A golf ball comprising a core and a cover, wherein an outermost surface of the golf ball has a coefficient of friction of greater than 0.6.
GOLF BALL HAVING HIGH SURFACE FRICTION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 10/462,548, filed Jun. 16, 2003, the entire disclosure of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to golf balls and, more particularly, to a golf ball outermost surface having specific friction and gloss properties. The outermost surface of the golf ball may be the outer surface of a coating layer or, alternatively, the outer surface of an outer cover layer.

BACKGROUND OF THE INVENTION

[0003] The United States Golf Association ("USGA") provides five (5) regulations to keep golf balls consistent. Specifically, the golf ball must weigh no more than 1.62 ounces and measure no less than 1.68 inches in diameter. The initial velocity of the ball as tested on a USGA machine at a set club head speed must not exceed 255 ft/sec. The overall distance of the ball as tested with a USGA specified driver at 160 ft/sec and a 10-degree launch angle must not exceed 296.8 yards. Furthermore, the ball must pass a USGA-administered symmetry test. Within the confines of these regulations, other performance characteristics of the ball, including distance, durability, feel, spin, sound, and the like may be modified through alterations in material compositions, constructions, diameters and/or thickness, and surface configurations of various portions of the ball, such as the core, the cover, intermediate layer(s) disposed between the core and the cover, and coating layer disposed about the cover. Other physical, mechanical, chemical, and/or optical properties of the portions, including color stability, compression, density, flexural modulus, gas or vapor permeability, hardness, stiffness, tear resistance, weight, gloss, and the like may also be affected by these alterations.

[0004] Traditionally, it is recognized that the back spin imparted to a golf ball when hit with a golf club provides in part the aerodynamic lift that makes the ball airborne and prolongs its flight time, as well as enables the ball to stop on a green. There are two force components acting on the golf ball during impact: a normal force at a right angle to the club face and a tangential force parallel to the club face. The ratio of the tangential force to the normal force represents the coefficient of friction ("COF") of the ball on the club face which, as known to a skilled artisan, has a direct effect on the amount of spin imparted to the ball. This effect is more prominent in irons of higher lofts. It is feasible, therefore, to impart specific properties to the outermost surface of the golf ball and achieve desirable performance characteristics.

[0005] The golf ball of the present invention, as disclosed herein below, has a COF of greater than 0.6. This may be brought about by using a high COF material composition for the outer cover layer, if the outer surface of the outer cover layer is the outermost surface of the golf ball. In a conventional golf ball employing materials such as balata, Surlyn®, or polyurethane as cover materials, a protective coating layer having a relatively high gloss (60° gloss being greater than about 80) is typically applied to encapsulate the golf ball cover and constitutes the only ball portion that makes direct contact with the club face. As such, it is desirable to dispose a high COF coating layer of superior mar and abrasion resistance and weatherability about the golf ball, to elevate the ball COF, enhance its durability and aesthetic appeal, and selectively optimize performance parameters such as spin, drag, and feel.

SUMMARY OF THE INVENTION

[0006] The present invention is directed to a golf ball having a high COF outermost surface. The high COF of the outermost surface is preferably greater than 0.6, more preferably greater than about 0.7, and most preferably about 0.8 to about 1.5. The outermost surface is hydrophobic, having a 60° gloss of preferably at least about 3, more preferably at least about 50, and most preferably about 80 to about 95. The outermost surface can be the outer surface of a cover or an outer cover layer, but is preferably the outer surface of a coating layer.

[0007] The coating layer can be translucent, transparent, or pigmented, having a thickness of about 0.0001 inches to about 0.01 inches. The coating layer has a Sward hardness of preferably less than about 20, more preferably less than about 10, and most preferably less than about 5. The coating layer has a cross hatch adhesion of about 90% to about 100%, and a pencil hardness of about 3 H to about 3 H. The coating layer is typically formed from a liquid reactive material, having a solid content by weight of at least about 40%.

[0008] In one embodiment the coating layer is formed from a two-component thermoset polyurethane. The polyurethane may be blended with a variety of additives, such as an UV absorber, a hindered amine light stabilizer, an antioxidant, an optical brightener, a filler, a coupling agent, a colorant, or a combination thereof.

[0009] The golf ball cover of the present invention can be a single-piece cover or a multi-layer cover comprising an outer cover layer and one or more inner cover layers. The single-piece cover or the outer cover layer is formed from at least one polymer material known to one skilled in the art. Suitable polymer materials for the cover include, but are not limited to, metalloocene-catalyzed polymers, ethylene/acid ionomers, thermoplastic or thermoset polyurethanes, or combinations thereof. Preferably, the coating layer is contiguous with the cover or the outer cover layer.

[0010] The high COF outermost surface as disclosed herein provides the golf ball with certain unique performance characteristics. Such golf balls display small changes in driver spin rate, but large changes in full wedge spin rate and half wedge spin rate. Specifically, the high COF golf balls have a spin rate change of less than about 15% when struck with a standard driver at a speed of about 160 ft/sec, and their launch angle is not changed much either. When struck with a full wedge at a speed of about 95 ft/sec, the high COF golf balls demonstrate an elevated launch angle and a spin rate reduction of at least about 5%. When struck with a half wedge at a speed of about 53 ft/sec, the high COF golf balls demonstrate an elevated launch angle and a spin rate reduction of at least about 10%. The reductions in full wedge and half wedge spin rates can be as high as about 60% or more.
To impart the golf ball with a high COF outermost surface, a material is used to form an outermost solid layer about a golf ball precursor. The material is first deposited onto the golf ball precursor through spraying, dipping, spin coating, or flow coating to form a substantially even layer of the material with a wet thickness of less than about 0.05 inches. Then the wet layer is cured into the outermost solid layer having a dry thickness of at least about 0.001 inches. The outermost solid layer is a coating layer or a cover layer.

DEFINITIONS

As used herein, the term “polyaryl” or “reactive polyaryl” refers to any one compound or a mixture of compounds containing a plurality of active hydrogen moieties per molecule. Illustrative of such active hydrogen moieties are —OH (hydroxy group), —SH (thio group), —COOH (carboxylic acid group), and —NHR (amine group), with R being hydrogen, alkyl, aryl, or epoxy; all of which may be primary or secondary. These active hydrogen moieties are reactive to free isocyanate groups, forming urethane, urea, thiourea or corresponding linkage depending on the particular active hydrogen moiety being reacted. The polyaryls may be monomers, homo-oligomers, co-oligomers, homopolymer, or copolymers. Oligomeric and polymeric polyaryls having at least one NCO-reactive group on each terminal of a backbone are typically employed as the soft segment in reaction products such as polyureas and polyurethanes. Depending on the terminal groups, the oligomeric and polymeric polyaryls may be identified as polyols (with —OH terminals only), polyamines (with —NHR terminals only), or amino alcohols (with both —OH and —NHR terminals). Such polyaryls with a relatively low molecular weight (less than about 5,000), and a wide variety of monomeric polyaryls, are commonly used as curing agents. The polyaryls are generally liquids or solids meltable at relatively low temperatures.

