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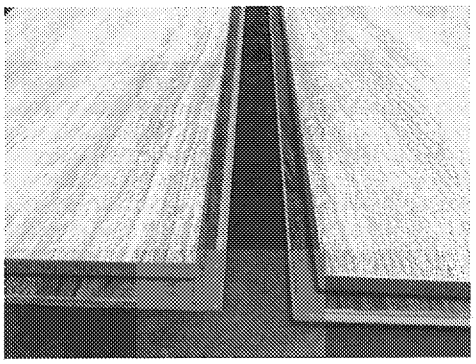
(54) **Title:** EASY TO INSTALL CERAMIC OR STONE TILE PRODUCT

FIG. 3



(57) **Abstract:** A hard tile product and system useful for covering floors, walls and other surfaces which are both easy to install and remove are provided.

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EASY TO INSTALL CERAMIC OR STONE TILE PRODUCT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to U.S. Provisional Patent Application Serial No. 62/486674, filed April 18, 2017, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] Ceramic tiles are among the most widely installed flooring around the world. Installing ceramic tiles, however, takes much effort and the cost of installation per square foot is very high compared to vinyl or wood planks which can be installed with click technology.

[0003] Various thermoplastic planks comprising a core, print layer and optionally an overlay are disclosed in, for example U.S. Patents 6,617,009, 6,986,934, 7,211,310, 7,419,717, 7,763,345, and 8,021,741. In these planks, the core is comprised of at least one thermoplastic material and the print layer is preferably an aminoplast resin impregnated printer paper. Optionally, the edges of these thermoplastic planks may have a tongue and groove design for attachment to each other in a floating floor system.

[0004] Various alternative configurations for attachment of planks of a plank flooring system are disclosed, for example, in U.S. Patents 7,770,350, 7,866,115, 8,099,919, and 8,875,465 and Published U.S. Patent Application Nos. 2003/0024199, 2004/0016196 and 2005/0097860.

[0005] Further, floor planks with a core modified to include a sound absorbing layer or a cork layer providing sound and heat insulation are disclosed in U.S. Patents 8,234,829 and 8,171,691, respectively.

[0006] A floor plank of a laminate of two layers of flexible plastic sheet material laminated together in offset relationship to define an offset marginal portion for each of the layers is disclosed in U.S. Patent 7,155,871.

[0007] Layered wood composites for flooring are disclosed in U.S. Patents 7,544,423 and 7,261,947.

[0008] In addition, floor coverings with protective aluminum oxide in the outermost surface are disclosed in Published U.S. Patent Application No. 2002/0025446, while building panels with a decorative surface having a wear layer including fibers, binders and wear resistant particles are disclosed in U.S. Patent 8,431,054.

[0009] Engineered waterproof plastic composite flooring and wall covering planks with a veneer layer, an extruded plastic composite core, a click-lock edge fastening system and an optional underlayer are disclosed in U.S. Patent 9,234,357. Various veneer layers inclusive of stone or tile veneers are disclosed. However, such a veneer is less than 3 mm thick as per industry standards. See veneer definition in en. with the extension wikipedia.org/wiki/Wood veneer of the world wide web. A stone or tile veneer less than 3 mm thickness can easily break and does not provide for robust flooring. Further, the adhesive layer that bonds veneer to the core is described as a water resistant hot melt adhesive and is applied during the manufacture of the engineered flooring at temperatures over 200°F. Hence, the tile will be very difficult to dismantle from the substrate when needed. Further, even if the tile is dismantled, damage to the tile or the substrate is likely, thereby preventing reuse.

[00010] Further, commercially available polymer cores can dent easily and provide inadequate support for a rigid ceramic tile on top. In addition, the polymer core has thermal expansion coefficient which is significantly more than that of ceramic tile, which could lead to damage to the joints, cracking of core, and buckling of floor itself.

