	36	3.875	0.2780	0.1899	10.0	1.12	40
	E	12	3.000	0.2427	0.1899	6.0	0.67	8
V	A	60	4.400	0.3206	0.2069	11.8	1.58	95
	B	158	4.285	0.3147	0.2069	11.2	1.50	236
	C	72	4.150	0.3080	0.2069	10.5	1.40	101
	D	36	3.875	0.2950	0.2069	9.2	1.22	44
	E	12	3.000	0.2597	0.2069	5.5	0.74	9

Table 5

Dimple pattern No.	I	II	III	IV	V
Front view	Fig. 2	Fig. 2	Fig. 2	Fig. 2	Fig. 2
Plane view	Fig. 3	Fig. 3	Fig. 3	Fig. 3	Fig. 3
Total number	338	338	338	338	338
Total lower volume Vi (mm^3)	285	325	405	445	485

(continued)

Dimple pattern No.	I	II	III	IV	V
Occupation ratio (%)	81.6	81.6	81.6	81.6	81.6

Table 6

Golf ball No.		1	2	3	4	5
Core	Formulation No.	B	C	D	B	B
	Diameter (mm)	39.5	39.1	39.5	39.5	39.5
	Compression deformation amount (mm)	3.2	3.24	3.18	3.2	3.2
	Core center hardness Ho	68.3	67.9	70.7	68.3	68.3
	Hardness H10 at 10 mm point	74.8	74.6	75.5	74.8	74.8
	Surface hardness Hs	82.3	81.9	79.3	82.3	82.3
	(H10-Ho)/S	0.46	0.48	0.56	0.46	0.46
	Hardness difference S (=Hs-Ho)	14.0	14.0	8.6	14.0	14.0
Intermediate layer	Formulation No.	c	c	c	e	c
	Thickness (mm)	1	1	1	1	1
	Surface hardness Hms (Shore C)	92	92	92	76	92
	Material hardness Hm (Shore D)	63	63	63	50	63
Cover	Formulation No.	9	9	9	9	f
	Thickness Tc (mm)	0.6	0.8	0.6	0.6	0.6
	Material hardness Hc (Shore D)	31	31	31	31	27
Dimple	Type (pattern)	IV	IV	IV	IV	IV
	Lower volume Vi (mm^3)	445	445	445	445	445
Golf ball	Surface hardness Hcs (Shore C)	84	79	84	71	82
	Compression deformation amount (mm)	2.79	2.82	2.77	2.89	2.79
(Hc/Tc)×(S×Hm/Vi)		102.4	76.8	62.9	81.3	89.2
Driver shot (head speed = 45m/s)	Spin rate (rpm)	2750	2940	2840	2900	2930
	Ball speed (m/s)	65.6	65.4	65.7	65.2	65.6
	Flight distance (m)	226.2	224.3	225.4	223.9	224.9
Driver shot (head speed = 35m/s)	Spin rate (rpm)	2830	3020	2900	2980	3000
	Ball speed (m/s)	50.8	50.7	50.9	50.5	50.8
	Flight distance (m)	168.4	167.2	168.1	166.4	167.8
Flight distance difference between H/S45-H/S35 shots		57.8	57.1	57.3	57.5	57.1