As used herein, the term “saturated” or “substantially saturated” means that the compound or material of interest is fully saturated (i.e., contains no double bonds, triple bonds, or aromatic ring structures), or that the extent of unsaturation is negligible, e.g., as shown by a bromine number in accordance with ASTM E234-98 of less than 10, preferably less than 5.

As used herein, the term “percent NCO” or “% NCO” refers to the percent by weight of free, reactive, and unreacted isocyanate functional groups in an isocyanate-functional molecule or material. The total formula weight of all the NCO groups in the molecule or material, divided by its total molecular weight, and multiplied by 100, equals the percent NCO.

As used herein, the term “equivalent” is defined as the number of moles of a functional group in a given quantity of material, and calculated from material weight divided by the equivalent weight, the latter of which refers to molecular weight per functional group. For isocyanates the equivalent weight is (4210 grams) % NCO; and for polyols, (5610 grams)/OH.

As used herein, the term “flexural modulus” or “modulus” refers to the ratio of stress to strain within the elastic limit (measured in flexural mode) of a material, indicates the bending stiffness of the material, and is similar to tensile modulus. Flexural modulus, typically reported in Pascal (“Pa”) or pounds per square inch (“psi”), is derived in accordance to ASTM D6272-02.

As used herein, the term “water vapor transmission rate” (“WVTR”) refers to the mass of water vapor that diffuses into a material of a given thickness per unit area per unit time at a specific temperature and humidity differential. Standard tests for WVTR include ASTM E96-00.

As used herein, the term “material hardness” refers to indentation hardness of non-metallic materials in the form of a flat slab or button as measured with a durometer. The durometer has a spring-loaded indenter that applies an indentation load to the slab, thus sensing its hardness. The material hardness can indirectly reflect upon other material properties, such as tensile modulus, resilience, plasticity, compression resistance, and elasticity. Standard tests for material hardness include ASTM D2240-02b. Unless otherwise specified, material hardness reported herein is in Shore D. Material hardness is distinct from the hardness of a golf ball portion as measured directly on the golf ball (or other spherical surface). The difference in value is primarily due to the construction, size, thickness, and material composition of the golf ball components (i.e., center, core and/or layers) that underlie the portion of interest. One of ordinary skill in the art would understand that the material hardness and the hardness as measured on the ball are not correlated or convertible.

As used therein, the term “compression,” also known as “ATI compression” or “PGA compression,” refers to points derived from a Compression Tester (ATI Engineering Company, Union City, N.J.), a scale well known in the art for determining relative compression of a spherical object. Compression is a property of a material as measured on a golf ball construction (i.e., on-ball property), not a property of the material per se.

As used herein, the term “coefficient of restitution” or “COR” for golf balls is defined as the ratio of a ball’s rebound velocity to its initial incoming velocity when the ball is fired out of an air cannon into a rigid vertical plate. The faster a golf ball rebounds, the higher the COR it has, the more the total energy remains when struck with a club, and the longer the ball flies. The initial velocity is about 50 ft/sec to about 200 ft/sec, and is usually understood to be 125 ft/sec, unless otherwise specified. A golf ball may have different COR values at different initial velocities.

The term “about,” as used herein in connection with one or more numbers or numerical ranges, should be understood to refer to all such numbers, including all numbers in a range.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is primarily directed to a new outermost surface for a golf ball. In a conventional golf ball, the portion that makes contact with a golf club in play is its outermost surface, which is typically formed from a coating layer disposed about the cover of the ball. The coating layer serves to protect the ball, the identifying indicia, and any paint layers; to enhance abrasion and shear resistance of the cover; and to add a pleasing, high gloss appearance to the ball. The coating layer may comprise a clear or pigmented primer coat and a translucent, transparent, clear, or pig-
mented topcoat, although for certain applications a single topcoat may suffice. The primer coat is applied to promote adhesion or to smooth surface roughness of the cover prior to application of the topcoat(s). Coating compositions are conventionally free of pigmentation and are water white. However, they may contain small amounts of dye, pigment, and optical brighteners so long as they still allow for a bright ball cover. Various identifying indicia may be applied either directly upon or alternatively upon the cover, the primer coat, or the topcoat.

[0023] The coating layer of the present invention preferably has a soft luxurious feel, capable of providing a high COF to the golf ball off certain clubs (i.e., a putter), without adversely affecting velocity or other desirable properties of the golf ball off other clubs (i.e., a driver). The material forming the coating layer has a Sward hardness of preferably less than about 20, more preferably less than about 10, and most preferably less than about 5. Sward hardness is tested according to ASTM D2134-66. The material also has a COF of preferably greater than 0.6, more preferably at least about 0.7, and most preferably from about 0.8 to about 1.5. The COF disclosed herein is a static coefficient of friction determined with an inclined plane apparatus (such as an inclinometer) according to ASTM D4518-91, titled “Standard Test Methods for Measuring Static Friction of Coating Surfaces.” Static friction is the force that holds back a stationary object up to the point that it just starts moving. Thus, the COF concerns the force restricting the movement of the stationary object with a relatively smooth, hard surface, such as a polished metal surface, resting on a coating layer. The inclined plane apparatus consists of a horizontal stationary plate rigidly mounted to a hinged incline plate attached to an actuator. Movement of the actuator arm permits adjustable inclined planes of up to 90°. A dry thin coating layer (less than about 0.01 inch in thickness) is formed on the hinged plane resting at 0° (in a horizontal position). At ambient temperature, a 2" x 1.5" x 1.5" polished aluminum block of 194.49 g is placed on the coating layer, and the hinged plate moves slowly to raise the incline gradually from 0°, until the aluminum block just starts to slide. The angle of friction at that inclined position, also referred to as slide angle and angle of sippage, is recorded. This procedure is repeated ten (10) times to provide an averaged angle of friction 0. The COF is numerically equivalent to the tangent of this angle of friction: $\tan \theta = \frac{\Delta \theta}{\Delta D}$.

[0024] Typically, a suitable free-radical initiator is used to begin the polymerization process of forming the particles in the one-component systems. The initiator may be a compound or a mixture of compounds, including thermal initiators and photoinitiators. Thermal initiators are preferably organic peroxides or azo compounds, such as di(4-amy1)peroxide, di(n-butyl) peroxide, dicumyl peroxide, lauryl peroxide, benzoyl peroxide, di[(2-t-buty1peroxy-isopropyl)-benzene peroxide, 1,1-bis[(t-buty1peroxy)-3,5-trimethylcyclohexane, 2,5-di(t-buty1peroxy)-2,5-dimethylhexane, n-buty1-4,4-bis(t-buty1peroxy)vulate, t-buty1 hydroperoxide, and the like. Photoinitiators include ultraviolet (“UV”) photoinitiators such as benzophenones, visible-light photoinitiators, or combinations of two or more thereof. The compound-based initiators may be present in an amount greater than about 0.1 parts per hundred of the total resin, preferably about 0.1 to about 15 parts, and more preferably about 0.2 to about 5 parts. The initiator may also be one or more energy means, such as heating, electron beam irradiation, x-ray irradiation, y-ray irradiation, UV light irradiation, visible light irradiation, infrared light irradiation, microwave irradiation, or any other high-energy radiation sources.
capable of generating reactive free radicals. Curing and subsequent formation of the coating is further facilitated by evaporation of the solvent(s) and/or addition of a curing agent.

