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(57) **Abrégé/Abstract:**
A low gloss capstock compound is disclosed. The combination of gloss inhibiting agents and polyolefin elastomer added to conventional polyethylene polymer resin achieves a gloss angle at 85° of below 10 GU. Optionally, the compound can also include weathering agents to improve outdoor durability. The compound can be fully formulated or a masterbatch for let-down into polymer to form the fully formulated compound.

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(54) **Title**: LOW GLOSS CAPSTOCK

(57) **Abstract**: A low gloss capstock compound is disclosed. The combination of gloss inhibiting agents and polyolefin elastomer added to conventional polyethylene polymer resin achieves a gloss angle at 85° of below 10 GU. Optionally, the compound can also include weathering agents to improve outdoor durability. The compound can be fully formulated or a masterbatch for let-down into polymer to form the fully formulated compound.

LOW GLOSS CAPSTOCK

FIELD OF THE INVENTION

[0002] This invention relates to a polymer compound for use as a low gloss capstock material.

BACKGROUND OF THE INVENTION

[0003] Plastic has taken the place of other materials in a variety of industries. In the packaging industry, plastic has replaced glass to minimize breakage, reduce weight, and reduce energy consumed in manufacturing and transport. In other industries, plastic has replaced metal to minimize corrosion, reduce weight, and provide color-in-bulk products. Recently, an entire industry has arisen called "wood polymer composites" ("WPC").

[0004] WPC has begun to replace wood in building and other construction materials where the wood is susceptible to rotting, warping, or discoloration. The advent of thermoplastic biofiber composites has made outdoor decks, porches, railings, windows and stairways more durable. With structural issues resolved, the next key to growing this market is making the plastic composite look like naturally-colored or stained wood.

[0005] The ability of WPC to simulate the appearance of natural wood, including its surface texture and wood grain coloration, and to provide greater durability compared to wood, are critical to WPC materials successfully replacing the natural wood itself. The colorants and additives used to achieve these characteristics, however, significantly add to the WPC products' costs. To reduce these costs, manufacturers have begun to incorporate various colorants

and additives into a thinner outer layer, or "capstock", which covers the core construction material, thus reducing the total amount of colorants and additives per linear foot of product.

SUMMARY OF THE INVENTION

[0006] What the art needs is a plastic material that simulates the appearance of wood. To achieve a wood-like appearance a key factor is that the material must exhibit low gloss, literally to minimize the shine that would otherwise betray the capstock as being plastic instead of wood.

[0007] The present invention solves this problem in the art with a polymer compound that comprises a low gloss capstock compound, comprising: (a) polyethylene in both pellet form and powder or flake form; (b) polyolefin elastomer; and (c) gloss inhibiting agents comprising silica and barium sulfate; wherein, when a surface of a strip of the compound is tested according to ASTM D523, D2457, the surface has a Gloss Angle at 85° of less than 10.

[0007a] In accordance with an aspect of the present invention, there is provided a low gloss capstock compound, comprising: (a) polyethylene in both pellet form and powder or flake form; (b) polyolefin elastomer; (c) gloss inhibiting agents comprising silica and barium sulfate; wherein when a surface of a strip of the compound is tested according to ASTM D523, D2457, the surface has a Gloss Angle at 85° of less than 10 GU.

[0007b] In accordance with another aspect of the present invention, there is provided a capstock made from the compound as described above.

[0007c] In accordance with another aspect of the present invention, there is provided the capstock as described above, wherein the compound further comprises (d) weathering agents comprising ultra-violet light absorber, hindered amine light stabilizer, and anti-oxidant; and wherein the capstock has a first surface attached or adhered to a substrate and a second surface exposed to sunlight.

[0007d] In accordance with another aspect of the present invention, there is provided a low gloss capstock composition, comprising: (a) polyethylene in both pellet form and powder or flake form; (b) polyolefin elastomer; (c) gloss inhibiting agents comprising both silica and barium sulfate; (d) hindered amine light stabilizer; wherein a surface of a test strip of the composition has less than less than 1 Delta E unit CIELAB after 2000 hours according to QUV Weathering test, wherein when a surface of a strip of the composition is tested according to ASTM D523, D2457, the surface has a Gloss Angle at 85° of less than 10 GU.

[0007e] In accordance with another aspect of the present invention, there is provided a capstock made from the composition as described above, wherein the capstock has a surface that simulates the appearance of natural wood.

[0007f] In accordance with another aspect of the present invention, there is provided the capstock as described above, wherein the composition further comprises (e) weathering agents comprising ultra-violet light absorber, and anti-oxidant; and wherein the capstock has a first surface attached or adhered to a substrate and a second surface exposed to sunlight.

[0008] If the material is to be used in an outdoor setting exposed to the environment, the compound also preferably needs to be durable beyond the durability which plastic inherently has over wood susceptible to rotting. A key measure of durability is weather-ability, which represents resistance to outdoor exposure to heat, sunlight and UV degradation. Particularly, the art needs a capstock material to cover the core WPC material providing both a wood-like appearance and durability against the effects of both natural sources such as wind, rain, and sun and human sources such as foot traffic, furniture moving, etc.

[0009] Optionally but preferably, the polymer compound also comprises weathering agents comprising ultra-violet stabilizer, hindered amine light stabilizer, and anti-oxidant.

[00010] The compounds of the present invention satisfy the requirements of low gloss and durability, as measured by two tests: Gloss Angles and Stress

Whitening, identified in the Examples below. Optionally but preferably, the compound also satisfies the requirements of Weatherability, also identified in the Examples below.

[00011] Regardless of the construction of the underlying substrate, capstocks made from the compounds of the present invention give the aesthetic and ornamental appearance of wood and also the structural and functional sunlight and stress resistance.

EMBODIMENTS OF THE INVENTION

[00012] Polyethylene

Polyethylene refers to a polymer made of ethylene-derived monomeric units. The polyethylene can be a homopolymer or a copolymer, including a terpolymer, having other monomeric units. Illustrative monomers may include alpha-olefins including, but not limited to, propylene, 1-butene, 1-pentene, 1-hexene, 1-octene, 1 decene and 4-methyl-1-pentene. One embodiment of the invention is a high density polyethylene (HDPE) resin having a melt flow index of about 0.2 to about 0.8 g/10 min., when measured using ASTM D1238 (2.16 kg at 190°C), and a density of from about 0.93 to about 0.97 and preferably from about 0.95 to about 0.96 g/cm^3.

