HIGHLY-NEUTRALIZED ACID POLYMER COMPOSITIONS HAVING A LOW MOISTURE VAPOR TRANSMISSION RATE AND THEIR USE IN GOLF BALLS

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ABSTRACT
The present invention is directed to a golf ball having at least one layer formed from a moisture resistant composition. The moisture resistant composition has a moisture vapor transmission rate of 12.5 g/mil/100 in²/day or less and comprises a highly neutralized acid polymer. Golf balls of the present invention include one-piece, two-piece, multi-layer, and wound golf balls. The composition may be present in any one or more of a core layer, a cover layer, or an intermediate layer.
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CROSS-REFERENCE TO RELATED APPLICATIONS


FIELD OF THE INVENTION

[0002] The present invention is directed to compositions having a moisture vapor transmission rate of 12.5 g/mil/100 in²/day or less and comprising a highly neutralized acid polymer. The present invention is also directed to the use of such compositions in golf equipment, and particularly in two-piece and multi-layer golf balls having an overall core diameter of 1.00 inch or greater. The present invention is also directed to one-piece golf balls formed from such compositions.

BACKGROUND OF THE INVENTION

[0003] Conventional golf ball core materials, such as polybutadiene rubber, have a tendency to absorb moisture when exposed to atmospheric moisture for prolonged periods. Such moisture absorption can lead to undesirable golf ball properties and performance. Thus, in some golf ball constructions, a water vapor barrier layer is necessary to prevent exposure of the core to atmospheric moisture or water.

[0004] Urethane is known to be useful as a golf ball cover layer material. However, urethane has a high moisture vapor transmission rate. Therefore, golf balls having a urethane cover typically require a layer underneath having a low moisture vapor transmission rate.

[0005] A desire remains in the golf ball industry for core compositions having low moisture vapor transmission rates. The present invention describes such compositions and the use thereof in a variety of golf ball core layers.

SUMMARY OF THE INVENTION

[0006] In one embodiment, the present invention is directed to a two-piece golf ball consisting of a single layer core having a diameter of 1.58 inches or greater and a polyurethane or polyurea cover having a thickness of 0.05 inches or less. The core has a compression of from 50 to 85 and is formed from a composition having a moisture vapor transmission rate of 12.5 g/mil/100 in²/day or less and comprising a highly neutralized acid polymer.

[0007] In another embodiment, the present invention is directed to a multi-layer golf ball consisting of an inner core layer, an outer core layer, and a polyurethane or polyurea cover. The inner core layer has a diameter of 1.58 inches or greater, a compression of from 50 to 85, and is formed from a composition having a moisture vapor transmission rate of 12.5 g/mil/100 in²/day or less and comprising a highly neutralized acid polymer. The outer core layer has a thickness of from 0.01 inches to 0.02 inches. The cover has a thickness of 0.04 inches or less.

[0008] In yet another embodiment, the present invention is directed to a one-piece golf ball formed from a composition having a moisture vapor transmission rate of 2.5 g/mil/100 in²/day or less and comprising a highly neutralized acid polymer. The ball has a diameter of from 1.62 inches to 1.74 inches, a compression of from 50 to 85, and a COR of 0.800 or greater.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Conventional golf balls can be divided into two general classes: solid and wound. Solid golf balls include one-piece, two-piece (i.e., solid core and a cover), and multi-layer (i.e., solid core of one or more layers and/or a cover of one or more layers) golf balls. Wound golf balls typically include a solid, hollow, or fluid-filled center, surrounded by a tensioned elastomeric material, and a cover.

[0010] Golf balls of the present invention include one-piece, two-piece, multi-layer, and wound golf balls having a variety of core structures, intermediate layers, covers, and coatings. Golf ball cores may consist of a single, unitary layer, comprising the entire core from the center of the core to its outer periphery, or they may consist of a center surrounded by at least one outer core layer. The center, innermost portion of the core is preferably solid, but may be hollow or liquid-, gel-, or gas-filled. The outer core layer may be solid, or it may be a wound layer formed of a tensioned elastomeric material. Golf ball covers may also contain one or more layers, such as a double cover having an inner and outer cover layer. Optionally, additional layers may be disposed between the core and cover.