[00011] A modular tile assembly having a substantially rigid substrate, at least one sealant layer and at least one stone, ceramic or porcelain tile is disclosed in U. S. Patent 7,993,731. The sealant layer that bonds stone, ceramic or porcelain tile to the substrate below is described as hot glue or polyurethane resin adhesive. Conventional adhesives such as one component thermo-setting urethane adhesives are described. Use of these adhesives makes removal of tile from substrate very difficult. Further, even if the tile is dismantled, damage to the tile or the substrate is likely, thereby preventing reuse.

[00012] A floating floor system that uses real porcelain tile is SnapStone. This system uses real porcelain tile which is permanently adhered to a tray engineered with click together tabs which are then snapped together to create grout lines. The system is described as being installable over most existing hard surfaces without the need for thin set, backer board and mortar. However, the plastic frame is specific to the size of tile and the number of stock keeping units for this system is large. Further, the tile has to be rectified as tolerances should be very tight. This limits offerings and increases the cost of the product.

[00013] Accordingly, there is a need for cost-effective, easy to install, hard tile products wherein each component in the assembly can be easily removed, replaced or reused when

needed. This will enable home owners to replace damaged tiles or refresh their flooring with tiles of new designs.

SUMMARY

[00014] The present disclosure relates to an easy to install hard tile product that significantly reduces effort and time for installation as well easy dismantling and replacement when needed thus creating value for the consumer.

[00015] An aspect of the present disclosure is directed to an engineered plank. The plank comprises hard tile comprising mineral or metal with a Mohs hardness scale rating of 4 or greater, a composite core with a Mohs hardness scale rating of less than 4, an attachment system which attaches the hard tile to the composite core, and a connection system to connect to adjacent engineered planks. In some nonlimiting embodiments, the attachment system is a removable attachment system so that the hard tile is not permanently attached to the composite core. Nonlimiting examples of hard tile which can be used in these engineered planks include ceramic, porcelain, natural stone, glass, metal or metal alloy such as steel. The present disclosure enables such hard tile to be assembled easily via the composite core, attachment system and connection system. Further, embodiments comprising a removable attachment system enable easy dismantling without damage to the hard tile or composite core.

[00016] In one nonlimiting embodiment of the engineered plank of the present disclosure, the thickness of the hard tile is greater than 3 mm

[00017] In one nonlimiting embodiment of the engineered plank of the present disclosure, the attachment system attaching the hard tile to the composite core comprises an adhesive. Nonlimiting examples of adhesives include removable hot melt adhesives, pressure sensitive adhesives, moisture resistant adhesives, and combinations thereof

[00018] In another nonlimiting embodiment of the engineered plank of the present disclosure, the attachment system attaching the hard tile to the composite core is magnetic.

[00019] In one nonlimiting embodiment, the composite core of the engineered plank has a coefficient of expansion of core in the range 5 $x10^{-6}$ to $30x10^{-6}$ inch/inch/deg F.

[00020] In one nonlimiting embodiment, the composite core of the engineered plank has a dent resistance such that long term denting per ASTM F970 is less than 0.005 inches and/or short term denting per ASTM F1914 is less than 0.005 inches.

[00021] In one nonlimiting embodiment, the composite core of the engineered plank comprises a polymer selected from high density polyethylene, polypropylene, polyethylene, low density polyethylene, polyamide, polyester, polyvinyl chloride, polylactic acid or a copolymer, recycled polymer or blend thereof. In one nonlimiting embodiment, the composite core may further comprise a filler and/or an additive.

[00022] In some nonlimiting embodiments, the engineered plank may further comprise a second attachment system on the composite core to which an underlayment layer may be adhered. In some nonlimiting embodiment, the engineered plank may further comprise an underlayment layer adhered to the composite core.

[00023] Another aspect of the present disclosure relates to a system for covering floors, walls and other hard surfaces with these engineered planks. The system comprises two or more of the engineered planks connected adjacently via the connection system.