[00013] It has been found that a mixture of forms of HDPE is helpful for making compounds of the present invention. The amount of HDPE for the compound is divided between pellets of HDPE and powder or flakes of HDPE, in a division ranging from about 80:20 to about 50:50 and preferably from about 65:35 to about 55:45 pellets:powder. While not being limited to a particular theory, it is believed that the combination of pellets and powder or flakes promotes a homogeneous blend and optimum compounding during manufacture of the compound.

[00014] Polyolefin Elastomers

[00015] Polyolefin elastomers, and particularly those which are metallocene-catalyzed olefin copolymers, constitute another polymer in the

compound of the present invention. These polyolefin elastomers (also sometimes known as "plastomers") are included in the compound to provide improved impact performance, melt strength, and processability, and to otherwise contribute to the durability of the compound against Stress Whitening during manufacture, transport, installation, and use.

[00016] Metallocene-catalyzed olefin copolymers are the best known polyolefin elastomers. Such copolymers are well known in the art, for example as disclosed in U.S. Pat. Nos. 6,451,894; 6,376,623; and 6,329,454. Such copolymers are available from a number of commercial sources, among them being ExxonMobil with its Exact™ brand of polyolefin elastomers and Dow Chemical Co. with its Engage™ brand of polyolefin elastomers.

[00017] It is well known that metallocene catalysis can yield quite precise polymeric structures. Within the possibilities of olefin monomers used in the copolymerization, it is preferred to use ethylene with a second olefin monomer having from 3 to 18 carbon atoms. Of the comonomer choices, octene is preferred because of the variation possible in melt flow properties of the resulting copolymer, resulting ethylene-octene copolymer.

[00018] Among the many possibilities of commercial metallocene-catalyzed olefin copolymers are the Engage™ brand of ethylene-octene copolymer polyolefin elastomers from Dow Chemical Company.

[00019] Melt flow indices for the polyolefin elastomer can range from about 0.5 to about 30 and preferably from about 0.5 to about 3 g/10 min, when measured using ASTM D1238 (2.16 kg at 190°C).

[00020] Among the several grades and products identified by the Engage™ brand, the compound of the present invention desirably uses Engage™ 8540 or Engage™ 7387 polyolefin elastomer or both together. Of the choices, use of Engage™ 8540 polyolefin elastomer is preferred.

[00021] Gloss Inhibiting Agents

[00022] Polyolefin polymers, such as high density polyethylene and polyolefin elastomers, have a natural gloss from their surfaces after molding or extruding into their final shape. As anyone who has seen a plastic article such as a polyethylene sheet or film, the high reflectivity of light shining upon the surface of that sheet or film is a readily recognized attribute of a thermoplastic.

[00023] The present invention minimizes that gloss at a variety of angles of viewing, but most important at 85° to the surface, almost directly orthogonal to a flat surface.

[00024] The building and construction industry has determined that the marketplace of consumers demands that Gloss Angle at 85° according to ASTM D523, D2457 be less than 10. Visual appearance of a low gloss, i.e., a single digit value at 85° is a requirement of the market and this invention. Desirably, the 85° Gloss Angle is as low as possible, less than 9 or 7 or 5, as can be achieved. One embodiment of the invention has resulted in an 85° Gloss Angle of less than 4.

[00025] To minimize gloss, the present invention adds a combination of two different inorganic chemicals as gloss inhibiting agents, silica and barium sulfate. It has been found that both are needed to provide the necessary reduction of gloss.

[00026] Silica is a common term for silicon dioxide and can be mined or manufactured via precipitation from solution. Particle sizes of silica can range from about 5 to about 12 and preferably from about 9 to about 11 micrometers. Pore volumes of the particles can range from about 0.4 to about 2.0 and preferably from about 1.0 to about 1.2 ml/g

[00027] Preferably, the silica is not agglomerated or aggregated, nor is the silica surface-treated.

[00028] Commercially available silica is sold as Silcron brand silicas by Millenium Chemicals of Hunt Valley, MD and Gasil™ brand silicas from INEOSSilicas of Joliet, IL. Of the available commercial choices, Gasil™ IJ45 silica is presently preferred because its 10.1 micrometer average particle size.

[00029] Barium sulfate can be mined or manufactured. If manufactured by precipitation reaction from barium sulfide, it is known as *blanc fixe* barium sulfate. Particle sizes of barium sulfate can range from about 0.5 to about 5 and preferably from about 0.7 to about 3 micrometers.

[00030] Commercially available precipitated barium sulfate is sold by Brenntag Specialties of South Plainfield, NJ, among other known sources.

[00031] While not being limited to a particular theory, it is believed that the combination of silica and barium sulfate provides desirable matting in the compound, resulting in reduced surface gloss in the compound when formed into a capstock.

[00032] Optional Weathering Agents

[00033] Compounds of the present invention optionally but preferably include the presence of weathering agents in order to preserve original coloration and structure of the compound after extrusion into the form of a capstock and installation of that capstock in an outside building or other construction item.

[00034] Ultra-violet radiation will discolor or bleach out the original color of the capstock of the compound unless different types stabilizers and anti-oxidants are present.

[00035] The first type of weathering agent is an ultra-violet light absorber, such as 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol, marketed by BASF (formerly Ciba) as Tinuvin™ 328 UV absorber.

[00036] The second type of weathering agent is a hindered amine light stabilizer (HALS), such as N,N',N'',N'''-tetrakis(4,6-bis(butyl-(N-methyl-2,2,6,6-tetramethylpiperidin-4-yl)amino)triazin-2-yl)-4,7-diazadecan-1,10-diamine and Butanedioic acid,dimethyl ester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol, marketed by Sabo SPA as SaboStab UV 119 HALS.

[00037] The third type of weathering agent is an antioxidant combining a high molecular weight hindered phenolic antioxidant with a phosphite

antioxidant, such as a mixture of Tris (2,4-di-tert-butylphenyl) phosphite and Tetrakis [methylene-3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate] methane in a 50:50 weight ratio, marketed by Songwon Ind. Co. Ltd. as Songnox 11B antioxidant.