[0011] Golf balls of the present invention have at least one layer formed from a moisture resistant composition comprising a highly neutralized polymer as disclosed herein. In a preferred embodiment, the layer formed from the moisture resistant composition is the core of a two-piece golf ball. In another preferred embodiment, the layer formed from the moisture resistant composition is the inner core layer of a multi-layer golf ball. In yet another preferred embodiment, the present invention provides a one-piece golf ball formed from the moisture resistant composition.

[0012] For purposes of the present disclosure, a composition is "moisture resistant" if it has a moisture vapor transmission rate ("MVTR") of 12.5 g/mil/100 in²/day or less. Preferably, the moisture resistant compositions of the present invention have an MVTR of 8.0 g/mil/100 in²/day or less, or 6.5 g/mil/100 in²/day or less, or 5.0 g/mil/100 in²/day or less, or 4.0 g/mil/100 in²/day or less, or 2.5 g/mil/100 in²/day or less, or 2.0 g/mil/100 in²/day or less. As used herein, moisture vapor transmission rate (MVTR) is given in g/mil/100 in²/day, and is measured at 20° C., and according to ASTM F1249-99.

[0013] Moisture resistant compositions of the present invention comprise a highly neutralized acid polymer
("HNP") and optionally one or more additional materials including, but not limited to, organic acids and salts thereof, fillers, additives, and non-fatty acid melt flow modifiers. In a preferred embodiment, the moisture resistant compositions consist essentially of an HNP and optionally one or more additional materials selected from the group consisting of organic acids and salts thereof fillers, additives, and non-fatty acid melt flow modifiers. Consisting essentially of, as used herein, means that the recited components are essential, while smaller amounts of other components may be present to the extent that they do not detract from the operability of the present invention.

[0014] As used herein, "highly neutralized" refers to the acid polymer after at least 70%, preferably at least 80%, more preferably at least 90%, even more preferably at least 95%, and even more preferably 100%, of the acid groups thereof are neutralized. The HNP may be neutralized by a cation, a salt of an organic acid, a suitable base of an organic acid, or any combination of two or more thereof.

[0015] Suitable HNPs are salts of homopolymers and copolymers of α,β-ethylenically unsaturated mono- or dicarboxylic acids, and combinations thereof. The term "copolymer," as used herein, includes polymers having two types of monomers, those having three types of monomers, and those having more than three types of monomers. Preferred acids are (meth) acrylic acid, ethylenic acid, maleic acid, capric acid, fumaric acid, itaconic acid, (methyl)acrylic acid is particularly preferred. As used herein, "(meth) acrylic acid" means methacrylic acid and/or acrylic acid. Likewise, "(meth) acrylate" means methacrylate and/or acrylate. Preferred acid polymers are copolymers of a C₃ to C₈ α,β-ethylenically unsaturated mono- or dicarboxylic acid and ethylene or a C₃ to C₈ α-olefin, optionally including a softening monomer. Particularly preferred acid polymers are copolymers of ethylene and (methyl)acrylic acid.

[0016] When a softening monomer is included, the acid polymer is referred to herein as an E/X/Y-type copolymer, wherein E is ethylene, X is a C₃ to C₈ α,β-ethylenically unsaturated mono- or dicarboxylic acid, and Y is a softening monomer. The softening monomer is typically an alkyl (meth) acrylate, wherein the alkyl groups have from 1 to 8 carbon atoms. Preferred E/X/Y-type copolymers are those wherein X is (meth) acrylic acid and/or Y is selected from (meth) acrylate, n-butyl (meth) acrylate, isobutyl (meth) acrylate, methyl (meth) acrylate, and ethyl (meth) acrylate. More preferred E/X/Y-type copolymers are ethylene/(meth) acrylic acid/n-butyl acrylate, ethylene/(meth) acrylic acid/methyl acrylate, and ethylene/(meth) acrylic acid/ethyl acrylate.

