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(54) **GOLF BALLS CONTAINING
HIGHLY-NEUTRALIZED ACID POLYMERS
AND IONIC PLASTICIZERS**

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(57) **ABSTRACT**

A golf ball comprising a core and a cover layer, wherein at least one of the core and the cover layer includes a polymer composition of a highly-neutralized acid polymer and an ionic plasticizer is disclosed and described. The highly-neutralized acid polymer can comprise at least 50 wt % of the polymer composition and have 70% to 100% of the acid groups neutralized. In addition, the ionic plasticizer can be alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, or combinations thereof.

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(63) Continuation-in-part of application No. 12/110,418, filed on Apr. 28, 2008, which is a continuation of application No. 11/216,726, filed on Aug. 31, 2005, now Pat. No. 7,365,128.

GOLF BALLS CONTAINING HIGHLY-NEUTRALIZED ACID POLYMERS AND IONIC PLASTICIZERS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 12/110,418, filed on Apr. 28, 2008, which is a continuation of U.S. Pat. No. 7,365,128, each of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to golf balls containing highly-neutralized acid polymers. More specifically, the present invention relates to golf balls containing specific combinations of highly-neutralized acid polymers and ionic plasticizers.

BACKGROUND OF THE INVENTION

[0003] Solid golf balls typically 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. Golf ball core and cover layers are typically constructed with polymer compositions including, for example, polybutadiene rubber, polyurethanes, polyamides, ionomers, and blends thereof. Ionomers, particularly ethylene-based ionomers, have become a common choice of polymers for golf ball layers because of their toughness, durability, and wide range of hardness values.

[0004] Ionomers can be stiffened by increasing the amount of neutralization. Neutralization to 70% and higher, including 100%, has been disclosed. However, in the absence of flow additives, at neutralization levels above about 60%, the melt flow of the ionomer is decreased to an extent such that processability decreases or disappears altogether. For trivalent cations, the percent neutralization at which the polymer becomes unprocessable, in the absence of flow additives, can be significantly lower.

[0005] Blending ionomers with fatty acids is a known method for improving the processability of highly-neutralized polymers. The use of polyhydric alcohols in golf ball compositions is also known in certain golf ball resins. Although improvements in processability and golf ball properties have been achieved, the use of fatty acids or their salts at high levels can lead to discoloration (yellowing) and to surface blooming with subsequent coating adhesion problems.

SUMMARY OF THE INVENTION

[0006] The present invention provides a golf ball comprising a core and a cover layer, wherein at least one of the core and the cover layer includes a polymer composition of a highly-neutralized acid polymer and an ionic plasticizer. The highly-neutralized acid polymer having acid groups can comprise at least 50 wt % of the polymer composition and have 70% to 100% of the acid groups neutralized. In addition, the ionic plasticizer can be selected from the group consisting of alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, and combinations thereof.

[0007] The present invention is also directed to a golf ball including a core and a cover layer. At least one of the core or the cover layer is formed from a polymer composition includ-

ing 1) a highly-neutralized acid polymer having acid groups comprising at least 50 wt % of the polymer composition. Preferably, 70% to 100% of the acid groups are neutralized; and 2) an ionic plasticizer, such as alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, or a blend thereof.

[0008] The core may be a single solitary layer or be a 'dual core', such as one including a center and an outer core layer. In a preferred embodiment, the cover layer is a 'double cover' having an inner cover layer and an outer cover layer.

[0009] In one embodiment, the polymer composition is present in the outer core layer or the inner cover layer. In another embodiment, the polymer composition is present in the core. In an alternative embodiment, the polymer composition is present in the cover layer.

[0010] The highly-neutralized acid polymer is typically a copolymer of a C_3 to C_8 α,β -ethylenically unsaturated carboxylic acid and a C_2 to C_6 α -olefin. The highly-neutralized acid polymer may further include a softening monomer admixed or copolymerized therewith. Preferably, the acid groups are at least 95% neutralized.

[0011] The ionic plasticizer is typically a polyalcohol ester, preferably one such as glycerol monostearate, pentaerythritol distearate, glycerine monooleate, glycerine dioleate, pentaerythritol tetrastearate, pentaerythritol tetraistearate, pentaerythritol tetraoleate, neo-pentyl glycol dioleate, or a blend thereof. The ionic plasticizer may also be montanic acid, montanic acid ester, or salt thereof. The montanic acid ester or salt thereof is a reaction product of montanic acid and an alcohol, such as C_1 - C_4 alkanols, C_1 - C_4 alkylene glycols, glycerol, and blends thereof. Preferably, the ionic plasticizer is an alkylene bis-amine. Preferably, the alkylene bis-amine is a fatty acid amine, such as bis-stearoylethylenediamine, ethylene bistearamide, oleamide, or erucamide. The ionic plasticizer may also be a zwitterionic compound, such as N,N-dimethyl-N-stearyl-N-(3-sulfoxypropyl)-ammonium betaine.

[0012] The golf ball ideally has a coefficient of restitution ("COR") of at least 0.810 and an Atti compression from 90 to 105, preferably 92 to 100. In one alternative embodiment, the polymer composition is substantially devoid of fatty acids and polyhydric alcohols.

[0013] The present invention is further directed to a golf ball including a solid core, a cover layer formed from a polyurethane or polyurea, and an intermediate layer disposed between the solid core and the cover layer. The intermediate layer is preferably formed from a polymer composition including 1) a highly-neutralized acid polymer having acid groups comprising at least 50 wt % of the polymer composition where at least 98% of the acid groups are neutralized; and 2) an ionic plasticizer, such as montanic acid, montanic acid ester, or salt thereof.