[00038] Other Optional Functional Additives

The polymer compounds of the present invention can include conventional plastics additives in an amount that is sufficient to obtain a desired processing or performance property for the compound. The amount should not be wasteful of the additive or detrimental to the processing or performance of the compound. Those skilled in the art of thermoplastics compounding, without undue experimentation but with reference to such treatises as Plastics Additives Database (2004) from Plastics Design Library, can select from many different types of additives for inclusion into the compounds of the present invention.

[00039] Non-limiting examples of optional additives include other antioxidants; biocides (antibacterials, fungicides, and mildewcides); surfactants; intercalated organoclays; other ultraviolet stabilizers; anti-static agents; bonding, blowing and foaming agents; dispersants; fillers and extenders, such as biofibers and particularly wood fiber or flour; fire and flame retardants and smoke suppressants; fly ash; impact modifiers; initiators; lubricants; micas; plasticizers; processing aids; release agents; silanes, titanates and zirconates; slip and anti-blocking agents; stabilizers; stearates; ultraviolet light absorbers; viscosity regulators; waxes; pest repellants; and combinations of them.

[00040] Optional Colorant

[00041] Colorant can be a pigment or a combination of pigments. The choice of colorants depends on the ultimate color and performance desired by the designer for the capstock. Pigments are preferred for durability to resist discoloration because of exposure to ultraviolet light.

[00042] The science of color is well known to those skilled in the art. Without undue experimentation, one can use color matching techniques to

identify a particular location in spherical color space. For example, one skilled in the art can use the teachings of PCT Patent Publication WO 2004/095319 to digitally map color space using specific polymer carriers and colorants as raw material ingredients. Alternatively, one can make small samples called plaques for visual review.

[00043] Colorants are commercially available from a number of sources well known to those skilled in the art. Commercially available pigments are well known to those skilled in the art and include organic and inorganic colorant chemistries. Commercial sources for pigments include multinational companies such as BASF, Bayer, Ciba-Geigy, Color-Chem International, Sun Chemical, Zhuhai Skyhigh Chemicals, and others.

[00044] Table 1 lists 51 commercially available pigment colorants in a variety of primary and secondary colors, 47 chromatics, 3 blacks, and 1 white.

Table 1
Commercial Pigment Colorants

Raw Material Name	CI_Name	Family	COLOR
TIOXIDE R-FC6 WHITE	PIGMENT WHITE 6	INORGANIC	WHITE
REGAL 660R BLACK POWDER	PIGMENT BLACK 7	ORGANIC	
MPC CHANNEL BLACK	PIGMENT BLACK 7	ORGANIC	
BK-5099 BLACK OXIDE	PIGMENT BLACK 11	INORGANIC	
HELIOGEN BLUE K7090	PIGMENT BLUE 15:3	ORGANIC	BLUE
Heliogen Blue K6903	PIGMENT BLUE B 15:1	ORGANIC	BLUE
34L2000 AZURE BLUE	PIGMENT BLUE 28	INORGANIC	BLUE

Table 1
Commercial Pigment Colorants

Raw Material Name	CI_Name	Family	COLOR
34L2001 AMAZON BLUE	PIGMENT BLUE 36	INORGANIC	BLUE
NUBIX G-58 ULTRAMARINE BLUE	PIGMENT BLUE 29	INORGANIC	BLUE
NUBIX C-84 ULTRAMARINE BLUE	PIGMENT BLUE 29	INORGANIC	BLUE
NUBIX E-28 ULTRAMARINE BLUE	PIGMENT BLUE 29	INORGANIC	BLUE
HELIOGEN GREEN K-8730	PIGMENT GREEN 7	ORGANIC	GREEN
HELIOGEN GREEN K 8605	PIGMENT GREEN 7	ORGANIC	GREEN
CHROMIUM OXIDE GREEN G-6099	PIGMENT GREEN 17	INORGANIC	GREEN
CROMOPHTAL ORANGE GP	PIGMENT ORANGE 64	ORGANIC	ORANGE
2920 BRILLIANT ORANGE	PIGMENT ORANGE 79	ORGANIC	ORANGE
NOVAPERM RED F5RKA	PIGMENT RED 170	ORGANIC	RED
225-2480 Sunbrite Scarlet 60:1	Pigment Red 60:1	ORGANIC	RED
IRGALITE RED LCB	PIGMENT RED 53:1	ORGANIC	RED
DCC-2782 Barium 2B Red	Pigment Red 60:1	ORGANIC	RED
Lithol Scarlet 4451	Pigment Red 48:2	ORGANIC	RED
CROMOPHTAL RED 2020	PIGMENT VIOLET 19	ORGANIC	RED
CROMOPHTAL MAGENTA P	PIGMENT RED 202	ORGANIC	RED
CROMOPHTAL PINK PT	PIGMENT RED 122	ORGANIC	RED
PALIOGEN RED K 3911 HD	PIGMENT RED 178	ORGANIC	RED
CROMOPHTAL RED 2030	PIGMENT RED 254	ORGANIC	RED
CROMOPHTAL RED	PIGMENT RED	ORGANIC	RED

Table 1
Commercial Pigment Colorants

Raw Material Name	CI_Name	Family	COLOR
2028	254		
Colortherm Red 110M	PIGMENT RED 101	INORGANIC	RED
Colortherm Red 130M	PIGMENT RED 101	INORGANIC	RED
Colortherm Red 180M	PIGMENT RED 101	INORGANIC	RED
CINQUASIA VIOLET RT-891-D	PIGMENT VIOLET 19	ORGANIC	VIOLET
CROMOPHTAL VIOLET GT	PIGMENT VIOLET 23	ORGANIC	VIOLET
PREMIER VU UMV (6112)	PIGMENT VIOLET 15	INORGANIC	VIOLET
SICOTAN BROWN K 2750 FG	PIGMENT YELLOW 164	INORGANIC	BROWN
FERRITAN FZ-1000	PIGMENT YELLOW 119	INORGANIC	Tan
NUBITERM Y-905K ZINC FERRITE	PIGMENT YELLOW 119	INORGANIC	Tan
PV FAST YELLOW HG	PIGMENT YELLOW 180	ORGANIC	YELLOW
IRGALITE YELLOW WGPH	PIGMENT YELLOW 168	ORGANIC	YELLOW
PV FAST YELLOW HGR (11-3071)	PIGMENT YELLOW 191	ORGANIC	YELLOW
PALIOTOL YELLOW K 2270	PIGMENT YELLOW 183	ORGANIC	YELLOW
CROMOPHTAL YELLOW HRPA	PIGMENT YELLOW 191:1	ORGANIC	YELLOW
CROMOPHTAL YELLOW GRP	PIGMENT YELLOW 95	ORGANIC	YELLOW
IRGALITE YELLOW WSR-P	PIGMENT YELLOW 62	ORGANIC	YELLOW
CROMOPTHAL YELLOW 3RLP	PIGMENT YELLOW 110	ORGANIC	YELLOW
9766 FD&C YELLOW # 6	PIGMENT YELLOW 104	ORGANIC	YELLOW