Two-component systems form a coating through a polymerization reaction of primary reactants upon mixing, optionally accompanied or followed by evaporation of the solvent(s). Coatings formed from two-component systems are generally preferred because of good cure at ordinary temperatures, formation of strong and stable linkages, and flexibility in choices of reactants. These characteristics makes the coatings resistant to water and chemical attacks, superior in strength and durability, and allows a high degree of freedom in designing the coating with desired physical, chemical, and optical properties.

Preferably, the coating composition of the present invention is a thermoset polyurethane system contains a component A and a component B reactive to each other. Component A comprises a polymer having at least one isocyanate-reactive functionality, such as a polyl, and optionally one or more isocyanate-reactive modifiers. Preferred polyls include polyols, polyanimes, polymer precursors, or mixtures of two or more thereof. Non-limiting examples of polyls include acrylic polyls, polyester polyls, polyether polyls, polyolefin polyls, polycarbonate polyls, polyamide polyls, amino alcohols, short oil alkyds, epoxy resins with secondary hydroxy groups, phenoxy resins, and polyvinyl polyls. Vinyl resins may be used preferably to promote adhesion. Polynimes precursors include radiation-curable monomers, oligomers, and polymers, such as acrylates, methacrylates, epoxies, and combinations of two or more thereof. Polyanimes and other polyls disclosed herein for various golf ball portions are also suitable for the coating layer.

Reactive component B comprises at least one isocyanate. Any isocyanate available to one of ordinary skill in the art is suitable for use according to the invention. The isocyanate may be organic, modified organic, saturated, aliphatic, cyclic, unsaturated, alicyclic, aromatic, substituted, or unsubstituted isocyanate or polyisocyanate monomers having two or more free reactive isocyanate ("NCN") groups; isomers thereof; modified derivatives thereof; dimers thereof; trimers thereof; or isocyanurates thereof. The isocyanate may also include any isocyanate-terminated multimeric adducts, oligomers, polymers, prepolymer, low-free-monomer prepolymer, quasi-prepolymer, and modified polyisocyanates derived from the isocyanates and polyisocyanates above. Low-free-monomer prepolymer refers to prepolymer having free isocyanate monomer levels less than about 0.5 weight percent.

In addition to the free reactive isocyanate groups, the suitable isocyanate further comprises at least one cyclic, aromatic, aliphatic, linear, branched, or substituted hydrocarbon moiety containing from 1 to about 20 carbon atoms, such as arenes, aralkyls, alcanes, or cycloalkanes. When multiple cyclic or aromatic groups are present, linear, branched or substituted hydrocarbons containing from 1 to about 10 carbon atoms can be present as spacers between such cyclic or aromatic groups. In some cases, the cyclic or aromatic group(s) may be substituted at the 2-(ortho-), 3-(meta-), and/or 4-(para-) positions. Substituted groups may include, but are not limited to, halogens, cyano groups, amine groups, silyl groups, hydroxyl groups, acid groups, alkoxy groups, primary or tertiary hydrocarbon groups, or a combination of two or more groups thereof. Any and all of the isocyanates disclosed herein may be used alone or in combination of two or more thereof.

Preferred isocyanates include diisocyanates (having two NCO groups per molecule), dimerized biurets or uretdiones thereof, trimerized isocyanurates thereof, and polyisocyanates such as monomeric trisocyanates. Exemplary diisocyanates include, but are not limited to, unsaturated isocyanates such as: p-phenylene diisocyanate ("p-PDII"); m-phenylene diisocyanate ("m-PDII"); o-phenylene diisocyanate ("o-PDII"); 2-(ortho-), 3-(meta-) and/or 4-(para-) positions. Substituted groups may include, but are not limited to, halogens, cyano groups, amine groups, silyl groups, hydroxyl groups, acid groups, alkoxy groups, primary or secondary or tertiary hydrocarbon groups, or a combination of two or more groups thereof. Any and all of the isocyanates disclosed herein may be used alone or in combination of two or more thereof.
prepolymers having at least two free reactive isocyanate groups as terminal groups, and optionally more pendant isocyanate groups, on the oligomeric or polymeric backbones. Isocyanate-terminated prepolymer and quasi-prepolymers are well known to the skilled artisan, and include, but are not limited to, the reaction products of any one or combination of two or more of the isocyanates listed above and any one or combination of two or more of the polyols disclosed herein.

[0033] Among the above-listed isocyanates, all of the saturated isocyanates display satisfactory light stability when used in golf ball cover layers, and are most preferred in the coating compositions of the present invention. Particular isocyanates such as biurets and isocyanurate trimers of hexamethylene diisocyanate may further enhance adhesion and abrasion resistance of the coating layer. Other relatively light-stable isocyanates include some of the unsaturated isocyanates, particularly those that are aromatic, including 1,2-, 1,3-, and 1,4-xylene diisocyanates, m-tetramethylxyylene diisocyanate, p-tetramethylxyylene diisocyanate, ureidolines of toluene diisocyanates, isocyanurates of toluene diisocyanates, and isocyanurates of diphenylmethane diisocyanates.

[0034] In a preferred embodiment, the coating layer is formed from a two-component polyurethane system in a single- or multi-solvent dispersion having a medium to high solid content, with the percentage of solids by weight being greater than about 40% and by volume being greater than about 30%. The polyurethane coatings may be based on water, non-aqueous solvents, or combinations thereof. Non-aqueous systems typically employ relatively high concentrations of one or more organic solvents; water is generally excluded from the reaction environment. Organic solvents are expensive, hazardous (toxic and flammable), and undesirable especially for large-scale production. Therefore, water-borne coating systems are generally preferred.

[0035] Two-component, water-based polyurethane systems are preferably water-reducible in that the addition of water does not increase the tendency of foaming of the coating. Such a coating layer may eliminate the need for a primer coat or an adhesion promoting layer. Specific forms of aqueous coatings are aqueous solutions, emulsions, and colloidal dispersions. In the aqueous solution (of resin), the resin used has a hydrophilic functional group; a curing agent is used except when the resin is a particular alkyd resin; and heating and drying at high temperatures is necessary. In the emulsion and colloidal dispersion, ions, hydrophilic polymers, and low-molecular emulsifiers are adsorbed or absorbed onto a hydrophobic polyurethane; the coating film formed has excellent water resistance and durability. For ease of processing, the coating system may have a pot life of at least about 30 minutes, preferably about 2 hours, and a curing temperature of about 25°C to about 90°C. To achieve desirable impact resistance, abrasion resistance, and the like, the coating layer is preferably thermostet, formed from a reactive liquid material.

