



- (51) **International Patent Classification:**
E04F 15/10 (2006.01) *B32B 27/06* (2006.01)
E04F 15/02 (2006.01)
- (21) **International Application Number:**
PCT/US2016/041959
- (22) **International Filing Date:**
13 July 2016 (13.07.2016)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
14/824,261 12 August 2015 (12.08.2015) US
- (71) **Applicant:** AFI LICENSING LLC [US/US]; 2500 Columbia Avenue, P.O. Box 3025, Lancaster, Pennsylvania 17604 (US).
- (72) **Inventors:** BRICKNER, Meredith, L.; 20 South Chestnut Street, Elizabethtown, Pennsylvania 17022 (US). RAMACHANDRA, Sunil; 1054 Whitmarsh Drive, Lancaster, Pennsylvania 17601 (US). ANSPACH, Kean, M.;

294 Stoney Hill Road, Quarryville, Pennsylvania 17566 (US). ESHBACH, John, R.; 160 Daplin Avenue, Marietta, Pennsylvania 17547 (US). TIAN, Dong; 2190 Butter Road, Lancaster, Pennsylvania 17601 (US).

- (74) **Agent:** GEERLOF, Christina, W.; AFI Licensing LLC, 2500 Columbia Avenue, P.O. Box 3025, Lancaster, Pennsylvania 17604 (US).
- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH,

[Continued on next page]

- (54) **Title:** IMPACT RESISTANT WEAR LAYER

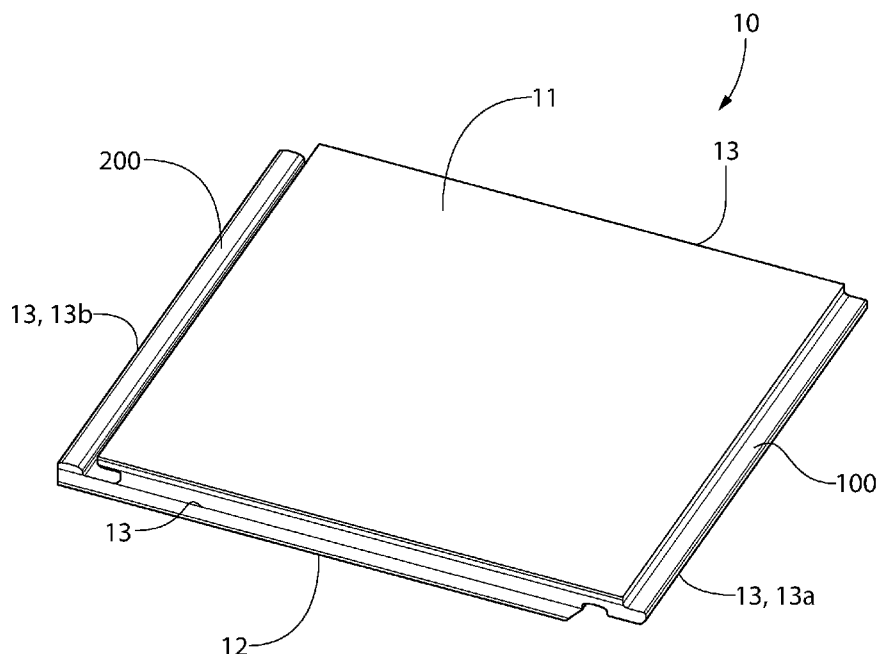


FIG. 1

[Continued on next page]



GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE,

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(57) Abstract: The invention is directed to dimensionally stable flooring panels that have mechanical locking profiles. The flooring panels having at least two layers that include a wear layer and a substrate layer, wherein the wear layer forms a part of the mechanical locking profiles.

IMPACT RESISTANT WEAR LAYER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Patent Application No. 14/824,261 filed August 12, 2015, the entirety of which is incorporated herein by reference.

BACKGROUND

[0002] Polymeric flooring systems comprise a plurality of flooring panels that are installed adjacent to one another. Previously, flooring panels having a flush side edge geometry allowed for tight seams between adjacent flooring panels. However, such flush edge geometry tends to allow for relative movement between each flooring panel in the fully installed state when mechanical stress is applied to the flooring system (i.e. walking on the flooring panels). To reduce the amount of relative movement, mechanical locking profiles have been formed in the side edge surfaces of these flooring panels, thereby improving the overall stability of resulting flooring system.

[0003] Specifically, mechanical locking profiles provide a first flooring panel having a first edge geometry (e.g. a tongue) and a second flooring panel having a second edge geometry that somewhat occupies the negative space of the first edge geometry (e.g., a groove). When the first and second flooring panels are brought together, the second edge geometry accepts the first edge geometry (or vice versa) causing the first and second flooring panels to interlock. In addition to increase stability, the mechanical locking profiles add to the overall cosmetic appearance of the flooring system by maintaining tight seams between the first and second edges of adjacent flooring panels.

[0004] However, creating mechanical locking profiles on polymeric flooring panels that comprise one or more polymeric layers, including a wear layer and a substrate, can be problematic because the polymeric layers require a balance of different performance properties. For example, the flooring panel must exhibit sufficient dimensional stability so that it does not shrink or expand overtime. Additionally, the flooring panel must have smooth edge profile even with the mechanical locking profile. Providing the requisite dimensional stability in the polymer layers, especially the upper wear layer, may create problem with respect to chipping in the side surface of the polymeric layer when the locking profile is machined. Chipping creates a

substantially rougher surface texture, which not only undermines the mechanical integrity of the flooring panel, but degrades the overall aesthetic appearance of each flooring panel as well as the seams between each flooring panel in the full installed flooring system.

[0005] Conventional polymeric flooring panels, such as vinyl tiles, typically use a plasticized polyvinyl chloride film as the wear layer. However, a plasticized wear layer may pose problems in that the plasticizer tends to migrate to the surface over time and the plasticized wear layer has to be thermally annealed to make the layer dimensionally stable.

[0006] Thus, there exists a need for wear layers that can provide desired dimensional stability without a post fabrication treatment and that resist chipping during the creation of the mechanical interlocking profile.

BRIEF SUMMARY

[0007] According to some embodiments, the present invention is directed to a flooring panel comprising a substrate layer and a wear layer atop the substrate layer. The wear layer may comprise a vinyl polymer and an impact modifier. The wear layer may also be substantially free of plasticizer.

[0008] In some embodiments, the present invention is directed to a method of forming a flooring panel, tile or sheet. For illustration purposes, the present flooring products are referred to as a flooring panel. The method may first comprise a step of forming a laminate structure comprising a substrate and a wear layer atop the substrate. The wear layer may comprise a vinyl polymer and an impact modifier, and the wear layer may be substantially free of plasticizer. Subsequently, the method may further comprise a step of machining a first edge of the laminate structure to form a first mechanical locking profile, and a second edge of the laminate structure to form a second mechanical locking profile, thereby forming the flooring panel. In some embodiments, the wear layer may form a first portion of each of the first and second mechanical locking profiles. In some embodiments, the substrate layer may form a second portion of each of the first and second mechanical locking profiles.

[0009] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0011] Figure 1 is a perspective view of a flooring panel according to some embodiments of the present invention;

[0012] Figure 2 is a side profile view of a laminate structure according to some embodiments of the present invention;

[0013] Figure 3 is a side profile view of a flooring panel according to some embodiments of the present invention.