[0017] The amount of ethylene or C₃ to C₈ α-olefin in the acid copolymer is typically at least 15 wt %, preferably at least 25 wt %, more preferably at least 38 wt %, and even more preferably at least 60 wt %, based on the total weight of the copolymer. The amount of C₃ to C₈ α,β-ethylenically unsaturated mono- or dicarboxylic acid in the acid copolymer is typically within a range having a lower limit of 1 wt %, or 3 wt %, or 4 wt %, or 5 wt %, and an upper limit of 20 wt %, or 25 wt %, or 30 wt %, or 35 wt %, based on the total weight of the copolymer. The amount of optional softening comonomer in the acid copolymer is typically within a range having a lower limit of 0 wt %, or 5 wt %, 10 wt %, 15 wt %, and an upper limit of 20 wt %, or 30 wt %, or 35 wt %, or 40 wt %, or 50 wt %, based on the total weight of the copolymer.

[0018] The acid polymer may be partially neutralized prior to being neutralized to 70% and higher. Suitable partially neutralized acid polymers include, but are not limited to, Surlyn® ionomers, commercially available from E. I. du Pont de Nemours and Company; AClyr® ionomers, commercially available from Honeywell International Inc.; and iotek® ionomers, commercially available from ExxonMobil Chemical Company.

[0019] In a particular embodiment, the acid polymer is selected from Nucrel® acid copolymers, commercially available from E. I. du Pont de Nemours and Company (such as Nucrel® 960, an ethylene/methylacrylic acid copolymer); Priorac® polymers, commercially available from Dow Chemical Company (such as Priorac® XUS 60758.08L and XUS60751.18, ethylene/methylacrylic acid copolymers containing 13.5 wt % and 15.0 wt % acid, respectively); and partially neutralized ionomers thereof.

[0020] Additional suitable acid polymers are more fully described, for example, in U.S. Pat. No. 6,953,820 and U.S. Patent Application Publication No. 2005/0049367, the entire disclosures of which are hereby incorporated herein by reference.

[0021] The acid polymers of the present invention can be direct copolymers wherein the polymer is polymerized by adding all monomers simultaneously, as described in, for example, U.S. Pat. No. 4,351,931, the entire disclosure of which is hereby incorporated herein by reference. Ionomers can be made from direct copolymers, as described in, for example, U.S. Pat. No. 3,264,272 to Rees, the entire disclosure of which is hereby incorporated herein by reference. Alternatively, the acid polymers of the present invention can be graft copolymers wherein a monomer is grafted onto an existing polymer, as described in, for example, U.S. Patent Application Publication No. 2002/0013413, the entire disclosure of which is hereby incorporated herein by reference.

[0022] Cations suitable for neutralizing the acid polymers of the present invention are selected from silicone, silane, and silicate derivatives and complex ligands; metal ions and compounds of rare earth elements; metal ions and compounds of alkali metals, alkaline earth metals, and transition metals; and combinations thereof. Particular cation sources include, but are not limited to, metal ions and compounds of lithium, sodium, potassium, magnesium, cesium, calcium, barium, manganese, copper, zinc, tin, rare earth metals, and combinations thereof. In a particular embodiment, the cation source is selected from metal ions and compounds of calcium, metal ions and compounds of zinc, and combinations thereof. In a particular aspect of this embodiment, the equivalent percentage of calcium and/or zinc salt(s) in the final composition is 50% or higher, or 60% or higher, or 70% or higher, or 80% or higher, or 90% or higher, based on the total salts present in the final composition, wherein the equivalent % is determined by multiplying the mol % of the cation by the valence of the cation. In another particular embodiment, the cation source is selected from metal ions and compounds of lithium, sodium, potassium, magnesium, calcium, zinc, and combinations thereof. A particular potassium-based cation source is Oxone®, commercially available from E. I. du Pont de Nemours and Company. Oxone®
is a monopersulfate compound wherein potassium monopersulfate is the active ingredient present as a component of a triple salt of the formula 2KHSO₅·KH₂SO₄·K₂SO₄ [potassium hydrogen peroxymonosulfate sulfate (5:3:2:2)]. In another particular embodiment, the cation source is selected from metal ions and compounds of lithium, metal ions and compounds of zinc, and combinations thereof. Suitable cation sources also include mixtures of lithium and/or zinc cations with other cations. Other cations suitable for mixing with lithium and/or zinc cations to produce the HNP include, but are not limited to, the “less hydrophilic” cations disclosed in U.S. Patent Application Publication No. 2006/0106175; conventional HNP cations, such as those disclosed in U.S. Pat. Nos. 6,756,436 and 6,824,477; and the cations disclosed in U.S. Patent Application Publication No. 2005/026740. The entire disclosure of each of these references is hereby incorporated herein by reference. In a particular aspect of this embodiment, the percentage of lithium and/or zinc salts in the composition is preferably 50% or higher, or 55% or higher, or 60% or higher, or 65% or higher, or 70% or higher, or 80% or higher, or 90% or higher, or 95% or higher, or 100%, based on the total salts present in the composition. The amount of cation source used is readily determined based on the desired level of neutralization.