Table 1
Commercial Pigment Colorants

Raw Material Name	CI_Name	Family	COLOR
9765 FD&C YELLOW # 5	PIGMENT YELLOW 100	ORGANIC	YELLOW
PALIOTOL YELLOW K 0961 (HD)	PIGMENT YELLOW 138	ORGANIC	YELLOW
SICOPLAST YELLOW 10-0770	PIG YEL 138 / PIG YEL 183	ORGANIC	YELLOW
SICOTAN YELLOW K 2001 FG	PIGMENT BROWN 24	INORGANIC	YELLOW
SICOTAN YELLOW K 1011	PIGMENT YELLOW 53	INORGANIC	YELLOW
COLORTHERM 10	PIGMENT YELLOW 42	INORGANIC	YELLOW

[00045] Achievement of a color match of a plaque with a desired color from the creativity of a designer or a pre-arranged color standard such as Pantone® color standards from an inventory of commercially available colorants is relatively straightforward for a skilled color matcher, even if a few iterations are required to satisfy the customer.

[00046] Pigments for this invention can include pigments intended for to simulate the appearance of natural wood. For example, to simulate the coloration of cedar wood, a combination of four pigments can be used: tan, white, red, and black.

[00047] Table 2 shows the acceptable, desirable, and preferable ranges of ingredients for the polymer compound of the present invention. The compound can comprise, consist essentially, or consist of the following ingredients.

Table 2 Ranges of Ingredients for Compound			
Ingredient (Wt. Percent)	Acceptable	Desirable	Preferable
Polyethylene (pellet form)	40-55	45-53	50-52
Polyethylene (powder or flake form)	25-40	28-38	30-34
Polyolefin elastomer	5-25	5-20	5-15
Silica Gloss Inhibiting Agent	1-5	1-4	1-3
Barium Sulfate Gloss Inhibiting Agent	1-5	1-3	1-2
Optional UVA Absorber	0-0.4	0-0.3	0.1-0.2
Optional HALS Stabilizer	0-0.5	0.1-0.5	0.3-0.5
Optional Anti-Oxidant	0-0.4	0.1-0.3	0.1-0.2
Optional Colorant	0-5	1-4	1-3
Other Optional Functional Additives	0-10	0-7	0-5

[00048] The form of the compound can be fully formulated or made into a masterbatch, a concentrated amount of the gloss inhibiting agents and, optionally, also the weathering agents in a smaller weight percentage of polymer resin(s). The masterbatch can be transported to the location of final plastic article formation and combined with the remainder of polyethylene and/or polyolefin elastomer at the time of extrusion or molding. Table 3 shows the acceptable, desirable, and preferable ranges of ingredients for the polymer compound of the present invention in the form of a masterbatch, based on a 20% usage level in the final compound, otherwise known as a 5:1 "let-down" ratio. The masterbatch can comprise, consist essentially, or consist of the following ingredients.

Table 3
Ranges of Ingredients for Masterbatch

Ingredient (Wt. Percent)	Acceptable	Desirable	Preferable
Polyethylene (pellet form)	0-25	0-15	0-5
Polyethylene (powder or flake form)	10-40	15-40	25-35
Polyolefin elastomer	20-75	35-75	50-75
Silica Gloss Inhibiting Agent	5-20	5-15	5-10
Barium Sulfate Gloss Inhibiting Agent	4-20	4-14	4-8
Optional UVA Absorber	0-5	0.25-3	0.5-1.5
Optional HALS Stabilizer	0-5	0.5-5	1-5
Optional Anti-Oxidant	0-5	0.1-3	0.5-1.5
Optional Colorant	0-50	0-35	0-20
Other Optional Additives	0-20	0-10	0-5

[00049] Processing

[00050] The preparation of compounds of the present invention is uncomplicated once the proper ingredients have been selected. The compound of the present can be made in batch or continuous operations.

[00051] Mixing in a continuous process typically occurs in an extruder that is elevated to a temperature that is sufficient to melt the polymer matrix with addition either at the head of the extruder or downstream in the extruder of the solid ingredient additives. Extruder screw speeds can range from about 50 to about 500 revolutions per minute (rpm), and preferably from about 100 to about 300 rpm. Typically, the output from the extruder is pelletized for later extrusion or molding into polymeric articles.

[00052] Mixing in a batch process typically occurs in a Banbury mixer that is also elevated to a temperature that is sufficient to melt the polymer matrix to permit addition of the solid ingredient additives. The mixing speeds

range from 60 to 1000 rpm. Also, the output from the mixer is chopped into smaller sizes for later extrusion or molding into polymeric articles.

[00053] Subsequent extrusion or molding techniques are well known to those skilled in the art of thermoplastics polymer engineering, whether one employs the compound or the masterbatch in combination with polymer(s). Without undue experimentation but with such references as "Extrusion, The Definitive Processing Guide and Handbook"; "Handbook of Molded Part Shrinkage and Warpage"; "Specialized Molding Techniques"; "Rotational Molding Technology"; and "Handbook of Mold, Tool and Die Repair Welding", all published by Plastics Design Library, one can make articles of any conceivable shape and appearance using compounds of the present invention.

USEFULNESS OF THE INVENTION

[00054] Compounds of the invention can be used to make capstocks, relatively thin outer layers attached or adhered to substrates used in the building and construction industry. The capstocks provide durability to the underlying substrate and a more aesthetically pleasing non-glossy appearance.