DETAILED DESCRIPTION

[0014] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0015] As used throughout, ranges are used as shorthand for describing each and every value that is within the range. Any value within the range can be selected as the terminus of the range. In addition, all references cited herein are hereby incorporated by referenced in their entireties. In the event of a conflict in a definition in the present disclosure and that of a cited reference, the present disclosure controls.

[0016] For the purpose of this invention, the term “about” means +/- 5%. For the purpose of this invention, the phrase “substantially free” means less than 4 wt. % based on the total weight of the referenced composition.

[0017] Unless otherwise specified, all percentages and amounts expressed herein and elsewhere in the specification should be understood to refer to percentages by weight. The amounts given are based on the active weight of the material.

[0018] As shown in Figures 1 and 3, the present invention is directed to a flooring panel 10 comprising a wear layer 30 and a substrate layer 20, the wear layer 30 atop the substrate layer 20.

[0019] The wear layer 30 of the present invention may comprise a polymer and one or more additives. According to some embodiments, the polymer is selected from thermoplastic polymer. In some embodiments, the additives may include impact modifier, filler, pigment, lubricant, stabilizer, and a combination of two or more thereof. Typically, a wear layer is produced by an extrusion or calendaring process.

[0020] The polymer may include a vinyl polymer, copolymers thereof, and mixtures of two or more thereof. Non-limiting examples of the vinyl polymer suitable for the wear layer include chlorinated vinyl polymers, such as polyvinyl chloride (PVC), polyvinylidene chloride (PVDC), and copolymers of vinyl chloride and alkene monomer – such as a copolymer of vinyl chloride and vinyl acetate, as well as mixtures thereof. According to some embodiments of the invention, the wear layer 30 of the present invention is substantially free of plasticizer. Without plasticizer, the resulting wear layer 30 exhibits greater dimensional stability over time with exposure to heat and moisture. In a preferred embodiment, the wear layer 30 comprises less than 0.05 wt. % of plasticizer based on the total weight of the wear layer 30. In a preferred embodiment, the wear layer 30 is entirely free (0 wt. %) of plasticizer based on the total weight of the wear layer 30. Non-limiting examples of plasticizer may include low molecular weight phthalate esters. According to the present invention, wear layer 30 that is produced substantially free of plasticizer is not formed from plastisol, as plastisol is a mixture of vinyl polymer resin and plasticizer.

[0021] Eliminating the plasticizer from the wear layer 30 of the flooring panel 10 increases dimensional stability. Without the plasticizer the wear layer 30 tends to be brittle and becomes more susceptible to chipping during machining of the laminate structure during the formation of the mechanical locking profiles. Thus, to offset this increased susceptibility, an impact modifier may be present in the wear layer in an amount ranging from 3 wt. % to about 15 wt. % - including all integers and sub-ranges there-between based on the total weight of the wear layer composition. In a preferred embodiment, the impact modifier is present in an amount ranging from about 4 wt. % to about 10 wt. % - including all integers and sub-ranges there-between. According to the present invention, the polymer and the impact modifier may be present in a weight ratio ranging from about 20:1 to about 7:1 – including all sub-ranges there-between. In a preferred embodiment, the polymer and impact modifier are present in a weight ratio ranging from about 20:1 to about 16:1.

[0022] According to some embodiments, the wear layer 30 may contain a polymer, an impact modifier, a processing aid, a lubricant and a stabilizer. An exemplary wear layer composition may contain a polymer, e.g., PVC, and an impact modifier, e.g., acrylic impact modifier.

[0023] A suitable processing aid that improves the processability of a chlorinated polymer, improving such properties as flowability, melt fusability, and surface appearance, includes

acrylic polymer processing aids. A suitable processing aid includes PARALOID™ K-120ND, available from Dow Chemical. Lubricants suitable for the invention include acrylic polymer lubricants, such as, PARALOID™ K-175, available from Dow Chemical; fatty acid lubricants, such as stearate metal salt lubricants, e.g., Synpro™ calcium stearate 114, available from Ferror; and combinations thereof. An exemplary wear layer composition may contain polyvinyl chloride, an acrylic impact modifier between 2 and 20 PHR (parts per hundred parts of polymer resin, PVC), an acrylic processing aid between 0.1 and 5 PHR, an acrylic lubricant between 0.1 and 5 PHR, a stearate metal salt lubricant between 0.1 and 5 PHR, and a calcium-zinc stabilizer between 0.1 and 5 PHR. A preferred wear layer composition may contain polyvinyl chloride, an acrylic impact modifier between 5 and 15 PHR (parts per hundred parts of polymer resin, PVC), an acrylic processing aid between 0.5 and 2 PHR, an acrylic lubricant between 0.5 and 2 PHR, a stearate metal salt lubricant between 0.5 and 2 PHR, and a calcium-zinc stabilizer between 0.5 and 2 PHR.

[0024] Suitable impact modifiers for the present invention include acrylic impact modifiers (ACR), chlorinated polyethylene (CPE), methyl methacrylate-butadiene-styrene copolymers (MBS), copolyamides, styrene-butadiene-styrene copolymers (SBS), acrylonitrile-butadiene-styrene copolymer (ABS), and a combination thereof. Suitable acrylic impact modifiers include ACRs with a core-shell structure having a crosslinked butyl acrylate core and a grafted methyl methacrylate shell. Suitable chlorinated polyethylene includes a high molecular copolymer of high density polyethylene and chlorine. Suitable methyl-methacrylate, butadiene and styrene copolymers include core-shell copolymer having a butadiene-styrene core and a grafted methyl methacrylate shell. Suitable copolyamides include random copolymers of polyamides including copolyamides based on caprolactam, laurolactam, amino undecyclic acid, and polyethylene glycol, which is typically used as hot melt adhesives. Such suitable material includes, for example, H1937 Platamid® available commercially from Arkema. Of these, preferred are acrylic impact modifiers since acrylic impact modifiers are less susceptible to oxidative degradation.

[0025] In some embodiments, the SBS comprises styrene and butadiene in a weight ratio of about 28:72 to about 48:52. In some embodiments, the SBS comprises styrene and butadiene in a weight ratio of about 30:70 to about 40:60. In some embodiments, the SBS comprises about a ratio of about 30:70 of styrene : butadiene. In some embodiments, the ABS comprises 40 wt. %

to 50 wt. % of styrene, 25 wt. % to 30 wt. % of butadiene, and 25 wt. % to 30 wt. % of acrylonitrile. In some embodiments, the impact modifier is substantially free of methyl-methacrylate-butadiene-styrene (MBS).

[0026] According to some embodiments, the core comprise polybutyl acrylic polymer and the shell may comprise polymethyl-methacrylate.

[0027] In some embodiments, the polymeric core may have a glass transition (T_g) that is lower than the T_g of the polymeric shell. According to some embodiments, the polymeric core may have a T_g ranging from about $-50\text{ }^{\circ}\text{C}$ to about $60\text{ }^{\circ}\text{C}$. In a preferred embodiment, the T_g of the polymeric core may range from about $-20\text{ }^{\circ}\text{C}$ to about $20\text{ }^{\circ}\text{C}$. According to some embodiments, the polymeric shell may have a T_g ranging from about $50\text{ }^{\circ}\text{C}$ to about $110\text{ }^{\circ}\text{C}$.