[0023] Moisture resistant compositions of the present invention optionally comprise one or more organic acids and/or salts thereof. Suitable organic acids are aliphatic organic acids, aromatic organic acids, saturated monofunctional organic acids, unsaturated monofunctional organic acids, monounsaturated monofunctional organic acids, and dimerized derivatives thereof. Particularly suitable are aliphatic, monofunctional organic acids, preferably having fewer than 36 carbon atoms. Particular examples of suitable organic acids include, but are not limited to, caprylic acid, caprylic acid, capric acid, lauric acid, stearic acid, behenic acid, erucic acid, oleic acid, linoleic acid, myristic acid, benzoic acid, palmitic acid, phenylactic acid, naphtalenoic acid, and dimerized derivatives thereof. Particularly suitable organic acid salts include those produced by a cation source selected from barium, lithium, sodium, zinc, bismuth, potassium, strontium, magnesium, calcium, and combinations thereof. Suitable organic acids are more fully described, for example, in U.S. Pat. No. 6,756,436, the entire disclosure of which is hereby incorporated herein by reference.

[0024] Moisture resistant compositions of the present invention optionally contain one or more additives and/or one or more fillers. Suitable additives include, but are not limited to, blowing and foaming agents, optical brighteners, coloring agents, fluorescent agents, whitening agents, UV absorbers, light stabilizers, defoaming agents, processing aids, mica, talc, nanofillers, antioxidants, stabilizers, softening agents, fragrance components, plasticizers, impact modifiers, acid copolymer wax, and surfactants. Suitable fillers include, but are not limited to, inorganic fillers, such as zircon oxide, titanium dioxide, tin oxide, calcium oxide, magnesium oxide, barium sulfate, zinc sulfate, calcium carbonate, zinc carbonate, barium carbonate, mica, talc, clay, silica, lead silicate, and the like; high specific gravity metal powder fillers, such as tungsten powder, molybdenum powder, and the like; regrind, i.e., core material that is ground and recycled; and nano-fillers. Filler materials may be dual-functional fillers, for example, zircon oxide (which may be used as a filler/acid scavenger) and titanium dioxide (which may be used as a filler/brightener material). Further examples of suitable fillers and additives include, but are not limited to, those disclosed in U.S. Patent Application Publication No. 2003/0225197, the entire disclosure of which is hereby incorporated herein by reference.

[0025] Moisture resistant compositions of the present invention optionally contain one or more non-fatty acid melt flow modifiers. Suitable non-fatty acid melt flow modifiers include polyamides, polyesters, polyacrylates, polyurethanes, polyesters, polyureas, polyurethanes, and combinations thereof. Additional melt flow modifiers, suitable for use in compositions of the present invention, include those described in copending U.S. Patent Application Publication No. 2006/0063893 and U.S. patent application Ser. No. 11/216,726, the entire disclosures of which are hereby incorporated herein by reference.