Table 6-Continued

Golf ball No.		6	7	8	9	10
Core	Formulation No.	B	E	B	E	A
	Diameter (mm)	39.5	39.5	39.5	39.5	39.5
	Compression deformation amount (mm)	3.2	3.16	3.2	3.16	3.21
	Core center hardness Ho	68.3	64.8	68.3	64.8	56.1
	Hardness H10 at 10 mm point	74.8	72.6	74.8	72.6	67.3
	Surface hardness Hs	82.3	82.2	82.3	82.2	81.8
	(H10-Ho)/S	0.46	0.45	0.46	0.45	0.44
	Hardness difference S (=Hs-Ho)	14.0	17.4	14.0	17.4	25.7
Intermediate layer	Formulation No.	c	c	d	c	e
	Thickness (mm)	1	1	1	1	1
	Surface hardness Hms (Shore C)	92	92	83	92	76
	Material hardness Hm (Shore D)	63	63	55	63	50
Cover	Formulation No.	9	9	9	f	f
	Thickness Tc (mm)	0.6	0.6	0.6	0.6	0.6
	Material hardness Hc (Shore D)	31	31	31	27	27
Dimple	Type (pattern)	V	IV	III	IV	V
	Lower volume Vi (mm^3)	485	445	405	445	485
Golf ball	Surface hardness Hcs (Shore C)	84	84	78	82	68
	Compression deformation amount (mm)	2.79	2.75	2.87	2.79	2.91
(Hc/Tc)×(S×Hm/Vi)		94.0	127.3	98.2	110.9	119.2
Driver shot (head speed = 45m/s)	Spin rate (rpm)	2750	2700	2820	2900	2850
	Ball speed (m/s)	65.6	65.7	65.3	65.6	65.1
	Flight distance (m)	225.6	227	225.1	225.1	224.8
Driver shot (head speed = 35m/s)	Spin rate (rpm)	2830	2790	2890	2970	2920
	Ball speed (m/s)	50.8	50.9	50.6	50.8	50.4
	Flight distance (m)	168.7	169.1	166.7	168	167.9
Flight distance difference between H/S45-H/S35 shots		56.9	57.9	58.4	57.1	56.9

Table 7

Golf ball No.		11	12	13	14	15
Core	Formulation No.	E	A	E	B	F
	Diameter (mm)	39.5	39.5	39.5	39.5	39.5
	Compression deformation amount (mm)	3.16	3.21	3.16	3.20	3.20
	Core center hardness Ho	64.8	56.1	64.8	68.3	55.4
	Hardness H10 at 10 mm point	72.6	67.3	72.6	74.8	70.6
	Surface hardness Hs	82.2	81.8	82.2	82.3	86.2
	(H10-Ho)/S	0.45	0.44	0.45	0.46	0.49
	Hardness difference S (=Hs-Ho)	17.4	25.7	17.4	14.0	30.8
Intermediate layer	Formulation No.	c	c	b	c	d
	Thickness (mm)	1	1	1	1	1
	Surface hardness Hms (Shore C)	92	92	97	92	83
	Material hardness Hm (Shore D)	63	63	68	63	55
Cover	Formulation No.	9	9	h	9	f
	Thickness Tc (mm)	0.6	0.6	0.6	0.6	0.6
	Material hardness Hc (Shore D)	31	31	36	31	27
Dimple	Type (pattern)	III	III	IV	I	IV
	Lower volume Vi (mm^3)	405	405	445	285	445
Golf ball	Surface hardness Hcs (Shore C)	84	84	92	84	75
	Compression deformation amount (mm)	2.75	2.8	2.66	2.79	2.89
(Hc/Tc)×(S×Hm/Vi)		139.8	206.6	159.5	159.9	171.3
Driver shot (Head speed = 45m/s)	Spin rate (rpm)	2700	2630	2560	2750	2650
	Ball speed (m/s)	65.7	65.6	65.9	65.6	65.2
	Flight distance (m)	227.7	228.4	229.1	227.6	226.9
Driver shot (Head speed = 35m/s)	Spin rate (rpm)	2790	2730	2690	2830	2760
	Ball speed (m/s)	50.9	50.8	51	50.8	50.5
	Flight distance (m)	167.9	168.2	169.2	166.8	167.9
Flight distance difference between H/S45-H/S35 shots		59.8	60.2	59.9	60.8	59