[0014] There has thus been outlined, rather broadly, certain features of the invention so that the detailed description thereof that follows may be better understood, and so that the present contribution to the art may be better appreciated. Other features of the present invention will become clearer from the following detailed description of the invention, taken with the accompanying claims, or may be learned by the practice of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0015] The following detailed description of the embodiments of the present invention is not intended to limit the

scope of the invention, as claimed, but is presented for purposes of illustration only, and not to necessarily limit features and characteristics of the present invention. Rather, the description is intended to set forth the best mode of operation of the invention, and to sufficiently enable one skilled in the art to practice the invention. Accordingly, the scope of the present invention is to be defined by the appended claims.

[0016] In describing and claiming the present invention, the following terminology will be used.

[0017] The singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a layer” includes reference to one or more of such layers.

[0018] As used herein with respect to an identified property or circumstance, “substantially” refers to a degree of deviation that is sufficiently small so as to not measurably detract from the identified property or circumstance. The exact degree of deviation allowable may in some cases depend on the specific context. For example, “substantially free,” as used herein, means that the composition does not contain the cited material in any significant amount, e.g., substantially free of fatty acids or their salts thereof may include either absolutely no fatty acids or salts, or an amount of less than 0.5 wt % based on the total polymeric weight of the composition.

[0019] As used herein, “adjacent” refers to the proximity of two structures or elements. Particularly, elements that are identified as being “adjacent” may be either abutting or connected. Such elements may also be near or close to each other without necessarily contacting one another.

[0020] As used herein, “highly-neutralized acid polymer” refers to an acid polymer or copolymer after at least 70%, at least 90%, at least 95%, at least 98%, or 100% of the acid groups thereof are neutralized by a cation source. Neutralization can be effected prior to, during, or after combining the acid polymer(s) with the polyhydric alcohol(s). Preferably, the polyhydric alcohol is combined with an unneutralized or partially neutralized (i.e., less than 70% neutralized) acid polymer, and a cation source is subsequently added to further neutralize the acid polymer to 70% neutralization or higher.

[0021] 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 polymerized together.

[0022] As used herein, “(meth) acrylic acid” means methacrylic acid and/or acrylic acid. Likewise, “(meth)acrylate” means methacrylate and/or acrylate.

[0023] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary.

[0024] Concentrations, amounts, and other numerical data may be presented herein in a range format. It is to be understood that such range format is used merely for convenience and brevity and should be interpreted flexibly to include not only the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. For example, a numerical range of about 1 to about 4.5 should be

interpreted to include not only the explicitly recited limits of 1 to about 4.5, but also to include individual numerals such as 2, 3, 4, and sub-ranges such as 1 to 3, 2 to 4, etc. The same principle applies to ranges reciting only one numerical value, such as “less than about 4.5,” which should be interpreted to include all of the above-recited values and ranges. Further, such an interpretation should apply regardless of the breadth of the range or the characteristic being described.

[0025] Other than in the operating examples, or unless otherwise expressly specified, all of the numerical ranges, amounts, values and percentages such as those for amounts of materials, and others in the specification may be read as if prefaced by the word “about” even though the term “about” may not expressly appear with the value, amount or range. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0026] 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.

[0027] In the present disclosure, any steps recited in any method or process claims may be executed in any order and are not limited to the order presented.

[0028] With this in mind, golf balls of the present invention can 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 comprise a single, unitary layer, comprising the entire core from the center of the core to its outer periphery. Alternatively, the cores may consist of a center surrounded by at least one outer core layer. The center, innermost portion of such multi-layer cores is most often 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 include one or more layers, such as a double cover having an inner and outer cover layer. Optionally, additional intermediate layers may be disposed between the core and cover. The HNP-containing composition is most often included in an intermediate layer, such as an outer core layer or inner cover layer, of a multi-layer golf ball. However, the HNP-containing composition can be included in any one of the layers or combinations of layers.

[0029] In the golf balls of the present invention, at least one layer comprises an HNP-containing composition, including an ionic plasticizer as described herein. The acid polymers of the present invention are generally homopolymers or copolymers of α,β -ethylenically unsaturated mono- or dicarboxylic acids, including combinations thereof. Non-limiting examples of α,β -ethylenically unsaturated mono- or dicarboxylic acids are (meth) acrylic acid, ethacrylic acid, maleic acid, crotonic acid, fumaric acid, itaconic acid. (Meth) acrylic acid is currently most common.

[0030] In one aspect of the present invention, acid polymers can be copolymers of a C_3 to C_8 α,β -ethylenically unsaturated mono- or dicarboxylic acid and ethylene or a C_3 to C_6 α -olefin, optionally including a softening monomer. Particularly

suitable acid polymers are copolymers of ethylene and (meth) acrylic acid, such as those including a softening monomer. When a softening monomer is included, such copolymers are 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. Specific non-limiting examples of E/X/Y-type copolymers are those where 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. Particularly suitable 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. In another aspect, the acid polymer can be ethylene-acrylic or (meth) acrylic copolymers or terpolymers (e.g. an alkyl ester such as butyl acrylate).

[0031] The amount of ethylene or C₃ to C₆ α -olefin in the acid copolymer is typically at least 15 wt %, in some cases at least 25 wt %, in other cases at least 40 wt %, and in others 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 from 1 wt % to 35 wt %, such as from 5 wt % to 30 wt %, from 5 wt % to 25 wt %, or from 10 wt % to 20 wt %, based on the total weight of the copolymer. If present, the amount of optional softening comonomer in the acid copolymer can be from 0.01 wt % to 50 wt %, from 5 wt % to 40 wt %, from 10 wt % to 35 wt %, or from 20 wt % to 30 wt %, based on the total weight of the copolymer.

[0032] Further examples of suitable acid polymers include Surlyn® ionomers, commercially-available from DuPont; AClyn® ionomers, commercially-available from Honeywell International Inc.; Iotek® ionomers, commercially-available from ExxonMobil Chemical Company; and the acid copolymers described in U.S. Patent Application Publication No. 2003/0130434, the entire disclosure of which is hereby incorporated herein by reference.

[0033] The acid polymers of the present invention can be direct copolymers where 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 also 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. Other polymer types can also be prepared, as are known in the art, e.g., block copolymers, random copolymers, etc.