[0036] Suitable coating systems of the present invention may be based on monomers and/or oligomers of acrylate, methacrylate, water/solvent-based polyurethane, epoxies, or combinations thereof. Weight percentage of the reactive monomers and/or oligomers may range from about 5% to about 95% of the total coating composition. Combinations of mono- and/or multi-functional monomers and/or oligomers are desirable for highly crosslinked coatings. Besides the initiators for the polymerization reaction, the coating layers may further incorporate additional reactants and additives known to one of ordinary skill in the art as being useful in other golf ball portions, such as the cover, the core, and the intermediate layer(s). For example, crosslinkers such as polyfunctional aziridines may be used in an amount of about 10% or less by weight of the total composition to promote adhesion to the substrate layer. UV absorbers, hindered amine light stabilizers, antioxidants, and optical brighteners can be used alone or in combination of two or more thereof, in an amount of less than about 5% by weight, to improve light stability and enhance aesthetic appeal. Other suitable reactants and additives include, without limitation, olefins, acrylates, acrylics, polysiloxanes, curing agents, catalysts, hardeners, thickeners, pigments, and other modifying agents, incorporated in appropriate amounts to achieve their desired effects. Colorants, including tints and pigments, when present, are preferably white, but may be any other visible color, or even fluorescent.

[0037] To improve uniformity, abrasion resistance, and/or weatherability of the coating layer, one or more fillers are selectively blended into the coating composition. Suitable fillers include silica, clay, calcium carbonate, and other finely powered inorganic fillers. Fillers such as ZnO and TiO2 are preferred because they reflect the harmful UV light, and enhance light stability of the coating. Certain fillers exhibit high viscosity at low shear force, capable of preventing the coating from creeping around the dimples. Other fillers are particularly effective in enhancing abrasion resistance of the coating layer, such as colloidal silica, which refers to silica in a single- or multi-solvent dispersion. The silica may be small spherical particles about 1 nm to about 200 nm in diameter, preferably about 50 nm to about 100 nm. Such nano-sized silica particles have refractive indices particularly suitable for clear coatings; they pose limited scattering or interference to light transmission. The solvent is water for water-reducible coating systems, or one or more monomers or oligomers of ketones or alcohols for dual cure systems that use a combination of two or more curing means (e.g., heating and UV irradiation). Suitable colloidal silica is either untreated or surface-pretreated, such as Cab-O-Sil® by Cabot Corp. of Tuscola, Ill., Nynas® 2040 by Nano Technologies of Ashland, Mass., Hylux® OC by Clariant Corporation of Charlotte, N.C., and Snowtex® by Nissan Chemical Industries of Tokyo, Japan. The colloidal silica is typically present in the coating material in an amount of at least about 5 weight percent of the coating composition, preferably about 5 to about 80 weight percent, more preferably about 10 to about 60 weight percent, and most preferably about 15 to about 30 weight percent. Colloidal silica is distinct from solid silica such as hydrous siliceous acid and siliceous anhydride. One or more organic or inorganic hard materials capable of being triturated may be optionally incorporated into the colloidal silica. The hard material preferably has a Mohs hardness of at least about 5, and can be bound to the coating matrix through a coupling reaction. Suitable hard materials include, but are not limited to, silicates and oxides such as MgO, ZnO, or zirconium oxide. The hard particles, when present, are in an amount of about 2 to about 25 weight percent of the coating, in addition to the colloidal silica.
An optional coupling agent may be used to bond the filler to the polymer matrix of the coating layer, to integrate the filler and keep it from sedimentation, and to promote adhesion and dispersion. Coupling agents are compounds having at least a first functionality linkable to the filler particle, and at least a second functionality linkable to the coating matrix or a reactive component therein. The first functional group includes hydroxy, phenoxy, hydroxy ether, silane, or aminoplast moieties. The second functional group includes hydroxy, isocyanate, carboxyl, epoxy, amine, urea, vinyl, amino, aminoplast, or silane moieties. The coupling agent preferably has a polyvalent backbone comprising one or more silicone or phosphorus moieties and alkyl groups having 1 to about 12 carbon atoms. Suitable coupling agents may be oligomeric or polymeric acrylates, polyesters, polyethers, polyurethanes, polyamides, epoxies, alkyds, or combinations of two or more thereof. Weight ratio of the coupling agent to the filler can be any amount that will result in the formation of a suitable abrasion resistant coating on a golf ball, preferably about 1:1 to about 1:90, more preferably about 1:1 to about 1:40, and most preferably about 1:6 to about 1:12. The weight ratio of colloidal silica/coupling agent combo to the resin/curable combo is preferably about 1:1 to about 1:50, more preferably about 1:1 to about 1:10, and most preferably about 1:4 to about 1:8.

Suitable coupling agents include silane coupling agents such as amine-functional silanes and acryloxy-functional silanes, carbamate-functional coupling agents, chromates, titanates, zirconium, zirconium silanolate, polymeric coupling agents, and combinations of two or more thereof. Preferred silane coupling agents have the formula Y(CH_{2})_{n}SiX_{3}, where Y is an organofunctional group (e.g., a substituted or unsubstituted aryl, alky or carboxylic group) bonding the polymer matrix to the central silicon atom via the stable (CH_{2})_{n} carbon chain, and X is a silicon-functional or alkoxyl group (e.g., OCH_{3}, OCH_{2}H_{2}, OC_{2}H_{2}OCH_{3}) that hydrolyzes and subsequently reacts with active sites on inorganic surfaces. Exemplary silane coupling agents include Silquest® A-174, A-1250, A-171, A-187, A-189, and A-1100 by OSI Specialties, Danbury, Conn., and silanes Z-6011, Z-6020, Z-6030, and Z-6040 by Dow Corning Corporation of Midland, Mich. Titanate coupling agents include, for example, monoalcohol titanate compounds, chlorotitanate compounds, acetyl titanate compounds, chlorotitanate compounds, neooxyl titanate compounds, cyclohexaetetram titanate compounds, and those available from Du Pont Company of Wilmington, Del. Zirconium coupling agents include, for example, zircoaluminate, zirconium propionate, neooxyl zirconate, ammonium zirconium carbonate, and those available from Magnesium Elektron, Inc. of Flemingston, N.J. Zircoaluminate coupling agents have both an aluminum and a zirconium functional group in addition to an organic functionality. Most preferable coupling agents for the present invention are silane coupling agents, including aminosilanes, mercaptosilanes, glycicylxylosilanes, epoxysilanes, methacryloxylosilanes, vinylsilanes, alkoxylxylosilanes oligomers, nionic silane dispersing agents, octyltrithoxysilane, methyltrithoxysilane, methyltrimethoxysilane, vinyltrithoxysilane, vinyltrimethoxysilane, vinyltris(2-methoxyethoxy)silane, γ-metacryloxypropyltrimethoxysilane, β-(3,4-epoxycyclohexyl)-ethyltrithoxysilane, γ-glycidoxypropyltrimethoxysilane, γ-mercaptopropyltrimethoxysilane, γ-aminopropyltrithoxysilane, aminoalkyl silicone solutions, modified aminoorganosilane, γ-aminopropyltrimethoxysilane, modified aminooorganosilane, β-(aminoethyl)-γ-aminopropyltrimethoxysilane, modified aminosilanes, triaminofunctional silanes, aminofunctional silanes, polyazamide silanes, γ-ureidopropyltriethoxysilane, isocyanato-functional silanes; and mixtures thereof.