Table 7-Continued

Golf ball No.		16	17	18	19
Core	Formulation No.	B	E	B	E
	Diameter (mm)	39.5	39.5	39.5	39.5
	Compression deformation amount (mm)	3.20	3.16	3.20	3.16
	Core center hardness Ho	68.3	64.8	68.3	64.8
	Hardness H10 at 10 mm point	74.8	72.6	74.8	72.6
	Surface hardness Hs	82.3	82.2	82.3	82.2
	(H10-Ho)/S	0.46	0.45	0.46	0.45
	Hardness difference S (=Hs-Ho)	14.0	17.4	14.0	17.4
Intermediate layer	Formulation No.	c	a	c	b
	Thickness (mm)	1	1	1	1
	Surface hardness Hms (Shore C)	92	95	92	97
	Material hardness Hm (Shore D)	63	66	63	68
Cover	Formulation No.	9	9	e	f
	Thickness Tc (mm)	0.6	0.6	0.6	0.6
	Material hardness Hc (Shore D)	31	31	50	27
Dimple	Type (pattern)	II	III	IV	III
	Lower volume Vi (mm^3)	325	405	445	405
Golf ball	Surface hardness Hcs (Shore C)	84	88	87	87
	Compression deformation amount (mm)	2.79	2.74	2.65	2.73
(Hc/Tc)×(S×Hm/Vi)		140.2	146.5	165.2	131.5
Driver shot (Head speed = 45m/s)	Spin rate (rpm)	2760	2740	2480	2800
	Ball speed (m/s)	65.6	65.7	65.9	65.7
	Flight distance (m)	227.8	227.4	229.7	226.9
Driver shot (Head speed = 35m/s)	Spin rate (rpm)	2830	2830	2600	2880
	Ball speed (m/s)	50.8	50.9	51	50.9
	Flight distance (m)	167.3	167.5	169.8	167.1
Flight distance difference between H/S45-H/S35 shots		60.5	59.9	59.9	59.8

[0117] It is apparent that the golf ball according to the present disclosure that comprises a spherical core, an intermediate layer positioned outside the spherical core, and an outermost cover positioned outside the intermediate layer and having a plurality of dimples formed thereon, wherein when a center hardness Ho (Shore C hardness) of the spherical core, a surface hardness Hs (Shore C hardness) of the spherical core, a hardness difference S=Hs-Ho, a material hardness Hm (Shore D hardness) of the intermediate layer, a material hardness Hc (Shore D hardness) of the outermost cover, a thickness Tc (mm) of the outermost cover, and a total lower volume Vi (mm^3) of the plurality of dimples satisfy $Vi>365$ and $(Hc/Tc)\times(S\times Hm/Vi)\leq 130$, has a small difference in the flight distance on a driver shot between hit at a high head speed and hit at a low head speed.

(The embodiments of the present disclosure)

[0118] The present disclosure (1) is a golf ball comprising a spherical core, an intermediate layer positioned outside the spherical core, and an outermost cover positioned outside the intermediate layer and having a plurality of dimples formed thereon, wherein when a center hardness Ho (Shore C hardness) of the spherical core, a surface hardness Hs (Shore C hardness) of the spherical core, a hardness difference S=Hs-Ho, a material hardness Hm (Shore D hardness)

of the intermediate layer, a material hardness Hc (Shore D hardness) of the outermost cover, a thickness Tc (mm) of the outermost cover, and a total lower volume Vi (mm^3) of the plurality of dimples satisfy Vi>365 and (Hc/Tc)×(S×Hm/Vi)≤130.

[0119] The present disclosure (2) is the golf ball according to the present disclosure (1), wherein 0.35<(H10-Ho)/S<0.6 is satisfied where H10 is a hardness at 10 mm point from a center of the spherical core.

[0120] The present disclosure (3) is the golf ball according to the present disclosure (1) or (2), wherein the hardness difference S<20.

[0121] The present disclosure (4) is the golf ball according to any one of the present disclosures (1) to (3), wherein Vi≥380.

[0122] The present disclosure (5) is the golf ball according to any one of the present disclosures (1) to (4), wherein Vi≥400.

[0123] The present disclosure (6) is the golf ball according to any one of the present disclosures (1) to (5), wherein the surface hardness (Shore C hardness) of the spherical core < a surface hardness (Shore C hardness) of the intermediate layer > a surface hardness (Shore C hardness) of the golf ball is satisfied.

[0124] The present disclosure (7) is the golf ball according to any one of the present disclosures (1) to (6), wherein the outermost cover contains a polyurethane as a resin component.

[0125] This application is based on Japanese Utility application No. 2023-001874 filed on May 31, 2023, the content of which is hereby incorporated by reference.