[00055] The substrate on which the capstock resides can be any metallic, ceramic, or polymeric material. Preferably, the substrate is polymeric.

[00056] Polymer composites used in the building and construction industries include polyolefins, poly(vinyl halides), polystyrenes, polycarbonates, and other engineering grade polymers suitable for use in the particular shape of construction. Of these choices, polyethylene is preferred because of the compatibility of that polymer resin with compounds of the present invention serving as the capstock.

[00057] The polymer composite of the substrate can include fillers to reduce cost of polymer. Fillers can be metallic, ceramic, or bio-derived. Among possible fillers are wood fiber, fly ash, granulated rubber particles, and

any other small size product of commerce which needs to be recycled in a sustainable way.

[00058] The capstock can be made separately from the substrate and subsequently fused or adhered to the substrate. Alternatively, the capstock can be co-extruded with the substrate.

[00059] The shape of the substrate, and hence the purpose of the capstock, can vary according to choice of architects and other building designers. Capstocks can be employed as the outer surface in windows and doors, decking and fencing, railings and spindles, stairways and steps, posts and pillars, shutters and fascia, etc. Currently, the largest volume of wood polymer composites used as substrates are deck planks and other lumber construction pieces. Capstocks of compounds of the present invention can be utilized to provide both a better durable surface than wood itself and a more aesthetically pleasing surface than the substrate itself.

[00060] Moreover, with the capstock covering the exposed surface(s) of the substrate, there need not be coloration or other finishing ingredients in the substrate. The substrate can be made with less expense, resulting in the overall construction item having all of the structural properties needed for the substrate and all of the durability and non-glossy appearance properties of the capstock.

[00061] General contractor home construction and do-it-yourself home improvement home owners both can benefit from composite substrates which have capstocks made according to the invention.

[00062] The thickness of the capstock depends on the thickness and construction purpose of the substrate. Generally, the thickness of the capstock can range from about 1 mm to about 4 mm and preferably from about 1.5 mm to about 3 mm. Stated another way, the thickness of the capstock relative to the thickness of the substrate can range from about 3% to about 20% and preferably from about 5% to about 10%.

[00063] The capstock can cover only the surface exposed to the most viewing by users of the construction item or can cover any other portion or the

entire remainder of all surfaces of the substrate. The capstock should cover at least all surfaces which are exposed to sunlight, in order that the substrate not be exposed to ultra-violet light and fade to a different color than the capstock which has weathering agent protection as described above.

[00064] Coloration of the capstock can mimic colors of popular wood species, such as redwood or cedar. Alternatively, the coloration can be chosen to be any color according to design choice for decorative or informative effect.

[00065] The outer surface of the capstock can be smooth or textured as desired, with a preference for some texturing if used where foot traffic is likely. Desirably, the capstock texture can resemble wood grain or other tactile effect to enhance its simulation of finished wood structures.

[00066] With capstock from compound of the invention, one of ordinary skill in building materials can protect substrates with a non-glossy capstock in an economical way with aesthetically pleasing results, preferably also with years of durability to outdoor uses.

[00067] Specifically, using QUV Weathering test explained below, the compound in the form of a test strip can have less than 1 Delta E unit CIELAB, desirably less than 0.5, and preferably less than 0.4 over 2000 hours of testing.

[00068] Specifically, using the Stress Whitening test explained below, test strips of the compound can have no noticeable stress whitening.

[00069] Specifically, using the Gloss Angle test explained below, test strips of the compound can have an 85° gloss angle of less than 10 Gloss Units, namely a single digit gloss angle.

[00070] The invention is further explained in the Examples.

EXAMPLES

[00071] Table 4 shows the ingredients and their commercial sources.

Table 4		
Ingredient	**Commercial Company**	**Location of Company**
0.38 melt pellet HDPE	Dow Chemical	Midland, MI
7 melt pellet HDPE	CP Chem	Houston, TX
0.5 melt flake HDPE	Innovene	Chicago, IL
0.8 melt flake HDPE	Dow Chemical	Midland, MI
Tinuvin 328 UVA	BASF	Florham Park, NJ
Tinuvin 783 UV HALS	BASF	Florham Park, NJ
Sabostab UV 119 (HALS) Hindered Amine	Sabo Srl	Levate, Italy
Songnox 11B PW AO	Songwon Ind. Co. Ltd.	Uisan, Korea
Talc 399 Talc	Mineral & Pigment Solutions	South Plainfield, NJ
GASIL IJ45 Silica	IneosSilicas	Joliet, IL
Blanc Fixe Barium Sulfate	Brenntag Specialties	South Plainfield, NJ
Dow Engage 8540 POE Polyolefin Elastomer	Dow Chemical	Midland, MI
Dow Engage 7387 POE Polyolefin Elastomer	Dow Chemical	Midland, MI
Nylon 12	Ube Industries	Tokyo, Japan
E43 MAH coupling agent	Westlake Polymers	Houston, TX
E25 MAH coupling agent	Westlake Polymers	Houston, TX
Color pigment	PolyOne Corporation	Avon Lake, OH

[00072] Comparative Example A was a control of a mixture of two different types of high density polyethylene (HDPE). Comparative Examples B-G were unsuccessful attempts to formulate a capstock with a single digit 85° gloss angle and other suitable physical properties. Examples 1- 3 were embodiments of the claimed invention.

[00073] Preparation of Comparative Examples A-D

[00074] Batch ingredients for each of Comparative Examples A-D were pre-weighed, including a contrasting colorant to measure 85° gloss angle, and

blended for three minutes using a Red Devil Model 5400 paint shaker.

[00075] Blends of each of Comparative Examples A-D were then melt compounded using a Brabender™ Plasticorder machine with a single screw extruder attachment having a 7.62 cm (3 inch) tape/strip die. The single screw had a L:D ratio of 20:1 and 2:1 compression. Temperatures in the two-barrel Zones and the Die were set at 188°C. Screw speed was 40 RPM. Brabender™ strips 7.6 cm wide by 0.5 mm thick were the product form, cut into pieces approximately 25 cm long.