The coating layer of the present invention may be a clear or pigmented primer or topcoat, or a single layer combining the properties of both, formed onto a damped cover layer or outer cover layer through any methods known to one of ordinary skill in the art. The formulations are generally applied in a fluid form, providing a very thin coating layer, about 0.0001 inches to about 0.01 inches, about the outer cover layer. Preferably, the thickness of the coating layer is about 0.001 inches to about 0.01 inches; more preferably, about 0.002 inches to about 0.005 inches. The amount of coating applied to a standard-sized golf ball of at least 1.68-inch in diameter is about 0.01 grams to about 1 grams. Specific application techniques useful to form the coating layer include casting, spraying, dipping, spin coating, electrostatic coating, flow coating, and others known to the skilled in the art. The coating layer may also be applied in a laminate form or by any other techniques known in the art. Preferred methods of applying the coating and reaction/coating conditions may vary with material compositions, but are well known to one of ordinary skill in the art. For instance, the curing temperature for the coating compositions of the present invention are preferably less than about 80°C, more preferably less than about 60°C, and most preferably about 0°C, to about 50°C.

The coating compositions of the present invention and their application in golf balls are further illustrated in the following non-limiting examples. Table I tabulates several polyurethane-based coating compositions provided by PPG Industries of Pittsburgh, Pa., with their respective averaged angles of friction (0) and COF calculated therefrom.

<table>
<thead>
<tr>
<th>Coating Composition</th>
<th>Averaged 0</th>
<th>COF 60° C</th>
<th>Friction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (S24903)</td>
<td>31°</td>
<td>0.6</td>
<td>90</td>
</tr>
<tr>
<td>A (SB302-66A)</td>
<td>39°</td>
<td>0.81</td>
<td>4</td>
</tr>
<tr>
<td>B (SB302-66B)</td>
<td>51°</td>
<td>1.23</td>
<td>90</td>
</tr>
<tr>
<td>C (SB302-66C)</td>
<td>40°</td>
<td>0.84</td>
<td>6</td>
</tr>
<tr>
<td>D (SB302-66D)</td>
<td>51°</td>
<td>1.23</td>
<td>87</td>
</tr>
<tr>
<td>E (SB302-66E)</td>
<td>48°</td>
<td>1.11</td>
<td>56</td>
</tr>
</tbody>
</table>

Experimental coating layers of the present invention, with a thickness of about 0.001 inch to about 0.005 inch, is applied on golf balls commercially available from Acushnet Company of Fairhaven, Mass. The golf balls comprise a solid polybutadiene core of about 1.59 inches in diameter and a Surlyn® ionomer-based cover layer of about 0.045 inch thick. Example groups Control and A through E used coating compositions Control and A through E of Table I, respectively. Averaged spin rates and corresponding launch angles of the example groups, each having at least 9 golf balls, are tested with a standard driver at a speed of about 160 ft/sec, a full wedge at a speed of about 95 ft/sec, and a half wedge at a speed of about 55 ft/sec. Results of these tests are listed in Table II below.
TABLE II

<table>
<thead>
<tr>
<th>Example</th>
<th>Driver Spin (rpm)</th>
<th>Full Wedge Spin (rpm)</th>
<th>Half Wedge Spin (rpm)</th>
<th>Stimp Meter Launch Angle (°)</th>
<th>Roll on Carpet (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2644/9.6</td>
<td>9370/25</td>
<td>5901/33</td>
<td>212.62</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2840/9.3</td>
<td>4121/32</td>
<td>2605/41</td>
<td>206.79</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2839/9.2</td>
<td>8559/26</td>
<td>5242/35</td>
<td>206.79</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2923/31.1</td>
<td>4060/52</td>
<td>2508/41</td>
<td>208.29</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2741/39.4</td>
<td>8054/27</td>
<td>4889/36</td>
<td>209.50</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>2618/9.6</td>
<td>6311/29</td>
<td>4348/37</td>
<td>209.04</td>
<td></td>
</tr>
</tbody>
</table>

[0043] While example groups A through E are all coated with a high COF coating layer, their roll distances on carpet are about the same as the control group. None of the high COF coating compositions A through B alter the driver spin or the associated launch angle by more than 15%. The largest increase in driver spin rate, as observed in example group C in comparison with the control group, is less than 11%. However, the same high COF coating compositions consistently influence the spin rates and corresponding launch angles of the example golf balls off the full wedge and the half wedge. Specifically, the full wedge and half wedge spin rates of groups A through E are reduced comparing to the control group, while the full wedge and half wedge launch angles are elevated at the same time. The high COF coating layer of the present invention preferably reduces the golf ball's full wedge spin rate and/or half wedge spin rate by at least about 5%, more preferably by at least about 10%, and most preferably about 15% to about 80%. Relatively small effects of the high COF coating layer are observed in example group B, which shows a spin reduction of about 8% and a launch angle elevation of about 1° when struck with a full wedge, and a spin reduction of about 13% and a launch angle elevation of about 2° when struck with a half wedge. Relatively large effects of high COF coating layer are observed in example group C, which shows a spin reduction of about 57% and a launch angle elevation of about 7° when struck with a full wedge, and a spin reduction of about 58% and a launch angle elevation of about 8° when struck with a half wedge. These empirical data seem to indicate the presence of an optimal COF value at which the spin reduction and the launch angle elevation are maximized. This optimal COF appears to lie somewhere between 0.8 and 1.

[0044] The coating layer of the present invention is relatively soft but durable, suitable for applications in sporting equipment in general. Preferably, the coating layer is used on golf equipment, including, but not limited to, golf balls; golf clubs (i.e., putters, drivers, and wedges) and club attachments, additions, or modifications, such as striking face inserts, back cavity of an iron-type club, crown or sole of a metal wood-type club; golf club components (i.e., shafts, hosels, and grips); golf club vibration damping devices; golf gloves and portions thereof, such as glove liners, securing methods, patches, and reinforcements; golf shoes and associated components (i.e., soles, toe-socks, spike socket spines, heel counters, toe “puffs,” uppers, soles, midsoles, outsoles, liners, and plastic golf spikes); golf bags and their associated framework, support legs, and stands; and any portion of the above items. When used on an outermost surface of a golf ball or a club face, substantially all of the coating layer remains adhered thereto after repeated impact between the golf ball and the club face, preferably at least about 90 weight percent remains, more preferably at least about 95 weight percent, and most preferably at least about 99 weight percent.

[0045] Golf balls of the present invention may have a variety of constructions, comprising at least a core, a cover, and one or more optional intermediate layers disposed between the core and the cover. The core may be a single solid mass, or include a center and one or more outer core layers. The center may further be solid, liquid-filled, gel-filled, or gas-filled. The cover may include an outer cover layer and, optionally, one or more inner cover layers. Any of the outer core layers, the intermediate layers, or the inner cover layers may be a continuous layer, a discontinuous layer, a wound layer, a molded layer, a lattice network layer, a web or net, an adhesion or coupling layer, a barrier layer, a layer of uniformed or non-uniformed thickness, a layer having a plurality of discrete elements such as islands or protrusions, a solid layer, a metallic layer, a liquid-filled layer, a gas-filled layer, or a foamed layer.