[0028] In some embodiments, the polymeric shell may have a T_g that is lower than the T_g of the polymeric core. The polymeric core may have a T_g ranging from about $50\text{ }^{\circ}\text{C}$ to about $110\text{ }^{\circ}\text{C}$. The polymeric shell may have a T_g ranging from about $-50\text{ }^{\circ}\text{C}$ to about $60\text{ }^{\circ}\text{C}$. In a preferred embodiment, the T_g of the polymeric shell may range from about $-20\text{ }^{\circ}\text{C}$ to about $20\text{ }^{\circ}\text{C}$.

[0029] Some embodiments of the present invention provide that the core-shell polymer particles have an average particle size ranging from about 50 nanometers (nm) to about 5,000 nm – including all sub-ranges and values there between. In one embodiment, the core-shell polymer particles have an average particle size ranging from about 50 nm to about 1,000 nm. In a non-limiting embodiment, the core-shell polymer particles have an average particle size ranging from about 100 nm to about 200 nm.

[0030] According to some embodiment of the present invention, the wear layer preferably has a Tensile Energy Absorption (TEA) value greater than about 4.5 Joules/cm^2 , at least (or greater than) about 4.6 Joules/cm^2 , at least (or greater than) about 4.7 Joules/cm^2 , at least (or greater than) about 4.8 Joules/cm^2 , at least (or greater than) about 4.9 Joules/cm^2 , preferably at least (or greater than) about 5 Joules/cm^2 . In some embodiments, the wear layer may have a TEA ranging from about 4.5 Joules/cm^2 to about 6.0 Joules/cm^2 – including all sub-ranges and values by a 0.1 Joules/cm^2 increment there-between. TEA is a measure of the ability of a film to absorb mechanical shocks. TEA can easily be determined by analyzing the relationship between stress and strain in the tensile test ASTM D828-97 (reapproved 2002). The area under the stress-strain curve can be mathematically derived, and then factored into an equation as given in the test method to yield tensile energy absorption (TEA). The higher the TEA in a film, the easier it is to

stress the film without it fracturing. It has been found that lower than a desired TEA value leads to chipping when a flooring panel with the wear layer is subjected to machining to profile the locking system.

[0031] Referring to the Figures, the flooring panel 10 may further comprise a top panel surface 11 and a bottom panel surface 12 that is opposite the top panel surface 11. In some embodiments, the top panel surface 11 is formed by the wear layer 30. In some embodiments, the bottom panel surface 12 is formed by the substrate layer 20. In some embodiments, the top panel surface 11 is formed by a top coat 40 applied atop the wear layer 30. In some embodiments, the bottom panel surface 12 is formed by an underlayment 50 beneath the substrate layer 20.

[0032] The flooring panel 10 may further comprise a plurality of panel edges 13 that extend between the top panel surface 11 and the bottom panel surface 12 of the flooring panel 10. The plurality of panel edges 13 defines a perimeter of the flooring panel 10. The panel edges 13 comprise a first panel edge 13a and a second panel edge 13b opposite the first panel edge 13a.

[0033] According to some embodiments, the wear layer 30 may form a first portion of each of the first panel edge 13a and the second panel edge 13b. In some embodiments, the substrate layer 20 may form a second portion of each of the first panel edge 13a and the second panel edge 13b.

[0034] According to some embodiments, the first panel edge 13a comprises a first mechanical locking profile 100. According to some embodiments, the second panel edge 13b comprises a second mechanical locking profile 200. The first mechanical locking profile 100 may be configured to accept the second mechanical locking profile 200. The wear layer 30 may form a portion of each of the first mechanical locking profile 100 and the second mechanical locking profile 200.

[0035] In some embodiments, the first mechanical locking profile 100 may comprise a first horizontal locking feature 110 – which may be in the form of a recess. In some embodiments, the first mechanical locking profile 100 may comprise a first vertical locking feature 120 – which may be in the form of a flange. In some embodiments, the second mechanical locking profile 200 may comprise a second horizontal locking feature 210, which may be in the form of a lip. In some embodiments, the second mechanical locking profile 200 may comprise a second vertical locking feature 220, which may be in the form of a flange.

[0036] The first horizontal locking feature 110 may be configured to cooperate with the second horizontal locking feature 210 to provide horizontal locking between adjacent flooring panels 10. The first vertical locking feature 120 may be configured to cooperate with the second vertical locking feature 220 to provide horizontal locking between adjacent flooring panels 10.

[0037] The first horizontal locking feature 110 comprises a first horizontal locking wall 111 and a second horizontal locking wall 112 that faces the first horizontal locking wall 111. The first vertical locking feature 120 comprises a first vertical locking surface 121 and a second vertical locking surface 122 that is opposite the first vertical locking surface 121. The first vertical locking feature may further comprise a first distal surface 123 that extends from the first vertical locking surface 121 to the second vertical locking surface 122 in a direct that is either oblique to or at a right angle to at least one of the first or second vertical locking surfaces 121, 122. The first vertical locking surface 121 may face substantially the same direction as the top panel surface 11 of the flooring panel 10. The second vertical locking surface 122 may face substantially the same direction as the bottom panel surface 12 of the flooring panel 10.

[0038] According to some embodiments of the present invention, the substrate layer 20 may form the first horizontal locking wall 111 and the second horizontal locking wall 112 of the first horizontal locking feature 110. According to some embodiments of the present invention, the substrate layer 20 may form the first vertical locking surface 121, the second vertical locking surface 122, and the first distal surface 123 of the first vertical locking feature 120.

[0039] The second horizontal locking feature 210 comprises a third horizontal locking wall 211 and a fourth horizontal locking wall 212 that is opposite the third horizontal locking wall 211. The second vertical locking feature 220 comprises a third vertical locking surface 221 and a fourth vertical locking surface 222. The third vertical locking surface 221 faces substantially the same direction as the bottom panel surface 12 of the flooring panel 10. The fourth vertical locking surface 222 faces substantially the same direction as the top panel surface 11 of the flooring panel 10.

[0040] According to some embodiments of the present invention, the substrate layer 20 may form the third horizontal locking wall 211 and the fourth horizontal locking wall 212 of the second horizontal locking feature 210. According to some embodiments of the present invention, the substrate layer 20 may form the third vertical locking surface 221, the fourth vertical locking surface 222 of the second vertical locking feature 220.

[0041] In some embodiments, a flooring system may be installed by positioning a first flooring panel and a second flooring panel adjacent to each other and locking the first mechanical locking profile 100 of the first flooring panel with the second mechanical locking profile 200 of the second flooring panel. Specifically, the first horizontal locking wall 111 of the first flooring panel 10 may be immediately adjacent to, preferably abutting, the third horizontal locking wall 211 of the second flooring panel 10. The first vertical locking surface 121 of the first flooring panel 10 may be immediately adjacent to, preferably abutting, the third vertical locking surface 221 of the second flooring panel 10.