[0034] Suitable cation sources include metal cations and salts thereof, organic amine compounds, ammonium, and combinations thereof. Most often, cation sources are metal cations and salts thereof, wherein the metal is lithium, sodium, potassium, magnesium, calcium, barium, lead, tin, zinc, aluminum, manganese, nickel, chromium, copper, or a combination thereof. Other cation sources can also be suitable. The amount of cation used in the HNP-containing composition is readily determined based on the desired level of neutralization.

[0035] The highly-neutralized acid polymer can comprise at least 50 wt % of the polymer composition such as about 60 wt % to about 95 wt %. Most often, the highly-neutralized acid polymer can comprise about 65 wt % to about 90 wt % of the polymer composition.

[0036] As previously described, the HNP-containing compositions of the present invention include one or more highly-neutralized acid polymer(s) and one or more polyhydric alcohol(s). It has been found that by adding a sufficient amount of a polyhydric alcohol to compositions containing an acid polymer, the acid groups of the acid polymer can be neutralized at high levels, including up to 100%, without requiring a fatty acid to maintain processability.

[0037] However, the HNP-containing compositions may contain fatty acids and salts thereof, but are processible without them. If used, organic acids can be blended or melt-blended with other ionomers or polymers as an unmodified or modified organic acid or salt thereof. Typically, the organic acids or salts thereof can be aliphatic, monofunctional organic acids having from 6 to 36 carbon atoms per molecule. These organic acids can be partially neutralized or fully neutralized. For example, greater than 80% or greater than 90%, and in some cases 100% of all the acid components in the blend can be neutralized. The organic acids can typically also be non-volatile and non-migratory. Non-limiting examples of suitable fatty acid as the organic acid can include caproic acid, caprylic acid, capric acid, lauric acid, palmitic acid, stearic acid, behenic acid, erucic acid, oleic acid, linoleic acid, and salts thereof. In one embodiment of the present invention, the HNP-containing composition is substantially free of fatty acids and their salts. However, fatty acids and salts thereof may be used in the HNP-containing composition without departing from the spirit of the invention.

[0038] Examples of suitable polyhydric alcohols include, but are not limited to, polyalkylene glycols, particularly polyethylene glycol and polypropylene glycol; polylactic acid; copolymers thereof; and blends thereof. Polyhydric alcohols of the present invention generally have a weight average molecular weight (M_w) of greater than 500, such as from 500 to 20,000, and in some cases from 1,000 to 20,000. In one embodiment, the polyhydric alcohol is polyethylene glycol or a copolymer thereof, including multi-armed polyethylene glycol polymers, such as those disclosed in U.S. Pat. No. 6,371,975, the entire disclosure of which is hereby incorporated herein by reference. Particularly suitable multi-armed polyethylene glycols are those modified with glutaric acid and hydroxysuccinimide ester groups, resulting in a 4-arm polyethylene glycol succinimidyl glutarate having an M_w of about 10,000. Such 4-arm polyethylene glycols are commercially-available from Shearwater Polymers of Huntsville, Ala.

[0039] While not wishing to be bound by theory, it is believed that polyhydric alcohols function as ionic plasticizers, which plasticize the ionic regions or domains of the polymer without plasticizing the non-ionic polymer backbone. They may also function as amphiphilic plasticizers, plasticizing both the ionic and non-ionic (i.e., olefinic) regions of the ionomer. Other suitable plasticizers include, but are not limited to, alkylamines (e.g., methylamine, ethylamine, propylamine, butylamine, hexylamine, octylamine, dimethylamine, trimethylamine, triethylamine, methylethylamine, methyl-n-butylamine, tetramethylethylene diamine, cyclohexylamine, and longer chain alkylamines, such as dimethylstearylamine); alkanol amines (e.g., dimethylethanol

amine, diethylethanol amine, dipropylethanol amine, and dibutylethanol amine); fatty acid amines (e.g., bisstearamides and alkylene bis-fatty acid amides, such as ethylene bisstearamide); glycerol and glycerol esters (e.g., glycerol acetate and glycerol monostearate); butanediol; hexamethyl phosphoramidate; N-ethyl toluene sulfonamide; N,N-dimethylacetamide; 2,2-dimethyl-1,2-ethanediol; and dimethyl sulfoxide. One or more of the following materials may also be used instead of, or in addition to, polyhydric alcohol(s) in compositions of the present invention: phthalate esters and modified phthalate esters (e.g., dioctyl phthalate and dibutyl phthalate); phthalates of linear alcohols; citrates (e.g., tributyl citrate and acetyl tributyl citrate); monoesters and diesters of polyoxyethylene alkyl ethers; polyoxyethylene alkylaryl ethers; polyoxyethylene alkylene ester sulfates; polyoxyethylene alkyl phenol ether sulfates; and polyoxyethylene sorbitan fatty acid esters (e.g., polyoxyethylene sorbitan monolaurate).

[0040] Although polyhydric alcohols can be included in the polymer resins of the present invention as described above, certain polyhydric alcohols can be particularly suitable as ionic plasticizers in accordance with one aspect of the present invention. As such, in one embodiment, ionic plasticizers can be alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, and combinations thereof. These ionic plasticizers can be used alone, or admixed with other plasticizers such as the aforementioned polyhydric alcohols and/of fatty acids.

[0041] In one specific embodiment, the ionic plasticizer can be a polyalcohol ester. Non-limiting examples of suitable polyalcohol esters can include polyalcohol stearate or oleate esters such as glycerol monostearate, pentaerythritol distearate, glycerine monooleate, glycerine dioleate, pentaerythritol tetrastearate, pentaerythritol tetraoleate, pentaerythritol tetraoleate, neo-pentyl glycol dioleate, and combinations thereof. Many of these polyalcohol esters are commercially available as the Kemfluid series (e.g., Kemfluid® 203, 203-4, 419, 219, 219-D, 223, 227, and 402 from Undesa).