[0026] Moisture resistant compositions of the present invention are optionally produced by blending the HNP with one or more additional polymers, such as thermoplastic polymers and elastomers. Examples of thermoplastic polymers suitable for blending with the invention HNPs include, but are not limited to, polyolefins, polyamides, polyesters, polyesters, polyether-esters, polyether-urea, polyurethanes, polyureas, polyacetal, polyacelone, acrylonitrile-butadiene-styrene resins, polyphenylene oxide, polyphenylene sulfide, styrene-acrylonitrile resins, styrene maleic anhydride, polyimides, aromatic polyketones, ionomers and ionomeric precursors, acid homopolymers and copolymers, conventional ionomers and HNPs (e.g., ionomeric materials sold under the trade names DuPont® HFPI 1000 and DuPont® HFPI 2000, commercially available from E. I. duPont de Nemours and Company), resin-modified ionomers, bimodal ionomers, polyurethanes, grafted and non-grafted metalloocene-catalyzed polymers, single-site catalyst polymerized polymers, high crystalline acid polymers, cationic ionomers, epoxy-functionalized polymers, anhydride-functionalized polymers, and combinations thereof. Particularly polyolefins suitable for blending include one or more, linear, branched, or cyclic, C₂-C₂₀ olefins, particularly polymers comprising ethylene or propylene copolymerized with one or more C₃-C₁₀ olefins, C₂₋C₁₀ a-olefins, or C₁-C₁₀ a-olefins. Particular conventional HNPs suitable for blending include, but are not limited to, one or more of the HNPs disclosed in U.S. Pat. Nos. 6,756,436, 6,894,098, and 6,953,820, the entire disclosures of which are hereby incorporated herein by reference. Examples of elastomers suitable for blending with the invention polymers include natural and synthetic rubbers, including, but not limited to, ethylene propylene rubber (“EPR”), ethylene propylene diene rubber (“EPDM”), hydrogenated and non-hydrogenated styrene block copolymer rubbers (such as S1, SIS, SBR, SBS, SIBS, and the like, where “S” is styrene, “I” is isobutylene, and “B” is butadiene), butyl rubber, halobutyl rubber, copolymers of isobutylene and para-alkylstylene, halogenated copolymers of isobutylene and para-alkylstylene, natural rubber, polyisoprene, copolymers of butadiene with acrylonitrile, polychloroprene, alkyl acrylate rubber, chlorinated isoprene rubber, acrylonitrile chlorinated isoprene rubber, polybutadiene rubber, and thermoplastic vulcanizates. Additional suitable blend polymers include those described in U.S. Pat. No. 5,981,658, for example at column 14, lines 30 to 56, and in U.S. Patent Application Publication No. 2005/0267240, for example at paragraph [0075], the entire disclosures of which are hereby incorporated herein by reference. The blends...
described herein may be produced by post-reactor blending, by connecting reactors in series to make reactor blends, or by using more than one catalyst in the same reactor to produce multiple species of polymer. The polymers may be mixed prior to being put into an extruder, or they may be mixed in an extruder.

[0027] The present invention is not limited by any particular method or any particular equipment for making the moisture resistant composition. In a preferred embodiment, the composition is prepared by the following process. An acid polymer, preferably ethylene(meth) acrylic acid, and at least one organic acid or salt thereof, and optional additional materials, such as additive(s), filler(s), and non-fatty acid melt flow modifier(s), are fed into a melt extruder, such as a single or twin screw extruder. A suitable amount of a cation source is added to the molten acid polymer composition such that at least 70% of all acid groups present are neutralized, including the acid groups of the acid polymer and the acid groups of the optional organic acid. Preferably at least 80%, more preferably at least 90%, and even more preferably at least 95%, and even more preferably at least 100%, of all acid groups present are neutralized. The acid polymer may be partially neutralized prior to contact with the cation source, preferably with a cation source selected from metal ions and compounds of calcium, magnesium, and zinc. The acid polymer/cation mixture is intensively mixed prior to being extruded as a strand from the die-head. In a particular aspect of this embodiment, the acid polymer is an ethylene/ethyl acrylate polymer selected from Nucrel® acid copolymers, commercially available from E. I. du Pont de Nemours and Company (such as Nucrel® 960, an ethylene/ethyl acrylate acid copolymer) and Primacor® polymers, commercially available from Dow Chemical Company (such as Primacor® XUS 60758.08L and XUS60751.18, ethylene/acidic acid copolymers containing 13.5 wt % and 15.0 wt % acid, respectively) Further examples of suitable moisture resistant compositions include, but are not limited to, compositions containing an HNP neutralized by a less hydroscopic cation source as disclosed in U.S. Patent Application Publication No. 2006/0106175, the entire disclosure of which is hereby incorporated herein by reference. In order to be processable, the moisture resistant composition of the present invention has a melt flow index of at least 0.5 g/10 min (190°C, 2.16 kg). Preferably, the melt flow index of the moisture resistant composition is at least 0.8 g/10 min, or within the range having a lower limit of 0.8 or 1.0 g/10 min, and an upper limit of 4.0 or 5.0 or 10.0 g/10 min. For purposes of the present disclosure, melt flow index is measured according to ASTM D1238.