[0042] In some embodiments of the present invention, each of the first panel edge 13a and the second panel edge 13b comprises an upper portion 300 that is adjacent to the top panel surface 11 of the flooring panel 10. The upper portion 300 of the first panel edge 13a may comprise a first recess 130. The first recess 130 may comprise a recess wall surface 131 that extends from the top panel surface 11 toward the bottom panel surface 13 in a direction that is either oblique or at a right angle to the top panel surface 11. The first recess 130 may further comprise a recess floor surface 132 that extends from the recess wall surface 131 toward the first distal surface 123 of the first vertical locking feature 120. The recess floor surface 131 may be coplanar with the first vertical locking surface 121 of the first vertical locking feature 120. In some embodiments, the recess floor surface 132 may extend outward from the recess wall surface 131 in a direction that is substantially parallel to at least one of the top panel surface 11 and the bottom panel surface 12.

[0043] According to some embodiments of the present invention, the wear layer 30 forms a portion of the recess wall surface 131 of the first recess 130. According to some embodiments of the present invention, the substrate layer 20 forms a portion of the recess wall surface 131 of the first recess 130. According to some embodiments of the present invention, the substrate layer 20 forms the recess floor surface 132 of the first recess 130. According to some embodiments, a top coat 40 forms a portion of the recess wall surface 131.

[0044] In some embodiments, the upper portion of the second panel edge 13b comprises a first flange 140. The first flange 140 may comprise a distal surface 141. In some embodiments, the distal surface 141 of the first flange 140 may extend from the top panel surface 11 toward the bottom panel surface 13 in a direction that is either oblique or at a right angle to the top panel surface 11. In some embodiments, the distal surface 141 of the first flange 140 may extend from

the top panel surface 11 to the third vertical locking 221 of the second vertical locking feature 220. According to some embodiments, the wear layer 30 forms a portion of the distal surface 141 of the first flange 140. According to some embodiments, the substrate layer 20 forms a portion of the distal surface 141 of the first flange 140. According to some embodiments, a top coat layer 40 forms a portion of the distal surface 141 of the first flange 140.

[0045] According to some embodiments, the flooring panel 10 having the first mechanical locking profile 100 and the second mechanical locking profile 200 may be formed by first creating a laminate structure 60, as shown in Figure 2. The laminate structure 60 may be formed by coupling the wear layer 30 and the substrate layer 20 together – the wear layer 30 being atop the substrate layer 20. The laminate structure 60 may further comprise one or more additional layers, as described herein.

[0046] The laminate structure 60 may comprise a top laminate surface 61, a bottom laminate surface 62, and a plurality of laminate edges 63 that extend between the top and bottom laminate surfaces 61, 62. The laminate edges 63 may comprise a first laminate edge 63a and a second laminate edge 63b that is opposite the first laminate edge 63a. The wear layer 30 forms a first portion of each of the first laminate edge 63a and the second laminate edge 63b. In some embodiments, the first and second laminate edges 63a, 63b are then machined by a suitable blade from a machining apparatus. A non-limiting example of a machining apparatus is a router comprising a rotating router blade.

[0047] According to some embodiments of the present invention, machining the first laminate edge 63a with the suitable blade forms the first mechanical locking profile 100 of the first panel edge 13a – such that the wear layer 30 forms a first portion of the first mechanical locking profile 100 and the substrate layer 20 form a second portion of the first mechanical locking profile 100. According to some embodiments of the present invention, machining the second laminate edge 63b with the suitable blade forms the second mechanical locking profile 200 of the second panel edge 13b – such that the wear layer 30 forms a first portion 300 of the second mechanical locking profile 200 and the substrate layer 20 form a second portion 400 of the second mechanical locking profile 200.

[0048] In some embodiments, during the formation of the flooring panel 10, specifically during the machining of at least one of the first laminate edge 63a or the second laminate edge 63b, at least a portion of the wear layer 30 is removed by the blade during machining. Using the wear

layer 30 formulation of the present invention provides first and second panel edges 13a, 13b – including the first and second mechanical locking profiles 100, 200 – that are substantially free of chips and have a smooth surface texture.

[0049] In some embodiments, the wear layer 30 may have a thickness ranging from about 3 to about 40 mil, preferably from about 5 to about 20 mil – including all integers and sub-ranges there-between.

[0050] In some embodiments, the substrate layer 30 of the flooring panel 10 may have an overall thickness ranging from about 60 to about 200 mil – including all integers and sub-ranges there-between. Some embodiments provide that the substrate layer 20 may be comprised of a single core layer comprised of binder and filler (not pictured). Such single core layer have a thickness ranging from 50 to 150 mil. As shown in Figure 3, some embodiments provide that the substrate layer 20 is comprised of multiple core layers – including at least an upper core layer 21 and a lower core layer 22, the upper core layer 21 being atop the lower core layer 22.

[0051] In some embodiments the upper core layer 21 comprises a first amount of binder and filler and the lower core layer 22 comprises a second amount of binder and filler, wherein the first amount of binder and filler is either the same or different than the second amount of binder and filler. In a preferred embodiment, the first amount of binder and filler is different than the second amount of binder and filler. The upper core layer 21 may have a thickness ranging from about 30 to about 100 – including all integers and sub-ranges there-between. The lower core layer 22 may have a thickness ranging from about 30 to about 100 – including all integers and sub-ranges there-between.

[0052] According to some embodiments, an intermediate core layer 23 may be positioned between the upper core layer 21 to the lower core layer 22. In some embodiments, the intermediate core layer 22 may be an adhesive, a thermal and/or acoustical insulating material, or a combination thereof.

[0053] In some embodiments, the binder of the core layers (i.e. the single core layer, the upper core layer 21, the lower core layer 22) may comprise addition polymers, such as acrylic polymers and vinyl polymers, condensation polymers, or a combination of two or more thereof. Non-limiting examples of vinyl polymer include polyvinyl chloride (PVC), polyvinylidene chloride (PVDC), copolymers of vinyl chloride and alkene monomer, as well as mixtures thereof. Non-limiting examples of condensation polymers include polyester, polyamide, and

polyurethane. In some embodiments, the filler may include particles of calcium carbonate, talc, alumina, cellulosic material, and combinations of two or more thereof.

[0054] In some embodiments, the substrate layer may be the polymeric core, which comprises a binder polymer and a filler of a Luxury Vinyl Tile (“LVT”), a Vinyl Composition Floor Tile (“VCT”), and a Solid Vinyl Floor Tile (“SVT”). Other suitable substrates that can be used with the wear layer include plastic composite cores and wood plastic composite cores. According to the present invention, “luxury vinyl tile” is an understood term of art in the flooring industry. According to ASTM F 1066, “Vinyl Composition Floor Tile” (VCT) is an accepted official standard category for flooring materials within the flooring industry. Similarly, according to ASTM F 1066, “Solid Vinyl Floor Tile” (SVT) is an accepted official standard category for flooring materials within the flooring industry.

[0055] In some embodiments, the flooring panel 10 may further comprise an underlayment layer 50 beneath the substrate layer 20. In some embodiments, the flooring panel 10 may further comprise a top coat 40 atop the wear layer 30. Some embodiments provide that one or more intervening layers located between the wear layer 30 and the top coat 40. A non-limiting example of such intervening layers include one or more decorative print layers. Some embodiments provide that one or more additional layers can be positioned between the wear layer 30 and the substrate layer 20.