[0042] In another embodiment, the ionic plasticizer can be a montanic acid, montanic acid ester, or salt thereof. Generally, the montanic acid ester or salt thereof can be a reaction product of montanic acid and an alcohol. The alcohol can most often include C₁-C₄ alkanols, C₁-C₄ alkylene glycols, glycerol, and combinations thereof. In one specific embodiment, the montanic acid ester is octacosanoic acid-methyl ester. Commercially-available montanic acids and their esters include Licowax® E powders and flakes, Licowax® OP partially saponified esters, Licowax® S, Licowax® E, Licowax® ET montanic esters, Licomont® V CaV calcium salts of montanic acid, Licomont® NaV sodium salts, and Licolub® WE 4, WE 40 esters (all available from Clariant). Montanic acid is a C₂₈-C₃₂ straight-chain mono-carboxylic acid. Montanic acid esters have high thermal stability and low volatility. An ester of montanic acid is the reaction product of this long chain mono-carboxylic acid with mono- or multi-functional organic alcohols. Such alcohols can include, but are not limited to, methanol, ethanol, propanol, ethylene glycol, propylene glycol, butylene glycol, and glycerol. The carboxylic endgroup may optionally be completely or partially saponified by reaction with bases such as sodium hydroxide or calcium hydroxide. The stoichiometry of the reaction between montanic acid and the alcohol can be adjusted so that the reaction product can be a completely esterified montanic acid, partially esterified montanic acid, completely reacted mono- or multi-functional alcohol, or par-

tially reacted mono- or multi-functional alcohol, completely or partially saponified carboxylic acid salt, or mixtures of these. The specific choice of montanic acid or its esters can affect, among other things, the viscosity of the composition and how miscible or immiscible it will be in the HNP materials. Although ranges can vary somewhat, montanic acid esters can generally be present in the polymer composition from about 0.001 wt % to about 20 wt %, such as 0.01 wt % to 10 wt %, and in some cases 0.01 wt % to about 5 wt %.

[0043] In another embodiment, the ionic plasticizer can be an alkylene bis-amine such as a fatty acid amine. Non-limiting examples of suitable fatty acid amines include bisstearoyl ethyl enedi amine, ethylene bisstearamide, oleamides (oleylamides), and erucamide. Commercial examples of such fatty acid amines include Licolub® FA 1 and Licowax® C (available from Clariant).

[0044] In another aspect of the present disclosure, the ionic plasticizer can be a zwitterionic compound. Suitable zwitterionic compounds can include at least one positive and one negative charge covalently bonded on a common charge center (e.g., an atom or group of atoms). One particular class of zwitterionic compounds has the formula:



where R₁, R₂, and R₃ independently denote an alkyl-, aryl-, alkaryl-, or aralkyl group having 1 to 30 carbon atoms. These groups can be un-substituted, or wholly or partially chlorinated or fluorinated, and can be optionally branched. Specific examples include phenol and un-branched, un-substituted alkyl group having 1 to 20 carbon atoms, such as phenyl, methyl or alkyl having 12 to 20 carbon atoms. R₄ denotes a bivalent alkylene group having 1 to 30 carbon atoms and which can be un-substituted or wholly or partially chlorinated or fluorinated and optionally branched. Specific examples include un-branched, un-substituted α,α-alkylene group C₁-C₅. Further, Y denotes nitrogen or phosphorus, and X denotes —SO₃⁻, —COO⁻, PO₃⁻, with —SO₃⁻, being particularly suitable. One specific example of a suitable zwitterionic compound is N,N-dimethyl-N-stearyl-N-(3-sulfopropyl)-ammonium betaine.

[0045] The amount of polyhydric alcohol present in the HNP-containing compositions of the present invention is typically at least 0.5 wt %, such as from 1 wt % to 15 wt %, and in some cases from 1.5 wt % to 10 wt %, based on the total polymeric weight of the composition. The amount of acid polymer present in the HNP-containing compositions of the present invention is typically at least 50 wt %, often from 50 wt % to 99.5 wt %, and in some cases from 60 wt % to 98 wt %, based on the total polymeric weight of the composition. Similarly, the amount of ionic plasticizer present in the HNP-containing compositions can generally range from 0.1 wt % to 50 wt %, such as 1 wt % to 40 wt %, and in some cases 10 wt % to 35 wt %. As mentioned, the plasticizers used in accordance with embodiments of the present disclosure can be alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, and combinations thereof. That being said, other more conventional plasticizer may or may not be present as well, e.g., fatty acids and/or polyhydric alcohols. Some embodiments are devoid of these other plasticizers, and other embodiments are co-formulated with these or other types of plasticizers.

[0046] The HNP-containing compositions of the present invention may also contain a melt flow modifier selected from polyesters, polyacrylates, thermoplastic polyureas, poly-

ethers, polyamides, and combinations thereof. Such non-fatty acid melt flow modifiers typically have an M_w of from 1,000 to 100,000 and a melt flow index of from 10 g/10 min to 1,000 g/10 min.

[0047] The HNP-containing compositions of the present invention can also include one or more other additives. Suitable additives include, but are not limited to, chemical blowing and foaming agents, optical brighteners, coloring agents, fluorescent agents, whitening agents, UV absorbers, light stabilizers, defoaming agents, processing aids, mica, talc, nano-fillers, antioxidants, stabilizers, softening agents, fragrance components, plasticizers, impact modifiers, TiO_2 , acid copolymer wax, surfactants, and fillers, such as zinc oxide, tin oxide, barium sulfate, zinc sulfate, calcium oxide, calcium carbonate, zinc carbonate, barium carbonate, clay, tungsten, tungsten carbide, silica, lead silicate, regrind (recycled material), and mixtures thereof. Suitable additives are more fully described in, for example, U.S. Patent Application Publication No. 2003/0225197, the entire disclosure of which is hereby incorporated herein by reference. Other optional additives can include fibers, flakes, particulates, microspheres, pre-expanded beads of glass, ceramic, metal or polymer, and the like which may be optionally foamed. Depending on the additive, such additives can be present in an amount of from 0 wt % to 60 wt %, based on the total weight of the composition.