Claims

1. A golf ball comprising a spherical core, an intermediate layer positioned outside the spherical core, and an outermost cover positioned outside the intermediate layer and having a plurality of dimples formed thereon, wherein

   a center hardness in Shore C hardness Ho of the spherical core,
   a surface hardness in Shore C hardness Hs of the spherical core,
   a hardness difference S=Hs-Ho,
   a material hardness in Shore D hardness Hm of the intermediate layer,
   a material hardness in Shore D hardness Hc of the outermost cover,
   a thickness in mm Tc of the outermost cover, and
   a total lower volume in mm^3 Vi of the plurality of dimples satisfy Vi>365 and (Hc/Tc)×(S×Hm/Vi)≤130.

2. The golf ball according to claim 1, wherein when 0.35<(H10-Ho)/S<0.6 is satisfied where H10 is a hardness at 10 mm point from a center of the spherical core.

3. The golf ball according to claim 1 or 2, wherein the hardness difference S<20.

4. The golf ball according to any one of claims 1 to 3, wherein Vi≥380.

5. The golf ball according to any one of claims 1 to 4, wherein the surface hardness in Shore C hardness of the spherical core < a surface hardness in Shore C hardness of the intermediate layer > a surface hardness in Shore C hardness of the golf ball is satisfied.

6. The golf ball according to any one of claims 1 to 5, wherein the outermost cover contains a polyurethane as a resin component.

7. The golf ball according to any one of claims 1 to 6, wherein the surface hardness Hs of the spherical core ranges from 60 to 95 in Shore C hardness.

8. The golf ball according to any one of claims 1 to 7, wherein the center hardness Ho of the spherical core ranges from 45 to 74 in Shore C hardness.

9. The golf ball according to any one of claims 1 to 8, wherein the material hardness Hm of the intermediate layer ranges from 50 to 73 in Shore D hardness.

10. The golf ball according to any one of claims 1 to 9, wherein a thickness Tm of the intermediate layer ranges from 0.8 mm to 3.0 mm.

11. The golf ball according to any one of claims 1 to 10, wherein the material hardness Hc of the outermost cover ranges from 20 to 40 in Shore D hardness.

12. The golf ball according to any one of claims 1 to 11, wherein the thickness Tc of the outermost cover ranges from 0.4 mm to 1.0 mm.

13. The golf ball according to claim 2, wherein the hardness H10 at 10 mm point from the center of the spherical core ranges from 60 to 84 in Shore C hardness.