[0046] The coating layer as described above is preferably disposed on or about a golf ball cover. The cover may comprise a single layer, or an outer cover layer and one or more inner cover layer(s). The cover layer, particularly the outer cover layer, of the present invention may comprise about 1 weight percent to about 100 weight percent, preferably about 5 weight percent to about 95 weight percent, of an ethylene/α-olefin copolymer, a grafted or non-grafted metalloocene-catalyzed polymer, or a thermoplastic or thermoset reaction product.

[0047] The reaction product is preferably formed from a liquid reactive material. More preferably, the reaction product is a polyurethane, polyurea, or polyurethane/polyurea hybrid comprising a polyol, an isocyanate, and an optional curing agent. The polyols are preferably incorporated into one or more soft segments of the reaction product. Suitable polyols such as polyols and polyamines are organic, modified organic, saturated, aliphatic, alicyclic, unsaturated, aromatic, substituted, unsubstituted, or ionic, having two or more reactive hydrogen groups per molecule, such as primary or secondary hydroxy groups or amine groups. The isocyanate-reactive hydroxy and/or amine groups may be terminal or pendant groups on the oligomeric or polymeric backbone, and in the case of secondary amine groups, may even be embedded within the backbone.

[0048] Any isocyanate available to one of ordinary skill in the art is suitable for use according to the invention. The isocyanate may be organic, modified organic, saturated, aliphatic, alicyclic, unsaturated, aliphatic, aromatic, substituted, or unsubstituted disocyanate or polyisocyanate monomers having two or more free reactive isocyanate (“NCO”) groups; isomers thereof; modified derivatives thereof; dimers thereof; trimers thereof; or isocyanurates thereof. The isocyanate may also include any isocyanatederminated multimeric adducts, oligomers, polymers, prepolymers, low-free-monomer prepolymers, quasi-prepolymers, and modified polyisocyanates derived from the isocyanates and polyisocyanates above. Low-free-monomer polymers refer to prepolymers having free isocyanate monomer levels less than about 0.5 weight percent. Curing agents are monomeric, oligomeric, or polymeric compounds used in
cover compositions for chain-extension and/or crosslink. Suitable curing agents for the invention include polyols and epoxides, preferably hydroxy curatives, amine curatives, and amino alcohol curatives having a molecular weight of about 50 to about 5,000.

[0049] For best light stability, all reactants in the polyurethane or polyurea compositions, including the polyol(s), the isocyanate(s), and the curing agent(s) are substantially saturated. A hindered secondary diamine having a high level of steric hindrance may be used to beneficially slow down the curing process. A variety of additives can optionally be incorporated into the cover layer compositions of the present invention in amounts sufficient to achieve their specific purposes and desired effects. Suitable additives include, but are not limited to, catalysts such as dibutyltin dilaurate, UV absorbers, hindered amine light stabilizers, antioxidants, accelerators, fillers, viscosity modifiers, release agents, plasticizers, compatibilizing agents, coupling agents, dispersing agents, colorants including pigments and dyes, optical brighteners, surfactants, lubricants, stabilizers, metals, processing aids or oils, blowing agents, freezing point depressants, and any other modifying agents known to one of ordinary skill in the art.

[0050] Other cover useful materials for the present invention include:

[0051] 1) Non-ionomeric acid polymers, such as copolymers E/Y of an olefin E having 2 to 8 carbon atoms and a carboxylic acid Y having 3 to 8 carbon atoms, or terpolymers E/X/Y having an additional softening comonomer X. The olefin E is preferably ethylene, and the acid Y includes acrylic, methacrylic, crotonic, maleic, fumaric, or itaconic acid. The comonomer X includes vinyl esters of aliphatic carboxylic acids having 2 to 10 carbon atoms, and alkyl ethers, alkyl acrylates, or alkyl alkylacrylates of alkyl groups having 1 to 10 carbon atoms. Depending on the acid content by weight, the polymer may be referred to as low-acid (about 2% to less than 10%), medium-acid (about 10% to less than 16%), and high-acid (about 16% to about 50%). The comonomer, when present, may be in an amount of about 2% to about 40% by weight of the acid polymer. Preferred non-ionomeric acid polymers include Nucrel® from E. I. DuPont de Nemours & Company and Escore® from ExxonMobil.

[0052] 2) Anionic and cationic ionomers such as the acid polymers above partially or fully neutralized with organic or inorganic cations, such as zinc, sodium, lithium, magnesium, potassium, calcium, manganese, nickel, ammonium (primary, secondary, tertiary), or the like. The extent of saturation ranges from about 5% to about 110%, preferably at least about 50%, more preferably at least about 70%. Preferred acid ionomers include Surlyn® from E. I. DuPont de Nemours & Company and Iotek® from ExxonMobil.

[0053] 3) Thermoplastic or thermoset (vulcanized) synthetic or natural rubbers, including polyolefins and copolymers or blends thereof, such as butyl, polychloroprene, polybutylenes, isoprene rubber, ethylene-propylene rubber, ethylene-butylene rubber, ethylene-propylene diene terpolymers, natural rubber, polyisoprene and polybutadiene copolymers, poly(styrene-co-maleic anhydride), acrylonitrile-butadiene-styrene copolymers, poly(styrene sulfonate); and homopolymers or copolymers produced using single-site catalyst such as metallocene (grafted or non-grafted).

[0054] 4) Polyphenylene oxide resins, polyarylene ethers, or blends of polyphenylene oxide with high impact poly(styrene such as Noryl® from General Electric Company.

[0055] 5) Thermoplastics, including polyesters, such as ethylene methylacrylate, ethylene ethylacrylate, ethylene vinyl acetate, poly(ethylene terephthalate), poly(butylene terephthalate), poly(propylene terephthalate), poly(trimethylene terephthalate), modified poly(ethylene terephthalate)/glycol, poly(ethylene naphthalate), cellulose esters, Hytrel® from E. I. DuPont de Nemours & Company, and Lomod® from General Electric Company; polycarbonates; polycetals; polyimides; polyetherketones; polyamides; thermoplastic block copolymers (Kraton® rubbers from Shell Chemical); and co-polycrystalline (Peax® from AtoFina); and elastomers in general.

[0056] 6) Vinyl resins such as polyvinyl alcohol, polyvinyl alcohol copolymers, polyvinyl chloride, block copolymers of alkyl aromatic vinyl polymers with vinyl aromatics and polyolefin, copolymers of vinyl chloride with vinyl acetate, acrylic esters or vinylidene chloride.

[0057] 7) Polyamides such as poly(hexamethylene adipamide) and others prepared from diamines, fatty acids, dibasic acids, and amino acids (poly(caprolactam)), and blends of polyamides with Surlyn®, ethylene homopolymers or copolymers or terpolymers, etc.

[0058] 8) Acrylic resins and blends of these resins with polyvinyl chloride or other elastomers.