[0056] In some embodiments, the top coat 40 may comprise one of the aforementioned vinyl polymers, polyurethane, or polyester, and fillers and additives. In some embodiments, the fillers may comprise abrasive particles, such as alumina, diamond, carbide or silica. In some embodiments, the top coat 40 is a clear coat having about 100% transparency. In some embodiments, the top coat 40 may have a thickness ranging from about 0.25 to about 1.5 mil – including all integers and sub-ranges there-between.

[0057] In some embodiments, the underlayment layer 50 may comprise an insulating material, such as cork, PVC, polyurethane, or polyolefin, which may be foamed or solid. In some embodiments, the underlayment layer 50 may have a thickness ranging from about 5 to about 100 mil – including all integers and sub-ranges there-between.

[0058] The following examples are prepared in accordance with the present invention. The present invention is not limited to the examples described herein.

EXAMPLES

[0059] Example 1

[0060] The following examples are prepared in accordance with some embodiments of the present invention. The examples are prepared by dry blending the ingredients in a dry blender creating a dry mix. Mixing mill rolls are pre-heated to 350 °F and the dry mix is slowly added to the nip of the mill roll. The dry mix is continually added until a clear film / sheet is developed on the mill roll at which point the sheet is pulled from the mill roll and cooled to room temperature. Each sheet is then tested for tensile energy absorption (TEA) using an Instron tensile strength testing machine.

[0061] The following compositions are used for the examples provided herein:

- Resin: 100 wt.% polyvinyl chloride polymer (PVC), commercially available from Formosa as Formolon 608;
- Impact Modifier 1 (“IM-1”) – 100 wt.% of acrylic polymer available from Dow as Paraloid HIA-80
- Impact Modifier 2 (“IM-2”) – 100 wt.% of copolyamide polymer available from Arkema as Platamid H 1937;
- Impact Modifier 3 (“IM-3”) – 100 wt.% of a polyester polymer produced from propanediol, isophthalic acid, phthalic acid, and adipic acid.;
- Impact Modifier 4 (“IM-4”) – 48 wt.% of polyester polymer available from BASF as Ecoflex F Blend C1200; 52 wt.% of polyesters similar to the polyester indicated above as IM-3;
- Impact Modifier 5 (“IM-5”) – 100% of terpolymer: methyl-methacrylate-butadiene-styrene (MBS) available from Dow as Paraloid BTA-730;
- Impact Modifier 6 (“IM-6”) – 100% of terpolymer: methyl-methacrylate-butadiene-styrene (MBS) available from Dow as Paraloid BTA-717;
- PA: Processing Aid - acrylic composition, commercially available from Dow as Paraloid K-120ND
- L-1: Lubricant – acrylic composition, commercially available from Dow as Paraloid K-175
- L-2: Lubricant – calcium stearate, commercially available from Ferro as Synpro Calcium Stearate 114-40 Veg

- S: Stabilizer (S) – Calcium Zinc, commercially available from Baerlocher as Baerostab B2389.
- CS1 – commercial MBS impact modified PVC film from Klockner, which contains a low level of the impact modifier.

[0062] The following amounts in Table 1 are in grams (g).

Table 1

	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Contro 11	Contro 12
										CS1
Resin	800. 0	800. 0	800. 0	800. 0	800. 0	800. 0	800. 0	800. 0	800.0	
IM-1 (Acrylic)	-	-	-	-	40.0	-	40.0	-	-	
IM-2 (Copolyamide)	96.0	-	-	-	-	-	-	48.0	-	
IM-3 (Polyester)	-	96.0	-	-	-	-	-	-	-	
IM-4 (Polyester)	-	-	112. 2	-	-	-	-	-	-	
IM-5 (MBS)	-	-	-	40	-	-	-	-	-	
IM-6 (MBS)	-	-	-	-	-	40	-	-	-	
PA	8.0	8.0	8.0	8.0	16.0	8.0	8.0	8.0	16.0	
L-1	4.0	4.0	4.0	4.0	12.0	4.0	4.0	6.0	12.0	
L-2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0	4.0	
S	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
Total	920. 0	920. 0	936. 2	864. 0	880. 0	864. 0	864. 0	872. 0	840.0	
TEA (J/cm2)	5.6	0.8	0.8	4.7	4.1	4.7	5.6	3.9	2.9	4.5

[0063] A flooring sample is produced thermally laminating a conventional LVT substrate and the commercial impact modified film CS1. The flooring sample is machined to provide a locking system. The machining of the flooring sample results in chipping of the CS1 layer. For Ex 2 and Ex 3, polyesters are added in the wear layer composition with the expectation that resilient polymer may provide improved tensile strength. Ex. 5 demonstrates that, as expected, the addition of a high content of processing aids reduces the tensile properties of the wear layer.

[0064] Example 2

[0065] Each sample is tested for resistance to yellowing by exposing each test sample to light for a period of time to simulate exposure to sunlight over an extended period of time. A visual assessment is then performed to see if yellowing had occurred in each sample. The results are provided below in Table 2.

Table 2

	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Control 2
Yellowing	N	N	N	Y	N	Y	N	N	N

[0066] Example 3

[0067] The wear layers of commercially available luxury vinyl tiles from various manufacturers are tested for the presence of a plasticizer in the layer.

Table 3

	Plasticizer	Plasticizer amount (wt. %)
Manufacturer 1	Y	19
Manufacturer 2	Y	39
Manufacturer 3	Y	8
Manufacturer 4	Y	9
Manufacturer 5	Y	10

[0068] The wear layer containing a plasticizer, e.g., phthalate plasticizer or nonphthalate plasticizer, such as cyclohexane dicarboxylic acid diisononyl ester, which plasticizer may migrate out to the wear layer surface and require a thermal annealing process to stabilize the layer.

CLAIMS

WHAT IS CLAIMED IS:

1. A flooring panel comprising:
 - a substrate layer; and
 - a wear layer atop the substrate layer, the wear layer comprising a vinyl polymer and an impact modifier, the wear layer being substantially free of plasticizer.
2. The flooring panel according to claim 1, wherein the flooring panel further comprises a top panel surface, a bottom panel surface, and a plurality panel edges extending between the top and bottom panel surfaces to define a perimeter of the flooring panel; wherein the panel edges comprise a first panel edge and a second panel edge opposite the first panel edge; and wherein the first panel edges comprises a first mechanical locking profile and the second panel edge comprises a second mechanical locking profile configured to accept the first mechanical locking profile.
3. The flooring panel according to claim 2, wherein the wear layer forms a first portion of each of the first and second panel edges; and wherein the substrate layer forms a second portion of each of the first and second panel edges.
4. The flooring panel according to any one of claims 2 to 3, wherein the first mechanical locking profile comprises a first horizontal locking feature and a first vertical locking feature; and wherein the second mechanical locking profile comprises a second horizontal locking feature configured to cooperate with the first horizontal locking feature to provide horizontal locking and a second vertical locking feature configured to cooperate with the first vertical locking feature to provide vertical locking.
5. The flooring panel according to any one of claims 2 to 4, wherein each of the first and second panel edges comprises an upper portion adjacent the top panel surface, the upper portion of the first panel edge comprising a first recess having a recess wall surface and a recess floor surface, and the upper portion of the second panel edge comprises a first flange having a distal surface; and wherein the wear layer forms a portion of the distal surface of the first flange and a portion of the recess wall surface of the first recess.