14. The golf ball according to any one of claims 1 to 13, wherein the value (Hc/Tc) ranges from 30 to 75.

15. The golf ball according to any one of claims 1 to 14, wherein the value (Hm/Vi) ranges from 0.08 to 0.22.

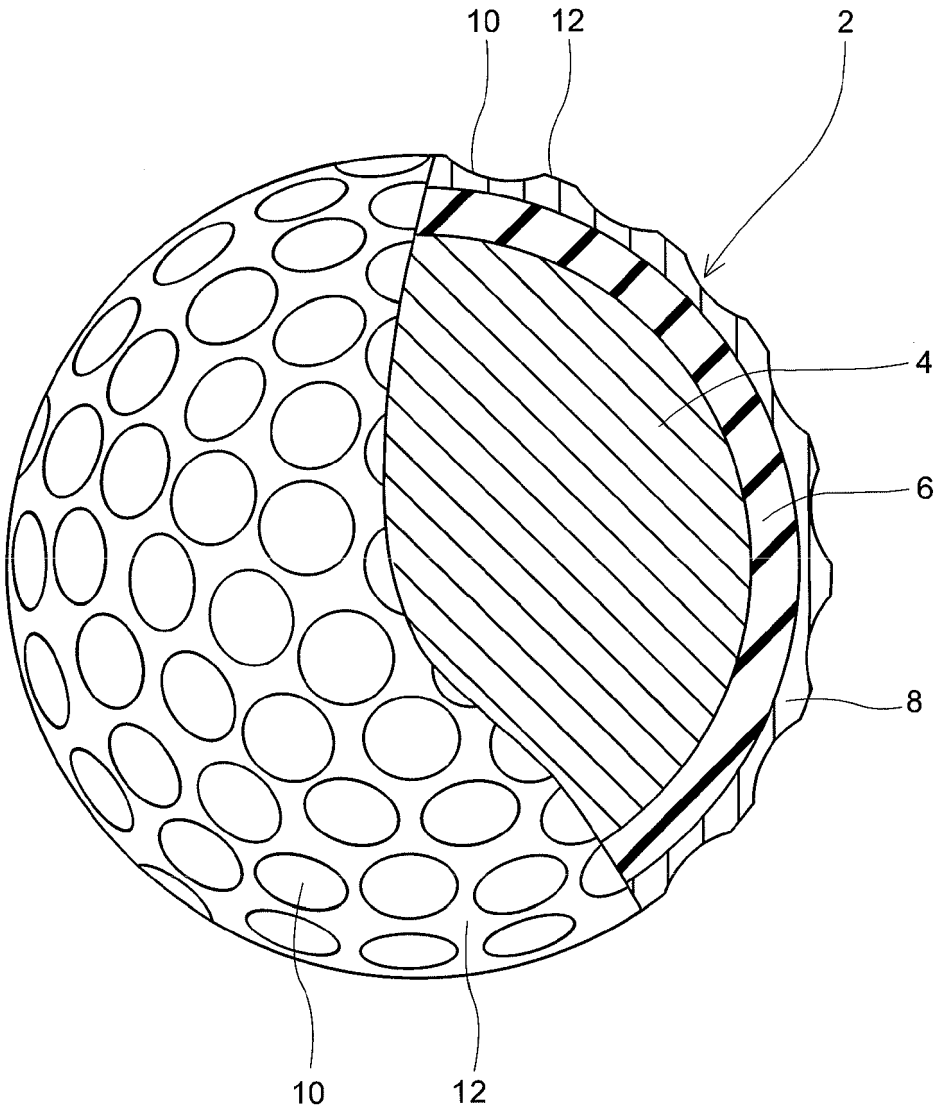

Fig. 1

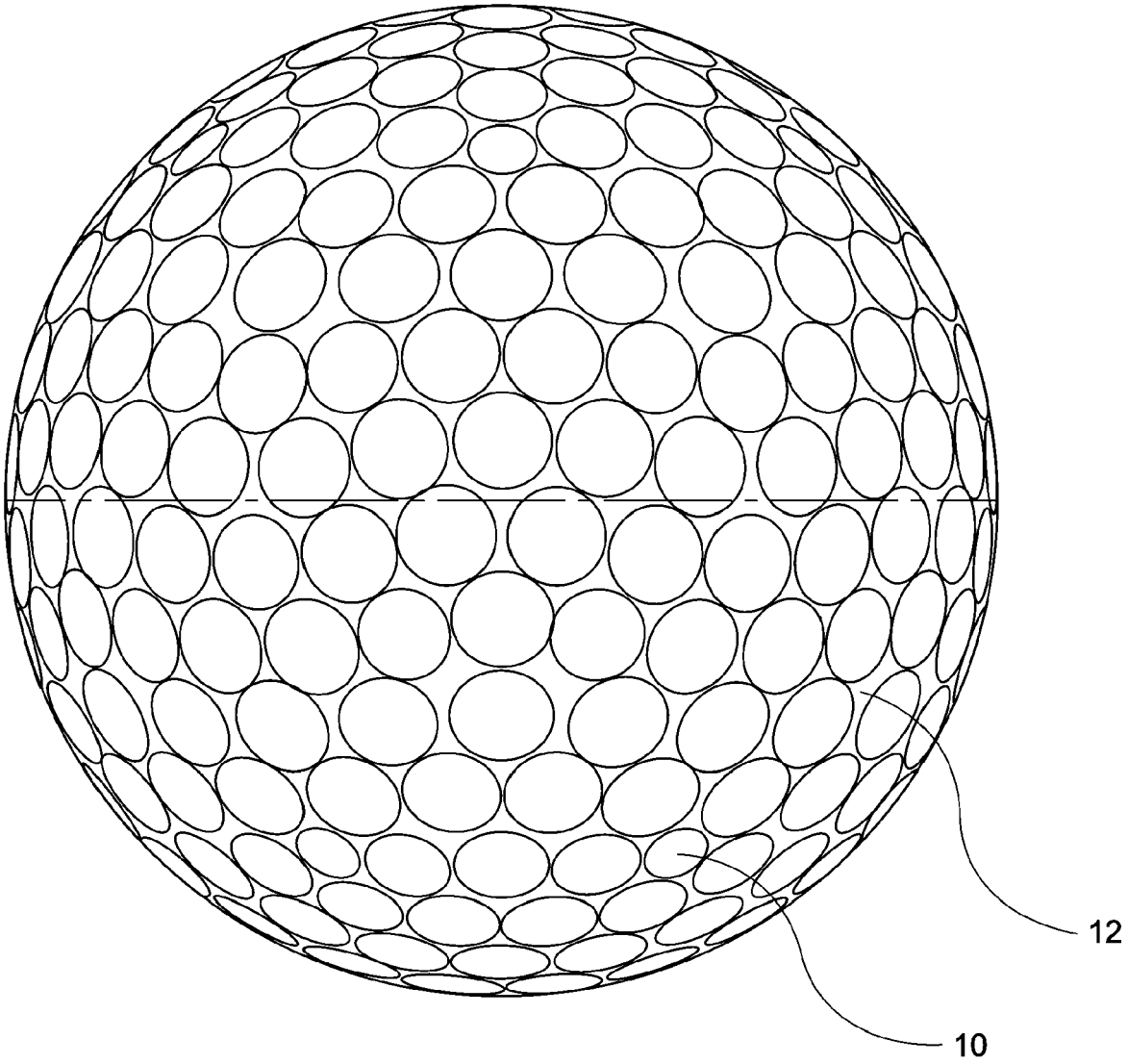

Fig. 2

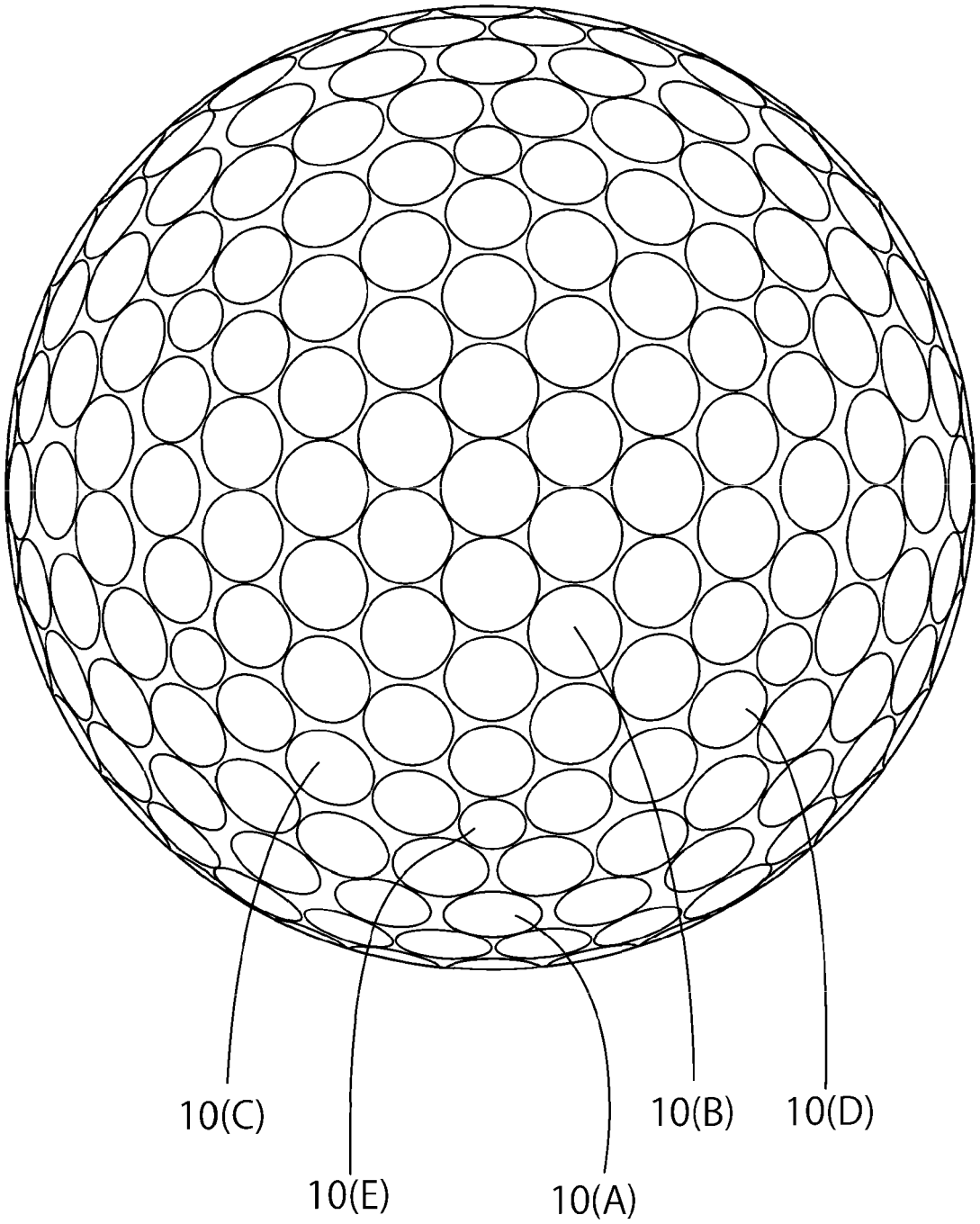

Fig. 3

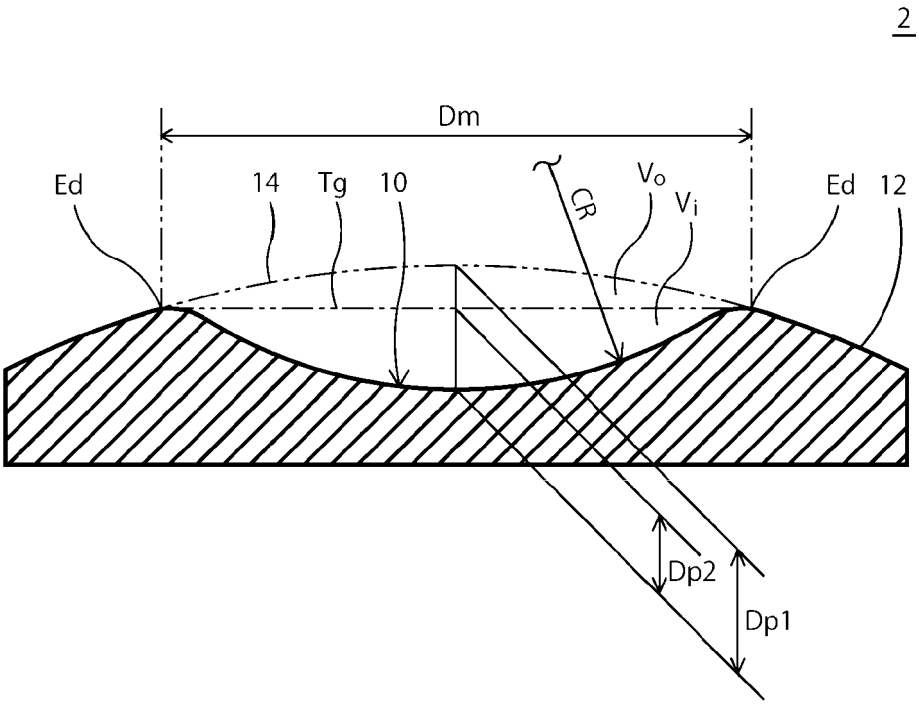

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 17 3137

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 October 2024	Lundblad, Hampus

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