[00024] In one nonlimiting embodiment, the hard tile is inset from the edge of the composite core to provide a gap when connected to an adjacent engineered plank. In this embodiment, when the gaps are filled in with grout, caulk or sealant, any water on the hard tile may be prevented from reaching click joints, potentially penetrating joints and reaching subfloors, thus preventing mold/mildew and odor issues.

[00025] In one nonlimiting embodiment, gaps between hard tile of connected planks are grouted using, for example, an acrylic, urethane, epoxy or cementitious grout. In one nonlimiting embodiment, any gaps between hard tile of connected planks are filled with a removable caulk or sealant, for example an acrylic latex, silicone, or butyl rubber. This embodiment, in addition to preventing water penetration, permits removal of the caulk or sealant from the grout lines, enabling moving and replacement of the planks as needed.

BRIEF DESCRIPTION OF THE FIGURES

[00026] FIG. 1 is a photograph of a cross-sectional view showing results of a short term dent test on a commercially available product having a composite core with PVC print layer and wear layer on top. Significant denting of the polymer core occurred within 15 minutes of load application.

[00027] FIG. 2 is a photograph of a cross-sectional view showing results of the short term dent test on a commercially available product having a composite core with PVC print layer and

wear layer on top. Significant denting of the polymer core still occurred 5 days after the initial denting (shown in FIG. 1). In FIG. 2, while the top PVC layers recovered, the core did not recover.

[00028] FIG. 3 is a photograph of a nonlimiting embodiment of the present disclosure with a ceramic tile adhered to a thick vinyl plank.

[00029] FIG. 4 is a photograph of a nonlimiting embodiment of the present disclosure, wherein two of the planks of FIG. 3 are connected together with a connection system of click joints of the composite core thereby creating a two-plank assembly.

[00030] FIG. 5 is a photograph of a nonlimiting embodiment of the present disclosure wherein two such assemblies of FIG. 4 are connected together with a connection system of click joints to form a four-plank assembly. As shown in FIG. 5, the space between clicked joints can be filled with a sealant/caulk.

[00031] FIG. 6 is a photograph of a nonlimiting embodiment of the present disclosure depicted a composite core with a magnetic attachment system for adhering of hard tile to the composite core.

[00032] FIG. 7 is a photograph of a nonlimiting embodiment of the present disclosure depicting an engineered plank of ceramic tile magnetically attached to the composite core.

DETAILED DESCRIPTION

[00033] Disclosed herein is an engineered plank and system of connected engineered planks for use as coverings for floors, walls and other hard surfaces.

[00034] The engineered planks of the present disclosure comprise a hard tile with Mohs hardness of 4.0 or greater. Such hard materials cannot be easily joined with, for example, tongue and groove type joints as they are not flexible enough to create water tight seals when the joints are assembled during installation Traditionally, such hard tile such as ceramic, porcelain and natural stone tile are installed with grout, which involves significant effort and cost to install.

[00035] In the engineered planks of the present disclosure, hard tile with Mohs hardness of 4.0 or higher are assembled on a composite core with a Mohs hardness of less than 4 and with a connection system which allows for easily joining during installation.

[00036] Hard tile used in the engineered planks of the present disclosure comprise mineral or metal with a Mohs hardness scale rating of 4 or greater. Nonlimiting examples include hard

tile comprising ceramic, porcelain, natural stone, glass, metal and/or metal alloy such as steel with Mohs hardness ranging from 4.5 for normal steel to 5.5 for glass, 7.0 for ceramic and 7.5-8.0 for hardened steel. Preferred is that the hard tile be 3 mm or greater in thickness. In one nonlimiting embodiment, the hard tile may range from 3 mm to 30 mm in thickness. In another embodiment, the hard tile may range from 3 mm to 25 mm in thickness. In yet another embodiment, the hard tile may range from 3 mm to 15 mm in thickness, or from 3 mm to 12 mm, or from 3 mm to 10 mm, or from 3 mm to 8 mm, or from 3 mm to 6 mm in thickness. Nonlimiting examples of such hard tile are commercially available and include Crossville and Laminam tile, both manufactured by Crossville Inc. (Crossville, TN), tile manufactured by Dal-tile (Dallas, TX), Crossville Inc. (Crossville, TN) and Marazzi (Sunnyvale, TX), and such.