6. The flooring panel according to any one of claims 1 to 5, wherein the vinyl polymer is selected from the group consisting of polyvinyl chloride (PVC), vinylidene chloride, and copolymers of vinyl chloride and alkylene.
7. The flooring panel according to any one of claims 1 to 6, wherein the impact modifier comprises an acrylic polymer, a vinyl polymer, a copolyamide, and combination of two or more thereof.
8. The flooring panel according to claim 7, wherein the impact modifier comprises an acrylic polymer consisting of a copolymer of methyl methacrylate – ethyl acrylate; a copolymer of styrene – butadiene – styrene; a copolymer of styrene – butadiene – acrylonitrile; a graft copolymer of methyl methacrylate and polybutyl acrylate; and a combination of two or more thereof.
9. The flooring panel according to claim 7, wherein the impact modifier comprises an acrylic polymer that has a core of polybutyl acrylic polymer and a shell of methyl-methacrylate.
10. The flooring panel according to any one of claims 1 to 9, wherein the vinyl polymer and impact modifier are present in a weight ratio ranging from about 20:1 to about 6:1 and the impact modifier comprises an acrylic polymer.
11. The flooring panel according to any one of claims 1 to 7, wherein the vinyl polymer and impact modifier are present in a weight ratio ranging from about 20:1 to about 6:1 and the impact modifier comprises a copolyamide.
12. The flooring panel according to any one of claims 1 to 11, wherein the wear layer has a thickness ranging from about 3 to about 40 mil.
13. The flooring panel according to any one of claims 1 to 12, wherein the substrate layer has a thickness ranging from about 60 to about 180 mil.
14. The flooring panel according to any one of claims 1 to 13, wherein at least one intervening layer is located between the wear layer and the substrate layer.
15. The flooring panel according to any one of claims 1 to 14, wherein the wear layer has a TEA value higher than about 4.6 Joules/cm².

16. The flooring panel according to any one of claims 1 to 15, wherein the substrate layer comprises a vinyl composition and the substrate layer being selected from the group consisting of a vinyl composition tile (VCT), a luxury vinyl tile (LVT), and a solid vinyl tile (SVT).
17. A method of forming a flooring panel comprising:
 - a) forming a laminate structure comprising a substrate and a wear layer atop the substrate, the wear comprising a vinyl polymer and an impact modifier, the wear layer being substantially free of plasticizer; and
 - b) machining a first edge of the laminate structure to form a first mechanical locking profile, and a second edge of the laminate structure to form a second mechanical locking profile, thereby forming the flooring panel;wherein the wear layer forms a first portion of each of the first and second mechanical locking profiles and the substrate layer forms a second portion of each of the first and second mechanical locking profiles.
18. The method of forming a flooring panel according to claim 17, wherein a portion of the wear layer is removed during step b).
19. The method of forming a flooring panel according to any one of claims 17 to 18, wherein the vinyl polymer and impact modifier are present in a weight ratio ranging from about 20:1 to about 7:1 comprises an acrylic polymer.
20. The method of forming a flooring panel according to any one of claims 17 to 19, wherein the vinyl polymer is selected from the group consisting of polyvinyl chloride (PVC), vinylidene chloride, and copolymers of vinyl chloride and an alkylene; and wherein the impact modifier comprises an acrylic polymer, polyester, chlorinated polyethylene, copolyamide, and combination of two or more thereof.