[0048] The cover layer, or any layer of a multiple layer cover, can be formed of suitable polymers such as the HNP materials described herein, polyurethanes, or polyureas. Most often, the outer cover layer comprises a light stable polyurethane or polyurea, and an inner cover layer or core layer will include the HNP materials described herein.

[0049] As briefly summarized above, golf balls of the present invention can be formed having a variety of internal configurations. For example, golf balls of the present invention can be wound, one-piece, two-piece, or multi-layer balls, wherein at least one layer comprises an HNP-containing composition described herein. In golf balls having two or more layers which comprise an HNP-containing composition, the HNP-containing composition of one layer may be the same or a different HNP-containing composition as another layer. The layer(s) comprising the HNP-containing composition can be any one or more of a core layer, an intermediate layer, or a cover layer. Although not required, the core can often include a center and an outer core layer. Similarly, the cover layer can be a double layer cover having an inner cover layer and an outer cover layer. The outer core layer or the inner cover layer would both be considered intermediate layers. Intermediate layers can also include thin moisture barrier layers, coating layers, adhesive layers, etc.

[0050] Typically, golf balls of the present invention are multi-layer balls having a compression molded rubber core, at least one injection or compression molded intermediate layer which comprises an HNP-containing composition, and a cast or reaction injection molded polyurethane or polyurea outer cover layer. The rubber core composition comprises a base rubber, a crosslinking agent, a filler, and a co-crosslinking or initiator agent. Typical base rubber materials include natural and synthetic rubbers, including, but not limited to, polybutadiene and styrene-butadiene. The crosslinking agent typically includes a metal salt, such as a zinc salt or magnesium salt, of an acid having from 3 to 8 carbon atoms, such as (meth) acrylic acid. The initiator agent can be any known polymerization initiator which decomposes during the cure

cycle, including, but not limited to, dicumyl peroxide, 1,1-di-(t-butylperoxy) 3,3,5-trimethyl cyclohexane, a-a bis-(t-butylperoxy) diisopropylbenzene, 2,5-dimethyl-2,5 di-(t-butylperoxy) hexane or di-t-butyl peroxide, and mixtures thereof. Suitable types and amounts of base rubber, crosslinking agent, filler, co-crosslinking agent, and initiator agent are more fully described in, for example, U.S. Patent Application Publication No. 2003/0144087, the entire disclosure of which is hereby incorporated herein by reference. Reference is also made to U.S. Patent Application Publication No. 2003/0144087, which is incorporated herein by reference, for various ball constructions and materials that can be used in golf ball core, intermediate, and cover layers of the present invention.

[0051] Cover compositions of the present invention include polyurethanes formed from the reaction product of at least one polyisocyanate and at least one curing agent. The curing agent can include, for example, one or more diamines, one or more polyols, or a combination thereof. The at least one polyisocyanate can be combined with one or more polyols to form a prepolymer, which is then combined with the at least one curing agent. Thus, when polyols are described herein they may be suitable for use in one or both components of the polyurethane material, i.e., as part of a prepolymer and in the curing agent. The curing agent includes a polyol curing agent preferably selected from the group consisting of ethylene glycol; diethylene glycol; polyethylene glycol; propylene glycol; polypropylene glycol; lower molecular weight polytetramethylene ether glycol; 1,3-bis(2-hydroxyethoxy)benzene; 1,3-bis-[2-(2-hydroxyethoxy)ethoxy]benzene; 1,3-bis-[2-(2-(2-hydroxyethoxy)ethoxy)ethoxy]benzene; 1,4-butanediol; 1,5-pentanediol; 1,6-hexanediol; resorcinol-di-(β -hydroxyethyl)ether; hydroquinone-di-(β -hydroxyethyl) ether; trimethylol propane; and combinations thereof.

[0052] Suitable polyurethane cover compositions of the present invention also include those formed from the reaction product of at least one isocyanate and at least one curing agent or the reaction product of at least one isocyanate, at least one polyol, and at least one curing agent. Preferred isocyanates include those selected from the group consisting of 4,4'-diphenylmethane diisocyanate, polymeric 4,4'-diphenylmethane diisocyanate, carbodiimide-modified liquid 4,4'-diphenylmethane diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, p-phenylene diisocyanate, toluene diisocyanate, isophoronediiisocyanate, p-methylxylene diisocyanate, m-methylxylene diisocyanate, o-methylxylene diisocyanate, and combinations thereof. Preferred polyols include those selected from the group consisting of polyether polyol, hydroxy-terminated polybutadiene, polyester polyol, polycaprolactone polyol, polycarbonate polyol, and combinations thereof. Preferred curing agents include polyamine curing agents, polyol curing agents, and combinations thereof. Polyamine curing agents are particularly preferred. Preferred polyamine curing agents include, for example, 3,5-dimethylthio-2,4-toluenediamine, or an isomer thereof; 3,5-diethyltoluene-2,4-diamine, or an isomer thereof; 4,4'-bis-(sec-butylamino)-diphenylmethane; 1,4-bis-(sec-butylamino)-benzene, 4,4'-methylene-bis-(2-chloroaniline); 4,4'-methylene-bis-(3-chloro-2,6-diethylaniline); trimethylene glycol-di-p-aminobenzoate; polytetramethyleneoxide-di-p-aminobenzoate; N,N'-dialkyldiamino diphenyl methane; p,p'-methylene dianiline; phenylenediamine; 4,4'-methylene-bis-(2-chloroaniline); 4,4'-methylene-bis-(2,6-diethylaniline); 4,4'-diamino-3,3'-diethyl-5,5'-dimethyl diphenyl-

methane; 2,2',3,3'-tetrachloro diamino diphenylmethane; 4,4'-methylene-bis-(3-chloro-2,6-diethylaniline); and combinations thereof.