[00037] In one nonlimiting embodiment, the edges of the hard tile are beveled to create a grouted appearance.

[00038] In one nonlimiting embodiment, the hard tile may be coated for easier cleaning. In one nonlimiting embodiment, the hard tile may include an additive to enhance, for example, antimicrobial efficacy.

[00039] In one nonlimiting embodiment, the hard tile are inset from the edge of the composite core to provide a gap when connected to an adjacent engineered plank. In this embodiment, when the gaps are filled in with grout, caulk or sealant, it prevents water on the hard tile from reaching click joints, potentially penetrating joints and reaching subfloors, thus preventing mold/mildew and odor issues.

[00040] The engineered planks further comprise a composite core. Composite core thickness varies from about 2 mm to about 20 mm.

[00041] In one nonlimiting embodiment, the composite core has a Mohs hardness rating less than 4.0.

[00042] In one nonlimiting embodiment, the composite core is a water resistant high density or medium density fiber board.

[00043] In one nonlimiting embodiment, the composite core comprises a polymer. Nonlimiting examples of polymers useful in the composite core of the present disclosure include high density polyethylene, polypropylene, polyethylene, low density polyethylene, polyamide, polyester, poly vinyl chloride (PVC), polylactic acid or any copolymers or recycled polymers or blends thereof.

[00044] In one nonlimiting embodiment, the composite core further comprises a filler. Nonlimiting examples of fillers useful in the composite core include limestone, talc, calcium carbonate, wood dust, bamboo dust, cork, perlite, glass fiber, polyamide fiber, cellulosic fiber, wood fiber, a polymeric fiber, glass, sand, synthetic fiber, fly ash, flax fiber, hemp fiber, Kaolin clay, Mica, Wollastonite (CaSiO3), carbon black or any combination thereof.

[00045] The composite core can have a density of 1.0 to 2.4 gm/cc, preferably in the range 1.3- 2.1 gm/cc.

[00046] In one nonlimiting embodiment, the filler to polymer ratio of the composite core ranges from about 5:95 to about 95:5 by weight.

[00047] In addition, the composite core may further comprise an additive. Nonlimiting examples of additives which can be used include colorants, anti-UV agents, UV absorbers, fire retardants, anti-fungal agents, antimicrobial agents, coupling agents, reinforcing agents, interfacial adhesion promoting agents, stabilizers, antioxidants, lubricants, plasticizers, and recycled additives and any combinations thereof.

[00048] In the present disclosure, the composite core may have a dent resistance such that long term denting per ASTM F970 is less than 0.005 inches. In addition, or alternatively, the composite core may have a dent resistance such that short term denting per ASTM F1914 is less than 0.005 inches.

[00049] Nonlimiting examples of core composites that have acceptable dent resistance (less than 0.005 inches of dent per ASTM F970) include STAINMASTER® 5.74"x47.74" Washed Oak, STAINMASTER® 12"x24" Light Brown Stone, and such commercial products.

[00050] In one nonlimiting embodiment, the composite core has a coefficient of expansion of core closer to the range of expansion of the hard tile. For example, porcelain tile has a coefficient of expansion of 2 $x10^{-6}$ inch/inch/deg F, clay tile has a coefficient of expansion of 3.5 x 10^{-6} inch/inch/deg F and marble has a coefficient of expansion ranging from 3.1 $x10^{-6}$ to 7.9 $x10^{-6}$ to $30x10^{-6}$ inch/inch/deg F. See americanelements with the extension .com/thermal-expansion-coe.html of the world wide web. Typical Luxury Vinyl core has PVC (expansion coefficient of about $28x10^{-6}$ inch/inch/deg F) and limestone (expansion coefficient of $4.4x10^{-6}$ inch/inch/deg F) as per americanelements with the extension .com/thermal-expansion-coe.html of the world wide web. Increasing filler content tends to decrease thermal coefficient of expansion (ref: Wood Plastic Composites, Anatole A Klyosov, Page 362). In one nonlimiting