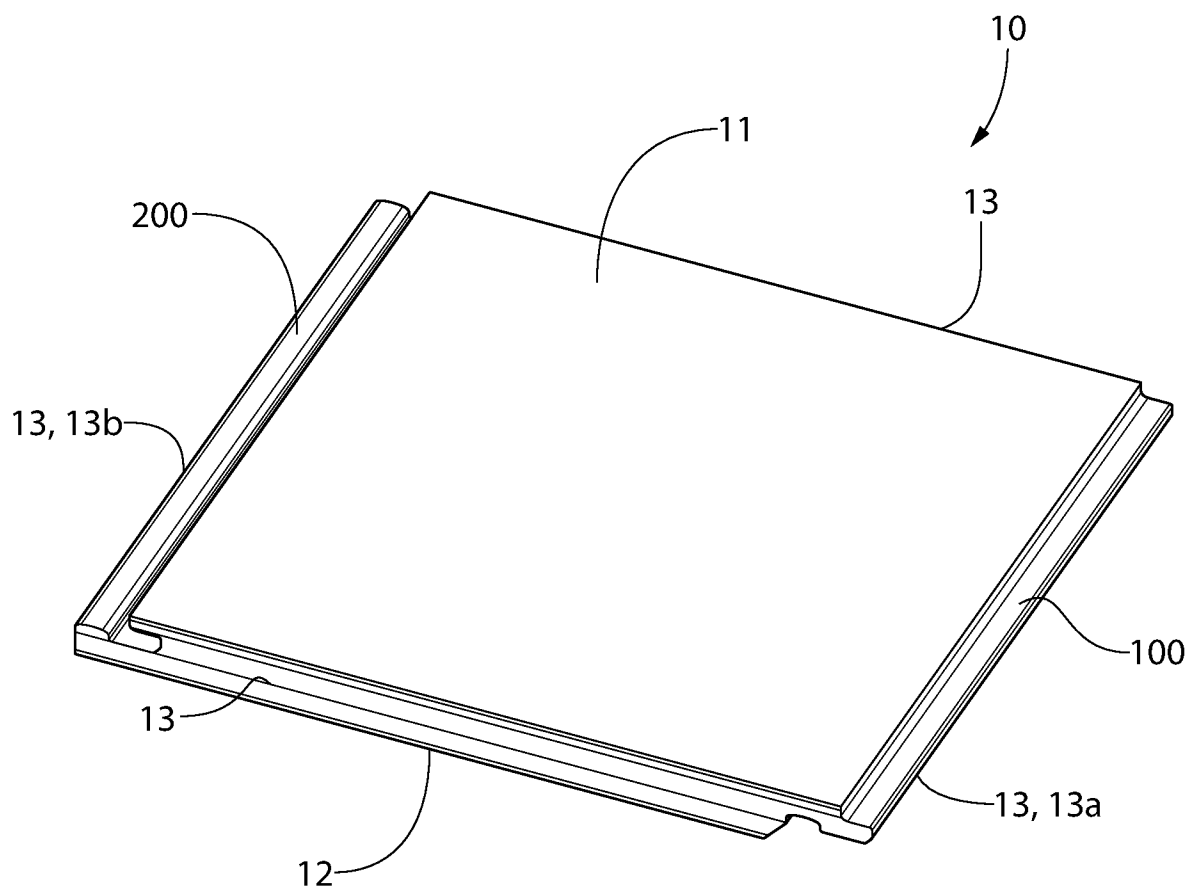
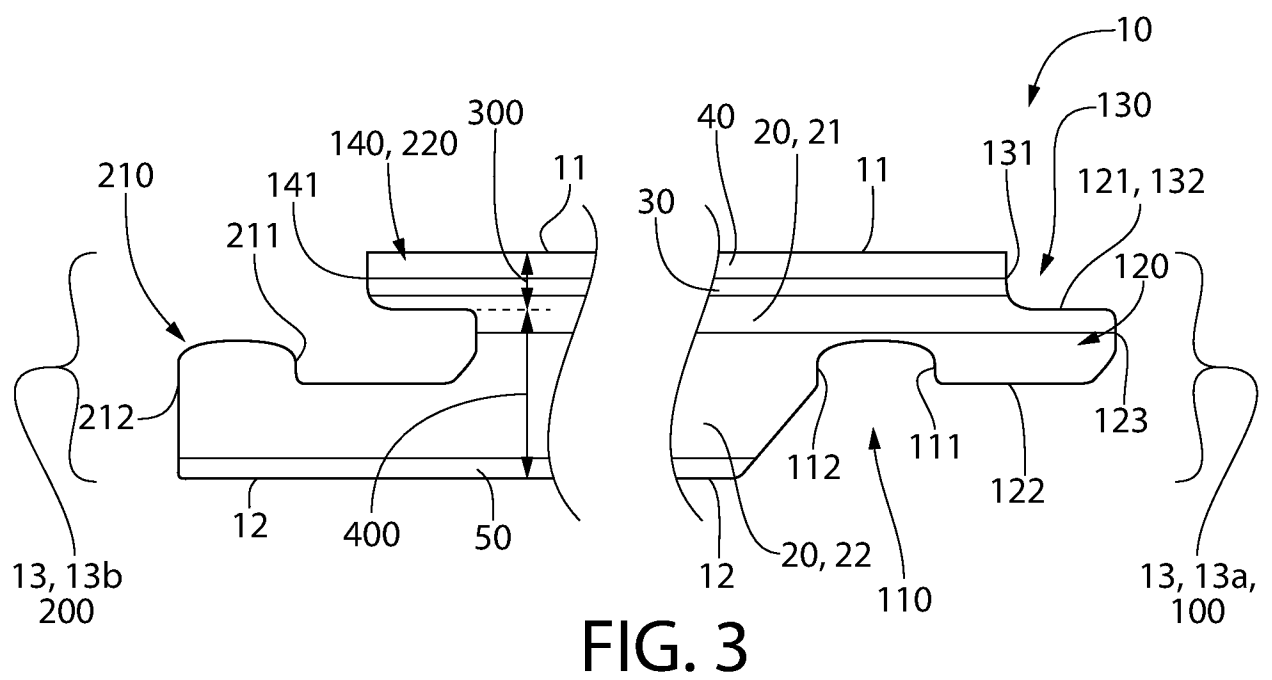
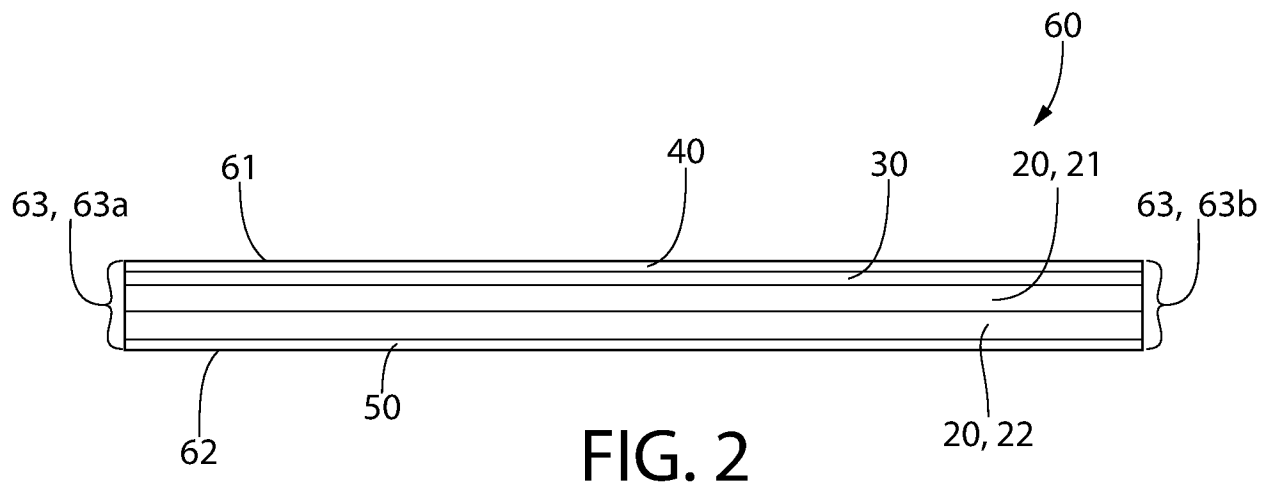


FIG. 1



A. CLASSIFICATION OF SUBJECT MATTER**E04F 15/10(2006.01)i, E04F 15/02(2006.01)i, B32B 27/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04F 15/10; E04B 2/18; E04B 2/00; B32B 37/00; E04F 15/02; E04B 5/00; B32B 37/12; E04C 2/20; B32B 27/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords:flooring panel, plank, wear layer, vinyl, polymer, groove, assemble, profile and tongue.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0167744 A1 (WHISPELL et al.) 14 July 2011 See paragraphs [0075]-[0092], [0105]-[0108], [0190], [0207] and figures 2-4, 9-10, 17, 22, 61.	1-20
A	US 2012-0135203 A1 (ALBERT et al.) 31 May 2012 See paragraphs [0016]-[0028] and figure 1.	1-20
A	US 2013-0014890 A1 (PERVAN et al.) 17 January 2013 See paragraphs [0011]-[0028] and figure 1a-1c.	1-20
A	US 2009-0151291 A1 (PERVAN, TONY) 18 June 2009 See paragraphs [0023]-[0043] and figures 1a-1b.	1-20
A	US 2004-0031226 A1 (MILLER et al.) 19 February 2004 See paragraphs [0009]-[0012] and figure 2.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 October 2016 (18.10.2016)

Date of mailing of the international search report

18 October 2016 (18.10.2016)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

BAE, Geun Tae

Telephone No. +82-42-481-3547



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/041959

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0167744 A1	14/07/2011	CA 2786529 A1	14/07/2011
		CN 102803625 A	28/11/2012
		CN 102803625 B	31/12/2014
		EP 2524090 A1	21/11/2012
		US 2014-0352248 A1	04/12/2014
		US 2016-0194885 A1	07/07/2016
		US 8833028 B2	16/09/2014
		WO 2011-085306 A1	14/07/2011
US 2012-0135203 A1	31/05/2012	CN 103097623 A	08/05/2013
		EP 2614195 A1	17/07/2013
		KR 10-2013-0136373 A	12/12/2013
		WO 2011-150076 A1	01/12/2011
US 2013-0014890 A1	17/01/2013	AU 2004-295646 A1	16/06/2005
		AU 2004-295646 B2	01/04/2010
		CA 2546689 A1	16/06/2005
		CA 2546689 C	07/08/2012
		CN 1886567 A	27/12/2006
		EP 1704291 A1	27/09/2006
		EP 1704291 B1	21/04/2010
		EP 2196598 A2	16/06/2010
		EP 2196598 A3	01/12/2010
		EP 2415947 A2	08/02/2012
		EP 2415947 A3	14/03/2012
		JP 2007-513276 A	24/05/2007
		JP 4652339 B2	16/03/2011
		US 2005-0210810 A1	29/09/2005
		US 2008-0172971 A1	24/07/2008
		US 2011-0041996 A1	24/02/2011
		US 2014-0115994 A1	01/05/2014
		US 7568322 B2	04/08/2009
		US 7886497 B2	15/02/2011
		US 8293058 B2	23/10/2012
		US 8613826 B2	24/12/2013
		WO 2005-054599 A1	16/06/2005
US 2009-0151291 A1	18/06/2009	BG 100126A	28/06/1996
		BG 61457B1	29/08/1997
		BR 9406718 A	06/02/1996
		CA 2150384 A1	24/11/1994
		CA 2150384 C	26/04/2005
		CA 2339339 A1	24/11/1994
		CA 2339339 C	21/06/2005
		CA 2339341 A1	24/11/1994
		CA 2339341 C	27/12/2005
		CA 2339342 A1	24/11/1994
		CA 2339342 C	20/12/2005
		CA 2339344 A1	24/11/1994