[0053] The present invention is not limited by the use of a particular polyisocyanate in the cover composition. Suitable polyisocyanates include, but are not limited to, 4,4'-diphenylmethane diisocyanate ("MDI"); polymeric MDI, carbodiimide-modified liquid MDI; 4,4'-dicyclohexylmethane diisocyanate; p-phenylene diisocyanate ("PPDI"); toluene diisocyanate ("TDI"); 3,3'-dimethyl-4,4'-biphenylene diisocyanate; isophoronediiisocyanate; hexamethylene diisocyanate; naphthalene diisocyanate; xylene diisocyanate; p-tetramethylxylene diisocyanate; m-tetramethylxylene diisocyanate; ethylene diisocyanate; propylene-1,2-diisocyanate; tetramethylene-1,4-diisocyanate; cyclohexyl diisocyanate; 1,6-hexamethylene-diisocyanate; dodecane-1,12-diisocyanate; cyclobutane-1,3-diisocyanate; cyclohexane-1,3-diisocyanate; cyclohexane-1,4-diisocyanate; 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethylcyclohexane; methyl cyclohexylene diisocyanate; triisocyanate of HDI; triisocyanate of 2,4,4-trimethyl-1,6-hexane diisocyanate; tetracene diisocyanate; naphthalene diisocyanate; anthracene diisocyanate; and combinations thereof. Polyisocyanates are known to those of ordinary skill in the art as having more than one isocyanate group, e.g., di-, tri-, and tetra-isocyanate. Preferably, the polyisocyanate is selected from MDI, PPDI, TDI, and combinations thereof. More preferably, the polyisocyanate includes MDI. It should be understood that, as used herein, the term "MDI" includes 4,4'-diphenylmethane diisocyanate, polymeric MDI, carbodiimide-modified liquid MDI, combinations thereof and, additionally, that the diisocyanate employed may be "low free monomer," understood by one of ordinary skill in the art to have lower levels of "free" monomer isocyanate groups than conventional diisocyanates, i.e., the compositions of the invention typically have less than about 0.1% free monomer groups. Examples of "low free monomer" diisocyanates include, but are not limited to Low Free Monomer MDI, Low Free Monomer TDI, and Low Free Monomer PPDI.

[0054] The at least one polyisocyanate should have less than 14% unreacted NCO groups. Preferably, the at least one polyisocyanate has no greater than 8.5% NCO, more preferably from 2.5% to 8.0%, even more preferably from 4.0% to 7.2%, and most preferably from 5.0% to 6.5%.

[0055] The present invention is not limited by the use of a particular polyol in the cover composition. In one embodiment, the molecular weight of the polyol is from about 200 to about 6000. Exemplary polyols include, but are not limited to, polyether polyols, hydroxy-terminated polybutadiene (including partially/fully hydrogenated derivatives), polyester polyols, polycaprolactone polyols, and polycarbonate polyols. Particularly preferred are polytetramethylene ether glycol ("PTMEG"), polyethylene propylene glycol, polyoxypropylene glycol, and combinations thereof. The hydrocarbon chain can have saturated or unsaturated bonds and substituted or unsubstituted aromatic and cyclic groups. Preferably, the polyol of the present invention includes PTMEG. Suitable polyester polyols include, but are not limited to, polyethylene adipate glycol, polybutylene adipate glycol, polyethylene propylene adipate glycol, ortho-phthalate-1,6-hexanediol, and combinations thereof. The hydrocarbon chain can have saturated or unsaturated bonds, or substituted or unsubstituted aromatic and cyclic groups. Suitable polycaprolactone polyols include, but are not limited to,

1,6-hexanediol-initiated polycaprolactone, diethylene glycol initiated polycaprolactone, trimethylol propane initiated polycaprolactone, neopentyl glycol initiated polycaprolactone, 1,4-butanediol-initiated polycaprolactone, and combinations thereof. The hydrocarbon chain can have saturated or unsaturated bonds, or substituted or unsubstituted aromatic and cyclic groups. Suitable polycarbonates include, but are not limited to, polyphthalate carbonate. The hydrocarbon chain can have saturated or unsaturated bonds, or substituted or unsubstituted aromatic and cyclic groups.

[0056] Polyamine curatives are also suitable for use in the curing agent of polyurethane compositions and have been found to improve cut, shear, and impact resistance of the resultant balls. Preferred polyamine curatives include, but are not limited to, 3,5-dimethylthio-2,4-toluenediamine and isomers thereof; 3,5-diethyltoluene-2,4-diamine and isomers thereof, such as 3,5-diethyltoluene-2,6-diamine; 4,4'-bis-(sec-butylamino)-diphenylmethane; 1,4-bis-(sec-butylamino)-benzene, 4,4'-methylene-bis-(2-chloro aniline); 4,4'-methylene-bis-(3-chloro-2,6-diethylaniline); polytetramethyleneoxide-di-p-aminobenzoate; N,N'-dialkyl-diamino diphenyl methane; p,p'-methylene dianiline; m-phenylenediamine; 4,4'-methylene-bis-(2-chloroaniline); 4,4'-methylene-bis-(2,6-diethylaniline); 4,4'-diamino-3,3'-diethyl-5,5'-dimethyl diphenylmethane; 2,2', 3,3'-tetrachloro diamino diphenylmethane; 4,4'-methylene-bis-(3-chloro-2,6-diethylaniline); trimethylene glycol di-p-aminobenzoate; and combinations thereof. Preferably, the curing agent of the present invention includes 3,5-dimethylthio-2,4-toluenediamine and isomers thereof, such as Ethacure® 300 or, alternatively, Ethacure® 100 and 100 LC. Suitable polyamine curatives, which include both primary and secondary amines, preferably have weight average molecular weights ranging from about 64 to about 2000.