[00076] Preparation of Comparative Examples E-G

[00077] Batch ingredients for Comparative Examples E-G were pre-weighed and blended first before being melt compounded using a twin screw extruder with a strand die resulted in cylindrical pellets. Table 5 shows the extruder temperature and other processing conditions. Pellets were the product form in colors of Redwood (Comp. Ex. E); Cedar (Comp. Ex. F); and Mandalay Red (Comp. Ex. G).

[00078] Pellets of Comparative Examples E-G were then further melt compounded, in the same manner as Comparative Examples A-D, using a Brabender™ Plasticorder machine with a single screw extruder attachment having a 7.62 cm (3 inch) tape/strip die. The single screw had a L:D ratio of 20:1 and 2:1 compression. Temperatures in the two-barrel Zones and the Die were set at 188°C. Screw speed was 40 RPM. Brabender™ strips 7.6 cm wide by 0.5 mm thick were the product form, cut into pieces approximately 25 cm long.

[00079] Preparation of Examples 1-3

[00080] Batch ingredients for Examples 1-3 were pre-weighed and blended first before being melt compounded using a twin screw extruder with a strand die resulted in cylindrical pellets. Table 5 shows the extruder temperature and other processing conditions. Pellets were the product form in natural polymer color.

[00081] Pellets of Examples 1-3 were then further melt compounded at a 98:2 weight percent ratio with cedar colorant, to serve as a contrasting agent for

testing, using a Brabender Plasticorder machine with a conical twin screw extruder attachment having a 7.62 cm (3 inch) tape/strip die. The conical twin screw had a L:D ratio of 10.6:1. Temperatures in the three-barrel Zones and the Die were set at 188°C. Screw speed was 20 RPM. Brabender strips 7.6 cm wide by 0.5 mm thick were the product form, cut into pieces approximately 25 cm long.

[00082] Table 6, broken into two Parts A and B, shows the formulations of Comparative Examples A-G and Examples 1 -3. Table 6, Parts A and B, also show the results of 85° Gloss Angle testing and Stress Whitening of Brabender strips for Comparative A - G and Examples 1-3 and QUV Weathering of Brabender strips of Comparative Example G and Examples 1 and 2 through 2000 hours.

[00083] The Gloss Angle test utilizes an average of four surface measurements on 25 cm long Brabender strip using a BYK/Gardner Micro Tri Gloss meter conforming to ASTM D523, D2457. The Stress Whitening test utilizes an internal flex test where the extruded strips are folded width-wise to create a crease in the strip and then the crease is visually examined for a whitish line indicating stress whitening. The QUV Weathering test utilizes the Q-Lab QUV Solar Eye instrument with water spray and a UV340 lamp. Each cycle includes eight hours UV exposure at 70°C ± 2.8°C , a five minute spray and 3 hours 55 minutes condensation at 50°C ± 3°C. Data collection occurs every 500 hours. The overall test duration was 2000 hours.

Table 5
Extrusion Compounding Conditions

	Examples A-D	**Example E**	**Example F**	**Example G**	**Example1**	**Example 2**	**Example 3**
Extruder Type	Brabender	NFM 58mm	Liestritz 36mm	Liestritz 36mm	Leistritz 32mm	Leistritz 36mm	Leistritz 36mm
	L/D 20:1 2:1 Single Screw	Twin Screw	Twin Screw	Twin Screw	Twin Screw	Twin Screw	Twin Screw
Machine Settings							
Feeder	NA	100	50	50	NA	NA	NA
Melt Temp	NA	205°C	170°C	170°C	NA	228°C	NA
Screw Speed (RPM)	40	NA	300	300	190	190	150
Rate (lbs/hr)	NA	NA	30	30	NA	75	33
Die Holes	NA	31	NA	NA	NA	NA	NA
Die type	3 inch tape/strip	strand	strand	strand	strand	strand	strand
Temperature Settings							
Zone 1	188°C	0	0	0	180°C	0	0
Zone 2	188°C	150°C	200°C	150°C	200°C	200°C	220°C
Zone 3		160°C	200°C	170°C	205°C	210°C	240°C
Zone 4		160°C	200°C	170°C	210°C	210°C	250°C
Zone 5		170°C	200°C	170°C	210°C	210°C	260°C
Zone 6		170°C	200°C	170°C		230°C	265°C
Zone 7		170°C	200°C	170°C		230°C	260°C
Zone 8		170°C	200°C	170°C		230°C	260°C

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Table 5
Extrusion Compounding Conditions

	Examples A-D	Example E	Example F	Example G	Example1	Example 2	Example 3
Zone 9		170°C	200°C	170°C		230°C	245°C
Zone 10			200°C	170°C		230°C	240°C
Zone 10 Die (L)		165°C					
Zone 11 Die (C)		165°C					
Zone 12 Die (R)		165C					
Die temp	188°C	NA	NA	NA	205°C	220°C	274°C
Amps	NA	NA	NA	NA	12	15	25
Torque %	NA	60	NA	NA	NA	NA	NA
Head Pressure	NA	200	NA	NA	NA	628	470
Vacuum	NA	on	on	on	NA	on	on
Screens	NA	none	none	none	NA	NA	NA
Waterbath Temp	NA	NA	NA	NA	NA	NA	NA

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Table 6, Part A					
	Example A	**Example B**	**Example C**	**Example D**	**Example E**
0.38 melt pellet HDPE	19.31%	77.27%	50.23%	33.80%	0.00%
7 melt pellet HDPE	0.00%	0.00%	0.00%	0.00%	58.00%
0.5 melt flake HDPE	0.00%	0.00%	0.00%	0.00%	19.36%
0.8 melt flake HDPE	77.27%	19.31%	33.80%	50.23%	0.00%
Tinuvin 328 UVA	0.00%	0.00%	0.00%	0.00%	0.15%
Tinuvin 783 UV HALS	0.00%	0.00%	0.00%	0.00%	0.40%
Sabostab UV 119 (HALS) Hindered Amine	0.00%	0.00%	0.00%	0.00%	0.00%
Songnox 11B PW AO	0.00%	0.00%	0.00%	0.00%	0.10%
Talc 399 Talc	0.00%	0.00%	0.00%	0.00%	20.00%
GASIL IJ45 Silica	1.45%	1.45%	1.45%	1.45%	0.00%
Blanc Fix Barium Sulfate	0.00%	0.00%	0.00%	0.00%	0.00%
Dow Engage 8540 POE Polyolefin Elastomer	0.00%	0.00%	0.00%	0.00%	0.00%
Dow Engage 7387 POE Polyolefin Elastomer	0.00%	0.00%	0.00%	0.00%	0.00%
Nylon 12	0.00%	0.00%	9.66%	9.66%	0.00%
E43 MAH coupling agent	0.00%	0.00%	2.94%	0.00%	0.00%
E25 MAH coupling agent	0.00%	0.00%	0.00%	2.94%	0.00%
Color pigment	1.96%	1.96%	1.96%	1.96%	1.90%
Total	100%	100%	100%	100%	100%