[0028] Moisture resistant compositions of the present invention can be used in a variety of applications. For example, moisture resistant compositions containing HNPs are suitable for use in golf equipment, including, but not limited to, golf balls, golf shoes, and golf clubs. Moisture resistant compositions containing HNPs are particularly suitable for use in one-piece golf balls, and in two-piece and multi-layer golf balls having an overall core diameter of 1.00 inch or greater.

[0029] Golf balls of the present invention can be wound, one-piece, two-piece, or multi-layer balls, wherein at least one layer is formed from a moisture resistant composition comprising an HNP as described herein. In golf balls having two or more layers which comprise a moisture resistant composition, the moisture resistant composition of one layer may be the same or a different moisture resistant composition as another layer. The layer(s) comprising the moisture resistant composition can be any one or more of a core layer (such as a center or an outer core layer), an intermediate layer, or a cover layer. Compositions of the present invention can be either foamed or filled with density adjusting materials to provide golf balls having modified moments of inertia.

[0030] Golf balls of the present invention generally have a coefficient of restitution ("COR") of at least 0.790, preferably at least 0.800, even more preferably at least 0.805, and even more preferably at least 0.810, and a compression of from 75 to 110, preferably from 90 to 100.

[0031] The present invention is not limited by any particular process for forming the golf ball layer(s). It should be understood that the layer(s) can be formed by any suitable technique, including injection molding, compression molding, casting, and reaction injection molding. Preferably, thermoset cover materials are formed into golf ball cover layers by casting or reaction injection molding and thermoplastic cover materials are formed into golf ball cover layers by compression or injection molding techniques.

[0032] By the present invention, it has been found that the moisture resistant compositions described herein are particularly suitable in one or more of the following golf ball constructions:

[0033] (1) one-piece golf balls;

[0034] (2) as the core layer of two-piece golf balls; and

[0035] (3) as the inner core layer of multi-layer golf balls.

[0036] In a preferred embodiment, the present invention provides one-piece golf ball formed from a moisture resistant composition described herein. The moisture resistant composition has an MVTR of 12.5 g·mil/100 in²/day or less, preferably 8.0 or less, more preferably 6.5 or less, even more preferably 5.0 or less, even more preferably 4.0 or less, even more preferably 2.5 or less, and most preferably 2.0 or less. The golf ball has a diameter of from 1.62 inches to 1.74 inches, preferably from 1.66 inches to 1.70 inches, and more preferably 1.68 inches. Preferably, the golf ball has a compression of from 50 to 85 and/or a coefficient of restitution ("COR") of 0.800 or greater.

[0037] In another preferred embodiment, the present invention provides a two-piece golf ball consisting of a single layer core and a single layer cover, wherein the core is formed from a moisture resistant composition described herein. The moisture resistant composition has an MVTR of 12.5 g·mil/100 in²/day or less, preferably 8.0 or less, more preferably 6.5 or less, even more preferably 5.0 or less, even more preferably 4.0 or less, even more preferably 2.5 or less, and most preferably 2.0 or less. Preferably, at least 80%, or at least 90%, or at least 95%, or at least 100%, of all acid functionalities present in the moisture resistant composition are neutralized. The core has a diameter of 1.58 inches or greater, preferably 1.62 inches. Preferably, the core has a compression of from 50 to 85 and/or a COR of 0.800 or greater. Preferably, the core has a specific gravity of 1.13. The cover has a thickness of 0.05 inches or less, preferably 0.03 inches. Suitable cover materials include, but are not limited to, thermoset and thermoplastic polyurethanes, ther-
moset and thermoplastic polyureas, thermoplastic rubbers, polyether-amides, polyether-esters, polyether-ureas, styrene/butadiene/styrene block copolymers, ionomers, polyethylene, synthetic and natural rubbers, and blends thereof. Thermoplastic polyurethanes are a preferred cover material.