[0057] At least one of a diol, triol, tetraol, or hydroxy-terminated curative may be added to the polyurethane composition. Suitable diol, triol, and tetraol groups include ethylene glycol; diethylene glycol; polyethylene glycol; propylene glycol; polypropylene glycol; lower molecular weight polytetramethylene ether glycol; 1,3-bis(2-hydroxyethoxy)benzene; 1,3-bis-[2-(2-hydroxyethoxy)ethoxy]benzene; 1,3-bis-[2-[2-(2-hydroxyethoxy)ethoxy]ethoxy]benzene; 1,4-butanediol; 1,5-pentanediol; 1,6-hexanediol; resorcinol-di-(4-hydroxyethyl)ether; hydroquinone-di-(4-hydroxyethyl)ether; and combinations thereof. Preferred hydroxy-terminated curatives include ethylene glycol; diethylene glycol; 1,4-butanediol; 1,5-pentanediol; 1,6-hexanediol, trimethylol propane, and combinations thereof. Preferably, the hydroxy-terminated curative has a molecular weights ranging from about 48 to 2000. It should be understood that molecular weight, as used herein, is the absolute weight average molecular weight and would be understood as such by one of ordinary skill in the art.

[0058] Both the hydroxy-terminated and amine curatives can include one or more saturated, unsaturated, aromatic, and cyclic groups. Additionally, the hydroxy-terminated and amine curatives can include one or more halogen groups. The polyurethane composition can be formed with a blend or mixture of curing agents. If desired, however, the polyurethane composition may be formed with a single curing agent.

[0059] Any method known to one of ordinary skill in the art may be used to combine the polyisocyanate, polyol, and curing agent of the present invention. One commonly employed method, known in the art as a one-shot method,

involves concurrent mixing of the polyisocyanate, polyol, and curing agent. This method results in a mixture that is inhomogeneous (more random) and affords the manufacturer less control over the molecular structure of the resultant composition. A preferred method of mixing is known as a pre-polymer method. In this method, the polyisocyanate and the polyol are mixed separately prior to addition of the curing agent. This method affords a more homogeneous mixture resulting in a more consistent polymer composition.

[0060] Suitable polyureas are further disclosed, for example, in U.S. Pat. Nos. 5,484,870 and 6,835,794, the entire disclosures of which are hereby incorporated herein by reference. Suitable polyurethane-urea cover materials include polyurethane/polyurea blends and copolymers comprising urethane and urea segments, as disclosed in U.S. Patent Application Publication No. 2007/0117923, the entire disclosure of which is hereby incorporated herein by reference.

[0061] Various properties of the golf ball can dramatically affect performance. These properties can be a result of the particular materials and golf ball design chosen.

[0062] In one preferred embodiment the golf ball includes a dual core (inner core and outer core layer) and a single cover layer. The inner core and/or outer core comprise a polymer composition that is a blend of a highly-neutralized acid polymer having acid groups comprising at least 50 wt % of the polymer composition, where 70% to 100% of the acid groups are neutralized; and an ionic plasticizer being selected from the group consisting of alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, and combinations thereof. The cover layer is preferably formed from a castable polyurethane or polyurea. The inner core has a diameter of about 0.50 inches to about 1.50 inches, more preferably about 0.75 inches to about 1.30 inches, most preferably about 1.00 inches to about 1.20 inches. The outer core diameter is preferably about 1.55 inches to about 1.64 inches, more preferably about 1.58 inches to about 1.62 inches. In this embodiment, the inner core has an Atti compression of about 60 or less, more preferably about 40 or less, and most preferably about 30 or less. The inner core surface hardness is preferably about 10 to about 50 Shore D, more preferably about 15 to about 40 Shore D, and most preferably about 20 to about 35 Shore D.

[0063] In this embodiment, the outer core layer surface hardness is preferably about 20 to about 60 Shore D, more preferably about 25 to about 55 Shore D, and most preferably about 30 to about 50 Shore D. The outer cover layer preferably has a thickness of about 0.015 inches to about 0.05 inches, more preferably about 0.02 inches to about 0.04 inches, and most preferably about 0.025 inches to about 0.035 inches. The material hardness of the outer cover layer is preferably about 30 to about 60 Shore D, more preferably about 35 to about 58 Shore D, and most preferably about 40 to about 55 Shore D.

[0064] In a second preferred embodiment, the above golf ball further includes an inner cover layer comprising a thermoplastic or thermosetting material, more preferably a thermoplastic material, and most preferably an ionomeric material. The inner cover layer, which is disposed between the outer cover layer and the outer core layer, preferably has a thickness of about 0.015 inches to about 0.05 inches, more preferably about 0.02 inches to about 0.04 inches, and most preferably about 0.025 inches to about 0.035 inches. The inner cover layer preferably has a material hardness of about

55 to about 80 Shore D, more preferably about 57 to about 75 Shore D, and most preferably about 62 to about 72 Shore D. In this embodiment, the outer core layer preferably has a diameter of about 1.51 inches to about 1.62 inches, more preferably about 1.53 inches to about 1.60 inches, and most preferably about 1.55 inches to about 1.58 inches.

[0065] Accordingly, the golf balls of the present invention can have a center having a diameter of from 1.00 inches to 1.63 inches and an Atti compression of from 40 to 160. Most often, the center has a surface hardness of from 20 Shore D to 70 Shore D. When present, the intermediate layer can generally have a material hardness of from 30 Shore D to 80 Shore D. Although other dimensions can be used, the intermediate layer typically has a thickness of from 0.020 inches to 0.090 inches, more often from 0.010 inches to 0.060 inches.

[0066] Golf balls of the present invention generally also have a coefficient of restitution of at least 0.790, such as at least 0.800, in some cases at least 0.805, and even other cases at least 0.810. Furthermore, an Atti compression of from 75 to 110, such as from 90 to 100, can be particularly suitable. COR is defined as the ratio of the rebound velocity to the inbound velocity when balls are fired into a rigid plate. In determining COR, the inbound velocity is understood to be 125 ft/s.