[0059] 9) Blends and alloys, including blends of polycarbonate and acrylonitrile-butadiene-styrene, blends of polyethylene and polyurethane, blends of polyvinyl chloride, acrylonitrile-butadiene-styrene or ethylene vinyl acetate or other elastomers, blends of thermoplastic rubbers with polyethylene or polypropylene.

[0060] The cover layer preferably has a flexural modulus of at least about 2,000 psi, a material hardness between about 20 Shore D and about 75 Shore D, and a hardness as measured on the ball of less than about 80 Shore D. In one embodiment, the cover layer has a Shore D hardness of about 30 to about 60 and a flexural modulus of about 10,000 psi to about 80,000 psi. A thin cover layer with a thickness of about 0.01 inches to about 0.04 inches is preferred for players with high swing speeds, while a relatively thick cover layer of greater than 0.04 inches to about 0.08 inch, more preferably about 0.05 inches to about 0.10 inch, is preferred for players with moderate swing speeds. In a preferred embodiment, the cover thickness is 0.03 inches or less.

[0061] While it is preferred that the golf ball be encapsulated in a coating layer as described above, it is possible to have a golf ball without the coating layer. In this embodiment, the outermost surface of the golf ball is comprised of a cover material having the desired high COF and other properties as the coating layer described above. This outermost surface may be the outer surface of a single-layered cover, or the outer surface of an outer cover layer in a golf ball cover that comprises the outer cover layer and one or more inner cover layers.
Any method known to one of ordinary skill in the art may be used to produce the cover layer of the present invention. One-shot method involving concurrent mixing of the isocyanate, the polyether polyol, and the curing agent is feasible, but the resulting mixture is non-homogeneous and difficult to control. The prepolymer method described above is most preferred, because it affords a more homogeneous mixture resulting in a more consistent polymer composition. The prepolymer may be reacted with a diol or a secondary diamine to form a thermoplastic material, or reacted with a triol, tetraol, primary diamine, triamine, or tetramine to form a thermoset material. Other methods suitable for forming the layers include casting, compression molding, reaction injection molding ("RIM"), liquid injection molding ("LIM"), injection-compression molding, pre-reacting the components to form an injection moldable thermoplastic material and then injection molding, and combinations thereof, such as RIM/compression molding, injection/compression molding, progressive compression molding, and the like. Thermoplastic formulations may be processed using any number of compression or injection molding techniques. Thermoset formulations may be castable, reaction injection moldable, sprayable, or applied in a laminate form or by any techniques known in the art. Castable reactive liquid materials such as polyurea, polyurethane, and polyurethane/polyurea hybrid can provide very thin layers such as outer cover layers that are desirable on golf balls. Other techniques include spraying, dipping, spin coating, or flow coating methods.

An optional intermediate layer may be disposed between the core and the core, preferably between the cover and the optional barrier layer. The intermediate layer may be part of the core as an inner cover layer, formed from non-ionic acid polymers or ionic polymer derivatives thereof, polyamides, polyolefins, polyurethanes, polyureas, epoxies, polyesters, polyetheresters such as Hytrek® from DuPont, polyetheramides such as Perlas® from Atofina, nylon, metal-melamine-catalyzed polymers, styrenic block copolymers such as Kraton® from Shell Chemicals, acrylonitrile-butadiene-styrene copolymers ("ABS"), polyvinyl chlorides, polyvinyl alcohol polymers, polycarbonates, polycarbonateamides, polyanamides, polyimides, polyetherketones, polyamideimides, silicones, metal salts of fatty acids, and combinations thereof, such as blends of polycarbonate and acrylonitrile-butadiene-styrene, blends of polycarbonate and polyurethane. Two or more of these materials may be blended together to form the intermediate layer.

The intermediate layer may incorporate a modulus-enhancing filler or a density-modifying filler to attain preferred physical and mechanical properties. The composition of the intermediate layer may have a modulus of about 2,000 psi to about 150,000 psi, a material hardness of about 60 Shore C to about 80 Shore D, and a thickness of about 0.005 inches to about 0.6 inch. The composition of the intermediate layer may be applied as a liquid, powder, dispersion, lacquer, paste, gel, melt, or solid half shells. The intermediate layer may be formed around the core or the inside of the cover by sheet stock or vacuum shrink-wrapping, compression molding, injection molding, vacuum deposition, RIM, lamination, casting, spraying, dipping, powder coating, or any other deposition means. Preferably, a combination of these methods is used, such as injection/compression molding, RIM/compression molding, pre-form/compression molding, injection molding/grinding, injection/progressive compression molding, co-injection molding, or simplified casting of a single block material.

The golf ball core is preferably solid and made from any suitable core materials including thermosets such as natural rubber, polybutadiene, polyisoprene, styrene-butadiene or styrene-propylene-diene rubber, and thermoplastics such as ionomer resins, polyamides, polyesters, or a thermoplastic elastomer. The core can also be formed from a castable material such as polyurethanes, polyureas, epoxies, silicones, etc. Preferred compositions for solid cores include a base rubber, a crosslinking agent, and an initiator. A preferred base rubber is 1,4-polybutadiene having a cis-bond of at least about 40%, a Mooney viscosity of at least 50, a molecular weight of at least about 150,000, and a polydispersity of less than about 4. Examples of desirable polybutadiene rubbers include Bruna® CB22 and CB23 from Bayer, Ubepol® 360L and 150L from Ube Industries, Carliflex® BCP820 and BCP824 from Shell Chemical, and Kinetix® 7245 and 7265 from Goodyear. Blends of two or more such polybutadienes are desirable for the solid cores. In one embodiment, a cobalt or nickel catalyzed polybutadiene having a Mooney viscosity of from about 50 to about 150 is mixed with a neodymium catalyzed polybutadiene having a Mooney viscosity of from about 30 to about 100. The weight ratio between the two polybutadienes may range between about 5:95 and 95:5. The polybutadiene can also be mixed with other elastomers known in the art, such as natural rubber, polyisoprene rubber and/or styrene-butadiene rubber, in order to modify the properties of the core.

Suitable cross-linking agents for the polybutadiene-based solid cores include metal salts of unsaturated fatty acid having 3 to 8 carbon atoms, such as zinc diacrylate, zinc dimethacrylate, and blends thereof. The crosslinking agent is typically present in an amount of about 15 parts to about 60 parts per 100 parts by weight of the base polymer. The initiator includes organic peroxide compounds, such as dicumyl peroxide, and azo initiators. The initiators are present in an amount of about 0.5 parts to about 2.5 parts per 100 parts by weight of the base polymer. A halogenated organosulfur compound such as pentachlorothiophenol ("PCTP") or ZnPCTP is blended into the base polymer to further enhance the softness and resiliency of the core. The halogenated organosulfur compound is present in an amount of about 0.1 part to about 2 parts, or alternatively, about 2 parts to about 5 parts per 100 parts by weight of the base polymer. The solid core may also include fillers such as tungsten powder and zinc oxide to adjust hardness, strength, modulus, weight, density and/or specific gravity of the core. Other optional additives include antioxidants, accelerators, processing aids or oils, cis-to-trans catalysts, coupling agents, stable free radicals, radical scavengers, scorch retarders, and blends thereof, used in amounts sufficient to achieve their specific purposes and desired effects.