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Table 6, Part A					
	Example A	**Example B**	**Example C**	**Example D**	**Example E**
Product Form	Brabender Strips	Brabender Strips	Brabender Strips	Brabender Strips	Pellets
Low Gloss Compounded Pellets					100%
Cedar Coloration					0%
Total					100%
Product Form					Brabender Strips
Gloss Angles - Brabender Strips (Average of Four Test Strips)					
85°	40.8	13.8	5.9	2.2	49.8
Stress Whitening Brabender Strips (1 = Noticeable; 2 = Slight; 3 = None)					
	1	1	1	1	1
QUV Weathering (Brabender Strips) CIELAB Delta E					
500 hours	Visible Rejection	Visible Rejection	Visible Rejection	Visible Rejection	Visible Rejection
1000 hours					
1500 hours					
2000 hours					

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Table 6, Part B					
	Example F	**Example G**	**Example 1**	**Example 2**	**Example 3**
0.38 melt pellet HDPE	18.95%	67.83%	45.48%	45.48%	51.48%
7 melt pellet HDPE	0.00%	0.00%	0.00%	0.00%	0.00%
0.5 melt flake HDPE	0.00%	0.00%	0.00%	0.00%	0.00%
0.8 melt flake HDPE	75.79%	16.96%	30.32%	30.32%	34.32%
Tinuvin 328 UVA	0.15%	0.15%	0.15%	0.15%	0.15%
Tinuvin 783 UV HALS	0.40%	0.40%	0.00%	0.00%	0.00%
Sabostab UV 119 (HALS) Hindered Amine	0.00%	0.00%	0.40%	0.40%	0.40%
Songnox 11B PW AO	0.10%	0.10%	0.15%	0.15%	0.15%
Talc 399 Talc	0.00%	10.00%	0.00%	0.00%	0.00%
GASIL IJ45 Silica	1.50%	1.50%	2.00%	2.00%	2.00%
Blanc Fix Barium Sulfate	1.50%	1.50%	1.50%	1.50%	1.50%
Dow Engage 8540 POE Polyolefin Elastomer	0.00%	0.00%	20.00%	0.00%	10.00%
Dow Engage 7387 POE Polyolefin Elastomer	0.00%	0.00%	0.00%	20.00%	0.00%
Nylon 12	0.00%	0.00%	0.00%	0.00%	0.00%
E43 MAH coupling agent	0.00%	0.00%	0.00%	0.00%	0.00%
E25 MAH coupling agent	0.00%	0.00%	0.00%	0.00%	0.00%
Color pigment	1.61%	1.56%	0.00%	0.00%	0.00%
Total	100%	100%	100%	100%	100%

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Table 6, Part B					
	Example F	**Example G**	**Example 1**	**Example 2**	**Example 3**
Product Form	Pellets	Pellets	Pellets	Pellets	Pellets
Low Gloss Compounded Pellets	100%	100%	98%	98%	98%
Cedar Coloration	0%	0%	2%	2%	2%
Total	100%	100%	100%	100%	100%
Product Form	Brabender Strips	Brabender Strips	Brabender Strips	Brabender Strips	Brabender Strips
Gloss Angles - Brabender Strips (Average of Four Test Strips)					
85°	17.2	10.3	3.9	8.9	7.9
Stress Whitening Brabender Strips (1 = Noticeable; 2 = Slight; 3 = None)					
	1	1	3	3	3
QUV Weathering (Brabender Strips) CIELAB Delta E					
500 hours	Visible Rejection	0.38	0.27	0.33	N/A
1000 hours		0.81	0.28	0.18	N/A
1500 hours		0.62	0.28	0.89	N/A
2000 hours		0.75	0.36	0.49	N/A

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[00084] A test of Brabender strips of each Comparative Examples A-G and Examples 1-3 rejected Comparative Examples C and D as lacking sufficient physical integrity as to be suitable for use as a capstock compound. Nylon 12, even with a maleic anhydride (MAH) coupling agent was not suitable for this capstock purpose.

[00085] A comparison of Examples 1-3 with Comparative Example A, the control, showed a performance improvement, for 85° Gloss Angle, of at least 4.5 times and achievement of the <10 Gloss Unit (GU) value required by the marketplace for 85° Gloss Angle testing on capstock. The comparison of 85° Gloss Angle for Comparative Examples B and E-G with Examples 1-3 showed the former were all >10 GU, whereas the latter were comfortably <10 GU.

[00086] Moreover, a comparison of Comparative Examples B-G with Examples 1-3 showed that only Examples 1-3 passed the Stress Whitening test. Stress Whitening is indicative of the likelihood of the capstock to display aesthetically objectionable whitish flex or stretch lines when subjected to physical stresses possibly imposed during the manufacture, transport, or installation of the finished article in the field or by physical stresses from the environment or other natural cause.

[00087] Finally, QUV Weathering Test results were excellent for Examples 1-2 and better than that shown by Comparative Example G. The lower the value, the better the commercial acceptance of the capstock compound.

[00088] Therefore, Examples 1-3 were determined very acceptable for use as a capstock compound in the building and construction industry.

[00089] The pellets of Examples 1-3 were further tested by melt mixing two percent of black colorant with 98 weight percent of compounded pellets and then injection molded using a 120 ton injection molding machine, at temperature settings of 200°C, to make test plaques of the dimensions of 14 cm long x 9 cm wide x 3 cm thick. Again, Examples 1-3 achieved 85° Gloss Angle

of less than 10. The compounds for such plaques were measured for Shore D Hardness using ASTM Test D2240 and Drop Dart Impact using ASTM Test D5420. Table 7 shows the results.