[0067] HNP-containing compositions of the present invention typically have a flexural modulus of from 3,000 psi to 200,000 psi, such as from 5,000 psi to 150,000 psi, in some cases from 10,000 psi to 125,000 psi, and in other cases from 10,000 psi to 100,000 psi. The material hardness of the HNP-containing compositions is generally from 30 Shore D to 80 Shore D, more often from 40 Shore D to 75 Shore D, and in some cases from 45 Shore D to 70 Shore D. The notched izod impact strength of the HNP-containing compositions of the present invention is generally at least 2 ft-lb/in, as measured at 23° C. according to ASTM D256.

[0068] As a guideline, in order to be processable, the HNP-containing composition can have a melt flow index of at least 0.5 g/10 min. More particularly, the melt flow index of the HNP-containing composition can be from 0.5 g/10 min to 10.0 g/10 min, such as from 1.0 g/10 min to 5.0 g/10 min, and in some cases from 1.0 g/10 min to 4.0 g/10 min.

[0069] The present invention is not limited by any particular method for making the HNP-containing composition. In one embodiment, the composition is prepared by an extrusion process utilizing a melt extruder, such as a single or twin screw extruder. In a typical extruder process, the acid polymer(s), polyhydric alcohol(s), and optional additives are fed, either simultaneously or separately, into the extruder and melt blended at a temperature typically within the range of from 200° C. to 550° C. The cation source is concurrently or subsequently added to neutralize the acid polymer(s) to a desired level. The acid polymer(s) may be partially neutralized prior to contact with the cation source. In another embodiment, the composition is prepared by heating and reacting the acid polymer(s) and polyhydric alcohol in solution at a temperature above the melting point of the polymeric components. In still another embodiment, an unneutralized ionomer can be blended with the ionic plasticizer and then neutralized. Optionally, a partially neutralized ionomer can be mixed with the plasticizer and subsequently additional cation added to further neutralize the ionomer.

[0070] Similarly, 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, but not limited to, injection molding, compression molding, casting, and reaction injection molding.

[0071] The compositions of the present invention can provide alternative routes to processable highly-neutralized polymers which can be effective and inexpensive. Furthermore, the present invention allows for a greater range of physical properties, e.g. flexibility, softer/faster combinations, improved toughness, increased scuff and shear resistance, and the like.

[0072] The foregoing detailed description describes the invention with reference to specific exemplary embodiments. However, it will be appreciated that various modifications and changes can be made without departing from the scope of the present invention as set forth in the appended claims. The detailed description is to be regarded as merely illustrative, rather than as restrictive, and all such modifications or changes, if any, are intended to fall within the scope of the present invention as described and set forth herein.

What is claimed is:

1. A golf ball comprising a core and a cover layer, wherein at least one of the core and the cover layer includes a polymer composition, comprising:

a highly-neutralized acid polymer having acid groups comprising at least 50 wt % of the polymer composition wherein 70% to 100% of the acid groups are neutralized; and

an ionic plasticizer being selected from the group consisting of alcohol esters, montanic acids, montanic acid esters, alkylene bis-amines, zwitterionic compounds, salts thereof, and combinations thereof.

2. The golf ball of claim 1, wherein the core includes a center and an outer core layer, or the cover layer is a double layer cover having an inner cover layer and an outer cover layer.

3. The golf ball of claim 2, and wherein the polymer composition is present in the outer core layer or the inner cover layer.

4. The golf ball of claim 1, wherein the polymer composition is present in the core.

5. The golf ball of claim 1, wherein the polymer composition is present in the cover layer.

6. The golf ball of claim 1, wherein the highly-neutralized acid polymer is a copolymer of a C_3 to C_8 α,β -ethylenically unsaturated carboxylic acid and a C_2 to C_6 α -olefin.

7. The golf ball of claim 1, wherein the highly-neutralized acid polymer further includes a softening monomer admixed or copolymerized therewith.

8. The golf ball of claim 1, wherein the acid groups are at least 95% neutralized.

9. The golf ball of claim 1, wherein the ionic plasticizer is a polyalcohol ester.

10. The golf ball of claim 9, wherein the polyalcohol ester is selected from the group consisting of glycerol monostearate, pentaerythritol distearate, glycerine monooleate, glycerine bisoleate, pentaerythritol tetrastearate, pentaerythritol tetraoleate, pentaerythritol tetraoleate, neo-pentyl glycol diolate, and combinations thereof.

11. The golf ball of claim 1, wherein the ionic plasticizer is a montanic acid, montanic acid ester, or salt thereof.

12. The golf ball of claim 11, wherein the montanic acid ester or salt thereof is a reaction product of montanic acid and an alcohol selected from the group consisting of C_1 - C_4 alkanols, C_1 - C_4 alkylene glycols, glycerol, and combinations thereof.

13. The golf ball of claim 1, wherein the ionic plasticizer is an alkylene bis-amine.

14. The golf ball of claim 13, wherein the alkylene bis-amine is a fatty acid amine.

15. The golf ball of claim 14, wherein the fatty acid amine is bis-stearoylethylenediamine, ethylene bisstearamide, oleamide, or erucamide.

16. The golf ball of claim 1, wherein the ionic plasticizer is a zwitterionic compound.

17. The golf ball of claim 16, wherein the zwitterionic compound is N,N-dimethyl-N-stearyl-N-(3-sulfopropyl)-ammonium betaine.

18. The golf ball of claim 1, wherein the golf ball has a coefficient of restitution of at least 0.810 and an Atti compression from 90 to 100.

19. The golf ball of claim 1, wherein the polymer composition is substantially devoid of fatty acids and polyhydric alcohols.

20. A golf ball, comprising:

a solid core;

a cover layer comprising a polyurethane or polyurea; and an intermediate layer disposed between the solid core and the cover layer, wherein the intermediate layer includes a polymer composition, comprising:

a highly-neutralized acid polymer having acid groups comprising at least 50 wt % of the polymer composition and wherein at least 98% of the acid groups are neutralized; and

an ionic plasticizer comprising a montanic acid, montanic acid ester, or salt thereof.

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