The core of the golf ball of the present invention has a diameter of at least about 0.5 inch. In one embodiment, the core diameter is at least about 1.0 inch, more preferably from about 1.5 inches to about 1.65 inches, and most preferably from about 1.55 inches to about 1.6 inches. The core may have a compression of from about 20 to about 120, more preferably from about 30 to about 100, and most preferably from about 40 to about 80. Alternatively, the core...
may be very soft, with a compression of less than about 20. The core should also be highly resilient, having a COR of at least about 0.75, preferably at least about 0.8. Conventional methods and techniques may be used to form the solid cores from the base compositions disclosed herein.

[0068] The golf ball of the present invention as described above preferably has a COR of greater than about 0.79, a compression of less than about 110, and a deflection at 100 kg of greater than about 1.5 mm. The golf ball preferably has an overall diameter of at least about 1.68 inches, more preferably from about 1.68 inches to about 1.76 inches. At least 60% of the outermost surface of the golf ball is covered by about 250 to about 450 dimples of equal or different shape and size. Preferred dimple patterns involving catenary curves, and preferred lift and drag characteristics of the golf ball of the present invention are disclosed in co-pending U.S. application Ser. Nos. 09/898,191 and 10/096,852, respectively, both incorporated herein by reference in their entirety.

[0069] Preferred golf ball constructions for the present invention include a core, a cover, and a coating layer disclosed herein disposed onto the cover. The core is a one-piece solid sphere formed of a polybutadiene or a blend of two or more polybutadienes with Mooney viscosity of greater than about 35, an initiator, and a ZDA level of about 15 phr or greater. Alternatively, the core is a dual core formed of a center and an outer core layer disposed about the center. The center includes a polybutadiene or a blend of two or more polybutadienes with Mooney viscosity of greater than about 35, an initiator, and a ZDA level of about 15 phr to about 40 phr. The core may further incorporate a regrind or filler such as tungsten metal powder. The center has a diameter of about 0.5 inches to about 1.6 inches. The outer core layer includes a polybutadiene or a blend of two or more polybutadienes with Mooney viscosity of greater than about 35, an initiator, and a ZDA level of about 25 phr to about 55 phr. The outer core layer may further incorporate a regrind, a polyisoprene such as butyl, or a filler such as tungsten metal powder. Optionally, the single-piece core, the center, or the outer core layer can incorporate ZnPCTP. The core has a diameter of less than about 1.64 inches, preferably about 1.5 inches to about 1.6 inches, more preferably about 1.55 inches to about 1.59 inches. The core has a compression of less than about 100, preferably about 20 to about 80, more preferably about 30 to about 70. The core also has a specific gravity of less than about 1.4 g/cm³, a deflection at 100 kg of greater than about 1.5 mm, and a COR of greater than about 0.75. An optional barrier layer with a MVTR of less than that of a Surlyn® by DuPont may be applied over the core. The cover is formed of a blend of metalloocene-catalyzed polymers and ethylene/acid ionomers, having a material hardness of about 25 Shore D to about 65 Shore D, a flexural modulus of greater than about 2,000 psi, and a thickness of about 0.03 inches to about 0.07 inches. Dimple coverage over the cover is greater than about 70%, with about 350 to about 450 dimples, preferably in anicosahedron design. The golf ball has a compression of about 60 to about 80, and a coefficient of restitution of greater than about 0.79.

[0070] All patents and patent applications cited in the foregoing text are expressly incorporated herein by reference in their entirety.

[0071] The invention described and claimed herein is not to be limited in scope by the specific embodiments herein disclosed, since these embodiments are intended solely as illustrations of several aspects of the invention. Any equivalent embodiments and various modifications apparent to those skilled in the art are intended to be within the scope of this invention. It is further understood that the various features of the present invention can be used singly or in combination thereof. Such modifications and combinations are also intended to fall within the scope of the appended claims.

What is claimed is:

1. A golf ball comprising a solid, polybutadiene-based core and an ionomer-based cover, wherein an outermost surface of the golf ball has a coefficient of friction of from 0.8 to 1.5 and is formed of a cured coating layer comprising a two-component, water-based system including a polymer having at least one isocyanate-reactive functionality and an isocyanate, and wherein the cured coating layer has a Sward hardness of less than 20.

2. The golf ball of claim 1, wherein the outermost surface has a 60° gloss of at least 3.

3. The golf ball of claim 1, wherein the outermost surface has a 60° gloss of 80 to 95.

4. The golf ball of claim 1, wherein the outermost surface is hydrophobic.

5. The golf ball of claim 1, wherein the coating layer has a thickness of 0.0001 inches to 0.01 inches.

6. The golf ball of claim 5, wherein the coating layer is translucent, transparent, or pigmented.

7. The golf ball of claim 5, wherein the coating layer has a Sward hardness of less than 5.

8. The golf ball of claim 5, wherein the coating layer has a Sward hardness of less than 5.

9. The golf ball of claim 5, wherein the coating layer has a solid content by weight of at least 40%.

10. The golf ball of claim 5, wherein the coating layer has a cross hatch adhesion of 90% to 100%.

11. The golf ball of claim 1, wherein the two-component system is thermoset.

12. A golf ball comprising a solid, polybutadiene-based core and an ionomer-based cover, wherein an outermost surface of the golf ball has a coefficient of friction of from 0.8 to 1.5 and is formed of a cured coating layer having a thickness of 0.0001 inches to 0.01 inches, and wherein the cured coating layer has a Sward hardness of less than 20 and is formed from a two-component, substantially saturated, thermoset polyurethane.

13. The golf ball of claim 12, wherein the polyurethane comprises a UV absorber, a hindered amine light stabilizer, an antioxidant, an optical brightener, a coupling agent, or a combination thereof.

14. The golf ball of claim 12, wherein the Sward hardness is less than 10.

15. The golf ball of claim 12, wherein the Sward hardness is less than 5.

16. A golf ball comprising a solid, polybutadiene-based core, an ionomer-based cover and a first cured coating with a coefficient of friction of from 0.8 to 1.5 and a Sward hardness of less than 20 disposed about the cover; wherein the first cured coating comprises a two-component, water-based polyurethane; and wherein the golf ball exhibits, in comparison to a second golf ball comprising a second cured coating layer with a second coefficient of friction of 0.6, a
spin rate change of less than 15% when struck with a driver at a speed of about 160 ft/sec.

17. The golf ball of claim 16, wherein the coating layer has a 60° gloss of at least 50.

18. The golf ball of claim 16, wherein the coating layer has a 60° gloss of 80 to 95.

19. The golf ball of claim 16, wherein the golf ball, when struck with a full wedge at a speed of about 95 ft/sec, has an elevated launch angle and a spin rate reduction of at least 5% in comparison to the second golf ball.

20. The golf ball of claim 16, wherein the golf ball has an elevated launch angle and a spin rate reduction of at least 10% when struck with a half wedge at a speed of about 53 ft/sec, in comparison to the second golf ball.