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/041959

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		CA 2339344 C	27/12/2005
		CN 1122623 A	15/05/1996
		CN 1285447 A	28/02/2001
		CN 1285448 A	28/02/2001
		CN 1294238 A	09/05/2001
		CN 1294239 A	09/05/2001
		CN 1514087 A	21/07/2004
		CZ 291953 B6	18/06/2003
		CZ 9502852 A3	15/05/1996
		DE 05025406 T1	17/12/2009
		DE 69413391 T2	04/02/1999
		DE 69413391 T3	25/05/2005
		DE 69421945 T2	27/04/2000
		DE 69421945 T3	05/01/2006
		DE 69422838 T2	15/06/2000
		DE 69432807 T2	19/05/2004
		DE 69433415 T2	16/09/2004
		DE 69434094 T2	24/03/2005
		DE 69434534 T2	18/05/2006
		DE 69434539 T2	24/05/2006
		DE 69434559 T2	01/06/2006
		DK 0698162 T3	28/12/1998
		DK 0698162 T4	06/12/2004
		DK 0855482 T3	10/04/2000
		DK 0855482 T4	19/09/2005
		DK 0877130 T3	17/04/2000
		DK 0969163 T3	15/11/2004
		DK 0969164 T3	08/03/2004
		DK 1260653 T3	05/12/2005
		DK 1260654 T3	30/01/2006
		DK 1267013 T3	05/12/2005
		DK 1626136 T3	06/04/2010
		EP 0698162 A1	28/02/1996
		EP 0698162 A1	29/07/1998
		EP 0698162 B1	16/09/1998
		EP 0698162 B2	27/10/2004
		EP 0855482 A2	29/07/1998
		EP 0855482 A3	18/11/1998
		EP 0855482 B1	01/12/1999
		EP 0855482 B2	08/06/2005
		EP 0877130 A2	11/11/1998
		EP 0877130 A3	18/11/1998
		EP 0877130 B1	26/01/2000
		EP 0958441 A1	02/05/2002
		EP 0958441 B1	23/07/2003
		EP 0969163 A2	05/01/2000
		EP 0969163 A3	02/02/2000
		EP 0969163 B1	20/10/2004
		EP 0969164 A2	05/01/2000
		EP 0969164 A3	02/02/2000

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/041959

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 0969164 B1	10/12/2003
		EP 1061201 A2	20/12/2000
		EP 1061201 A3	01/08/2001
		EP 1061201 B1	04/06/2003
		EP 1260653 A2	27/11/2002
		EP 1260653 A3	18/12/2002
		EP 1260653 B1	09/11/2005
		EP 1260654 A2	27/11/2002
		EP 1260654 A3	18/12/2002
		EP 1260654 B1	23/11/2005
		EP 1267013 A1	18/12/2002
		EP 1267013 B1	02/11/2005
		EP 1361318 A2	12/11/2003
		EP 1361318 A3	07/01/2004
		EP 1626136 A2	15/02/2006
		EP 1626136 A3	23/04/2008
		EP 1626136 B1	06/01/2010
		EP 1626136 B2	19/08/2015
		EP 2166177 A2	24/03/2010
		EP 2166177 A3	11/05/2011
		ES 2122280 T3	16/12/1998
		ES 2122280 T5	16/05/2005
		ES 2140983 T3	01/03/2000
		ES 2140983 T5	16/10/2005
		ES 2141630 T3	16/03/2000
		ES 2194662 T3	01/12/2003
		ES 2209326 T3	16/06/2004
		ES 2230797 T3	01/05/2005
		ES 2249521 T3	01/04/2006
		ES 2251550 T3	01/05/2006
		ES 2251551 T3	01/05/2006
		ES 2337584 T3	27/04/2010
		FI 113486 B	30/04/2004
		FI 117764 B	15/02/2007
		FI 117765 B	15/02/2007
		FI 20001601 A	04/07/2000
		FI 20001602 A	04/07/2000
		FI 20061069 A	04/12/2006
		FI 951211 A0	15/03/1995
		GR 3032335 T3	27/04/2000
		GR 3032392 T3	31/05/2000
		HU 214470 B	30/03/1998
		HU 75843 A2	28/05/1997
		HU T75843 A	28/05/1997
		JP 2001-032382 A	06/02/2001
		JP 2001-032383 A	06/02/2001
		JP 2001-040860 A	13/02/2001
		JP 2001-049844 A	20/02/2001
		JP 3444889 B2	08/09/2003
		JP 3515494 B2	05/04/2004

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/041959

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 3547692 B2	28/07/2004
		JP 3547693 B2	28/07/2004
		JP 3547694 B2	28/07/2004
		JP 8510022 A	22/10/1996
		KR 10-0387661 B1	19/09/2003
		KR 10-0413372 B1	13/01/2004
		LV 11491 A	20/08/1996
		LV 11491 B	20/02/1997
		NO 20061755 A	11/11/1994
		NO 305614 B1	28/06/1999
		NO 320446 B1	05/12/2005
		NO 321469B1	15/05/2006
		NO 950790 A	22/05/1995
		NO 986137 A	22/05/1995
		NO 993136 A	24/06/1999
		NZ 266232 A	26/11/1996
		US 05706621 A	13/01/1998
		US 05860267 A	19/01/1999
		US 06023907 A	15/02/2000
		US 2001-0029720 A1	18/10/2001
		US 2002-0178673 A1	05/12/2002
		US 2002-0178674 A1	05/12/2002
		US 2002-0178682 A1	05/12/2002
		US 2003-0009972 A1	16/01/2003
		US 2003-0196405 A1	23/10/2003
		US 2005-0166502 A1	04/08/2005
		US 2006-0283127 A1	21/12/2006
		US 6182410 B1	06/02/2001
		US 6205639 B1	27/03/2001
		US 6324803 B1	04/12/2001
		US 6516579 B1	11/02/2003
		US 6880305 B2	19/04/2005
		US 7086205 B2	08/08/2006
		US 7121059 B2	17/10/2006
		US 7775007 B2	17/08/2010
		US 7823359 B2	02/11/2010
		US 7856785 B2	28/12/2010
		US E039439 E1	26/12/2006
		US RE39439 E1	26/12/2006
		WO 94-26999 A1	24/11/1994
		WO 98-24994 A1	11/06/1998
US 2004-0031226 A1	19/02/2004	CN 1685120 A	19/10/2005
		CN 1685120 B	30/01/2013
		US 7441384 B2	28/10/2008
		WO 2004-016873 A1	26/02/2004