[0038] In another preferred embodiment, the present invention provides a multi-layer golf ball comprising an inner core layer, an outer core layer, and a cover, wherein the inner core layer is preferably formed from a moisture resistant composition described herein. The moisture resistant composition has an MVT of 12.5 g/mil/100 in²/day or less, preferably 8.0 or less, more preferably 6.5 or less, even more preferably 5.0 or less, even more preferably 4.0 or less, even more preferably 2.5 or less, and most preferably 2.0 or less. Preferably, at least 80%, more preferably at least 90%, more preferably 95%, and even more preferably 100%, of all acid functionalities present in the moisture resistant composition are neutralized. The inner core layer has a diameter of 1.58 inches or greater, preferably 1.62 inches. Preferably, the inner core layer has a compression of from 50 to 85 and/or a COR of 0.800 or greater. The outer core layer has a thickness of from 0.01 inches to 0.02 inches, preferably 0.015 inches. Preferably, the inner core layer has a specific gravity of 1.13 and the outer core layer has as a specific gravity which is at least 2.5 times the specific gravity of the inner core. The cover has a thickness of 0.04 inches or less, preferably 0.015 inches. Suitable cover materials include the materials given above for two-piece golf balls of the present invention. Thermoplastic polyurethanes are a preferred cover material. Suitable outer core materials include loaded or filled compositions selected from natural and non-natural rubber, polyurethane, polyurea, epoxy, polyester; thermoplastic polymers loaded with a specific gravity increasing filler, fiber, flake or particulate; reactive coating and casting materials, e.g., epoxies, styrenated polyesters, polyurethanes or polyureas, liquid PBR’s, silicones, silicate gels, agar gels; and non-reactive coating and casting materials, e.g., any combination of a polymer either in melt or flowable form, polymer, dissolved or dispersed in a volatile solvent. Suitable outer core materials also include a “thin dense layer” material as disclosed in U.S. Pat. No. 6,494,795; a thermoplastic as disclosed in U.S. Pat. Nos. 6,149,535 and 6,152,834; and a loaded thin film or “pre-preg” or a “densiﬁed loaded ﬁlm,” as described in U.S. Pat. No. 6,010,411. The entire disclosure of each of these references is hereby incorporated herein by reference.

[0040] For purposes of the present invention, compression is measured according to a known procedure, using an Atti compression test device, wherein a piston is used to compress a ball against a spring. The travel of the piston is fixed and the deflection of the spring is measured. The measurement of the deflection of the spring does not begin with its contact with the ball; rather, there is an offset of approximately the first 1.25 mm (0.05 inches) of the spring’s deflection. Very low stiffness cores will cause the spring to deflect by more than 1.25 mm and therefore have a zero compression measurement. The Atti compression tester is designed to measure objects having a diameter of 42.7 mm (1.68 inches); thus, smaller objects, such as golf ball cores, must be shimmed to a total height of 42.7 mm to obtain an accurate reading.

[0041] For purposes of the present invention, COR is determined according to a known procedure wherein a golf ball or golf ball subassembly (e.g., a golf ball core) is fired from an air cannon at a given velocity (125 U’s for purposes of the present invention). Ballistic light screens are located between the air cannon and the steel plate to measure ball velocity. As the ball travels toward the steel plate, it activates each light screen, and the time at each light screen is measured. This provides an incoming transit time period inversely proportional to the ball’s incoming velocity. The ball impacts the steel plate and rebounds through the light screens, which again measure the time period required to transit between the light screens. This provides an outgoing transit time period inversely proportional to the ball’s outgoing velocity. COR is then calculated as the ratio of the incoming transit time period to the outgoing transit time period, COR = T_{in}/T_{out}.

[0042] When numerical lower limits and numerical upper limits are set forth herein, it is contemplated that any combination of these values may be used.

[0043] All patents, publications, test procedures, and other references cited herein, including priority documents, are fully incorporated by reference to the extent such disclosure is not inconsistent with this invention and for all jurisdictions in which such incorporation is permitted.

[0044] While the illustrative embodiments of the invention have been described with particularity, it will be under-
stood that various other modifications will be apparent to and can be readily made by those of ordinary skill in the art without departing from the spirit and scope of the invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the examples and descriptions set forth herein, but rather that the claims be construed as encompassing all of the features of patentable novelty which reside in the present invention, including all features which would be treated as equivalents thereof by those of ordinary skill in the art to which the invention pertains.