[00090] Among Examples 1-3, the only marketable difference was the results of a Ford Motor Company test specification (Ford BN 108-13) "Five Finger or Five Arm Scratch Test" using a Taber™ Model 710 Multi-Finger Scratch/Mar Tester. Using the molded plaques, the test results for Examples 1-3 are also shown in Table 7 and demonstrated a preference Example 1 over Example 3 and Example 3 over Example 2 for uses in the market on plastic articles where resistance to scratch and mar are also important.

Table 7

	Example 1	**Example 2**	**Example 3**
Low Gloss Compounded Pellets	98%	98%	98%
Cedar Coloration	2%	2%	2%
Total	100%	100%	100%
Product Form	Brabender Strips	Brabender Strips	Brabender Strips
Gloss Angles - Brabender Strips			
85°	6.6	4.5	6.2
Shore D Durometer Hardness			
	58	55	60
Drop Dart Impact			
Passing Rate	5 for 5	5 for 5	5 for 5
Ford Scratch Test (Ford BN 108-13)			
7 Newtons	1	1	1
10 Newtons	1	2	1
15 Newtons	3	4	3
20 Newtons	3	4	4

[00091] The invention is not limited to the above embodiments. The claims follow.

What is claimed is:

1. A low gloss capstock composition, comprising:

(a) polyethylene in both pellet form and powder or flake form;

(b) polyolefin elastomer;

(c) gloss inhibiting agents comprising both silica and barium sulfate;

(d) hindered amine light stabilizer;

wherein a surface of a test strip of the composition has less than less than 1 Delta E unit CIELAB after 2000 hours according to QUV Weathering test,

wherein when a surface of a strip of the composition is tested according to ASTM D523, D2457, the surface has a Gloss Angle at 85° of less than 10 GU.

2. The composition of Claim 1, wherein the composition further optionally comprises (e) weathering agents comprising ultra-violet light absorber, and anti-oxidant; wherein (d) hindered amine light stabilizer is N,N',N'',N'''-tetrakis(4,6-bis(butyl-(N-methyl-2,2,6,6-tetramethylpiperidin-4-yl)amino)triazin-2-yl)-4,7-diazadecane-1,10-diamine and butanedioic acid1,4-dimethylester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol; and wherein the composition has ingredients in the range of weight percents of the composition:

Polyethylene (pellet form)	45-53
Polyethylene (powder or flake form)	28-38
Polyolefin elastomer	5-20
Silica Gloss Inhibiting Agent	1-4
Barium Sulfate Gloss Inhibiting Agent	1-3
Ultra-violet Light Absorber	0-0.3
Hindered Amine Light Stabilizer	0.1-0.5
Anti-Oxidant	0.1-0.3

3. The composition of Claim 1, wherein the composition further optionally comprises (e) weathering agents comprising ultra-violet light absorber, and anti-oxidant; wherein (d) hindered amine light stabilizer is N,N',N'',N'''-tetrakis(4,6-bis(butyl-(N-methyl-2,2,6,6-tetramethylpiperidin-4-yl)amino)triazin-2-yl)-4,7-diazadecane-1,10-diamine and butanedioic acid1,4-dimethylester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol; and wherein the composition is a masterbatch and has ingredients in the

range of weight percents of the masterbatch, based on a 20% usage level in a final low gloss capstock composition:

Polyethylene (pellet form)	0-15
Polyethylene (powder or flake form)	15-40
Polyolefin elastomer	35-75
Silica Gloss Inhibiting Agent	5-15
Barium Sulfate Gloss Inhibiting Agent	4-14
Ultra-violet Light Absorber	0.25-3
Hindered Amine Light Stabilizer	0.5-5
Anti-Oxidant	0.1-3

4. The composition of Claim 2 or Claim 3 further comprising colorant.

5. The composition of Claim 4, further comprising other additives selected from the group consisting of biocides; surfactants; intercalated organoclays; anti-static agents; bonding, blowing and foaming agents; dispersants; fillers and extenders; fire and flame retardants and smoke suppressants; fly ash; impact modifiers; initiators; lubricants; micas; plasticizers; processing aids; release agents; silanes, titanates and zirconates; slip and anti-blocking agents; stabilizers; stearates; ultraviolet light absorbers; viscosity regulators; waxes; pest repellants; and combinations of them.

6. The composition of Claim 2,

wherein the ultra-violet light absorber is 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol; and

wherein the anti-oxidant is a mixture of Tris (2,4-di-tert-butylphenyl) phosphite and Tetrakis [methylene-3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate] methane in a 50:50 weight ratio.

7. The composition of Claim 3,

wherein the ultra-violet light absorber is 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol; and

wherein the anti-oxidant is a mixture of Tris (2,4-di-tert-butylphenyl) phosphite and Tetrakis [methylene-3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate] methane in a 50:50 weight ratio.

8. The composition of any one of Claims 1-7, wherein each of the two different forms of polyethylene has a melt flow index of 0.2 to 0.8 g/10 min, when measured using ASTM D1238 (2.16 kg at 190°C), and wherein each of the two different forms of polyethylene has a density of from about 0.93 to about 0.97 g/cm^3.

9. The composition of any one of Claims 1-7, wherein the polyolefin elastomer is ethylene-octene copolymer.

10. The composition of any one of Claims 1-7, wherein the silica has a particle size ranging from about 5 to about 12 micrometers, wherein the barium sulfate has a particle size ranging from about 0.5 to about 5 micrometers.

11. The composition of Claim 1 or Claim 2 or Claim 6, wherein the composition is in the form of a capstock attached or adhered to a substrate.

12. A capstock made from the composition of any one of Claims 1-10, wherein the capstock has a surface that simulates the appearance of natural wood.

13. The capstock of Claim 12, wherein the composition further comprises (e) weathering agents comprising ultra-violet light absorber, and anti-oxidant; and wherein the capstock has a first surface attached or adhered to a substrate and a second surface exposed to sunlight.

14. The capstock of Claim 13, wherein the second surface has no noticeable stress whitening and less than 1 Delta E CIELAB color change.

15. The capstock of Claim 12, wherein the substrate is a building or construction item.