What is claimed is:

1. A two-piece golf ball consisting of;
   a single layer core having a diameter of 1.58 inches or greater, a compression of from 50 to 85, and formed from a moisture resistant composition, wherein the moisture resistant composition has a moisture vapor transmission rate (MVTR) of 12.5 g mil/100 in²/day or less and consists essentially of a highly neutralized acid polymer and optionally one or more additional materials selected from the group consisting of fillers, additives, and melt flow modifiers; and
   a polyurethane or polyurea cover having a thickness of 0.05 inches or less.

2. The golf ball of claim 1, wherein the core has a diameter of 1.62 inches and the cover has a thickness of 0.03 inches.

3. The golf ball of claim 1, wherein at least 80% of the acid groups present in the moisture resistant composition are neutralized to salts.

4. The golf ball of claim 3, wherein at least 50% of the acid groups present in the moisture resistant composition are neutralized to salts having counterions selected from the group consisting of Zn, Ca, and combinations thereof.

5. The golf ball of claim 1, wherein at least 70% of the acid groups present in the moisture resistant composition are neutralized to salts having counterions selected from the group consisting of lithium, sodium, potassium, magnesium, calcium, zinc, and combinations thereof.

6. The golf ball of claim 1, wherein the core has a specific gravity of from 1.13.

7. The golf ball of claim 1, wherein the moisture resistant composition has a MVTR of 4.0 g mil/100 in²/day or less.

8. The golf ball of claim 3, wherein the core has a COR of 0.800 or greater and the moisture resistant composition has a MVTR of 2.5 g mil/100 in²/day or less, and wherein 100% of all acid functionalities present in the moisture resistant composition are neutralized.

9. A multi-layer golf ball consisting of:
   an inner core layer having a diameter of 1.58 inches or greater, a compression of from 50 to 85, and formed from a moisture resistant composition, wherein the moisture resistant composition has a moisture vapor transmission rate (MVTR) of 12.5 g mil/100 in²/day or less and consists essentially of a highly neutralized acid polymer and optionally one or more additional materials selected from the group consisting of organic acids and salts thereof, fillers, additives, and non-fatty acid melt flow modifiers;
   an outer core layer having a thickness of from 0.01 inches to 0.02 inches; and
   a polyurethane or polyurea cover having a thickness of 0.04 inches or less.

10. The golf ball of claim 9, wherein the inner core layer has a diameter of 1.62 inches.

11. The golf ball of claim 10, wherein the outer core layer has a thickness of 0.015 inches and the cover has a thickness of 0.015 inches.

12. The golf ball of claim 9, wherein the inner core layer has a specific gravity of 1.13.

13. The golf ball of claim 12, wherein the outer core layer has a specific gravity which is at least 2.5 times the specific gravity of the inner core.

14. The golf ball of claim 9, wherein the moisture resistant composition has an MVTR of 2.5 g mil/100 in²/day or less.

15. The golf ball of claim 9, wherein at least 80% of the acid groups present in the moisture resistant composition are neutralized to salts.

16. The golf ball of claim 15, wherein at least 50% of the acid groups present in the moisture resistant composition are neutralized to salts having counterions selected from the group consisting of Zn, Ca, and combinations thereof.

17. The golf ball of claim 11, wherein the inner core layer has a COR of 0.800 or greater and the moisture resistant composition has an MVTR of 2.5 g mil/100 in²/day or less, and wherein 100% of all acid functionalities present in the moisture resistant composition are neutralized.

18. A one-piece golf ball having a diameter of from 1.62 inches to 1.74 inches, a compression of from 50 to 85, a COR of 0.800 or greater, and formed from a moisture resistant composition, wherein the moisture resistant composition has a moisture vapor transmission rate (MVTR) of 2.5 g mil/100 in²/day or less and consists essentially of a highly neutralized acid polymer and optionally one or more additional materials selected from the group consisting of fillers, additives, and melt flow modifiers.

19. The golf ball of claim 18, wherein at least 80% of the acid groups present in the moisture resistant composition are neutralized to salts.

20. The golf ball of claim 19, wherein at least 50% of the acid groups present in the moisture resistant composition are neutralized to salts having counterions selected from the group consisting of Zn, Ca, and combinations thereof.

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