embodiment, the composite core used in the present disclosure has a coefficient of expansion of core in the range 5 $x10^{-6}$ to $30x10^{-6}$ inch/inch/deg F. At this decreased coefficient of expansion, damage to the joints, cracking of the core, and/or buckling of any covering comprising the planks is reduced

[00051] The engineered planks further comprise an attachment system which attaches the hard tile to the composite core. In one nonlimiting embodiment, the attachment system is a removable attachment system allowing for removal, dismantling and/or replacement of tile attached to the composite core without damage to the tile or composite core.

[00052] In one nonlimiting embodiment, the attachment system of the engineered planks comprises an adhesive which adheres the hard tile to the composite core. Various adhesives capable of adhering hard tile such as stone, ceramic or porcelain tile to the composite core can be used. Nonlimiting examples include: hot melt adhesives such as ethylene vinyl acetate copolymer, ethylene acrylate copolymer, ethylene n-butyl acrylate, ethylene acrylic acid, ethylene ethyl acetate, polyurethanes, and amorphous polyolefins; pressure sensitive adhesives such as styrene-ethylene/propylene, styrene-isoprene-styrene (SIS), acrylate polymer, biobased acrylates, thermo plastic elastomer, natural rubber, silicone rubber; and moisture resistant adhesives such as a commercially available EnviroSTIX™ adhesive, which is a polyacrylic product made by Base King in Dalton, GA, polyvinyl acetate, epoxy resin, resorcinol-formaldehyde, and polyurethane. Removable adhesives made of acrylic copolymer emulsions such as Covinax 211-15, Covinax 211-01, Covinax 225-00, and removable pressure sensitive adhesive such as Covinax SMA-01 made by Franklin International, Columbus, Ohio are suitable when removal of tiles may be desired. Removable hot melt adhesive such as 3M 3798 LM made by 3M, St Paul, MN are also suitable.

[00053] In an alternative nonlimiting embodiment, the engineered plank further comprises an attachment system which magnetically attaches the stone, ceramic or porcelain tile to the composite core. See Example 5 and FIG. 6 for an embodiment of the present disclosure that depicts magnetic attachments of the hard tile to the composite core. In one nonlimiting embodiment, magnetic properties are built into the tile and the composite core. This enables the tile and the composite core to be attached and dismantled when needed. In another nonlimiting embodiment, the magnetic properties are part of a peel-and-stick polymeric sheet material and these are attached to the bottom of hard tile and the top of the composite core to enable

attachment with ability to dismantle when needed. In another nonlimiting embodiment, the magnetic properties are part of a peel-and-stick polymeric sheet material which is attached to the bottom of hard tile and the bottom of the composite core. This enables attachment of hard tile to composite core and provides the ability to dismantle when needed. In another nonlimiting embodiment, the magnetic properties are part of a peel-and-stick polymeric sheet material which is attached to the bottom of hard tile and the composite core rests on an underlayment which has magnetic properties either built in or from a peel-and-stick polymeric sheet. This enables attachment of hard tile to the composite core and provides the ability to dismantle when needed.

[00054] In addition, the engineered plank of this disclosure comprises a connection system to connect to adjacent engineered planks. Various ways for connection to an adjacent engineered plank via the core are known and can be used in the present disclosure. In one nonlimiting embodiment, the composite core is edge profiled using currently available click-lock technologies to have tongue and groove type joints. Various designs for this click-lock technology have been described and are available from Unilin (Wielbeke, Belgium), Valinge (Viken, Sweden), or Classen (Kaisersesch, DE). Such technologies are widely used in the hard surfaces flooring industry. Alternatively, a lock-grip strip technology may be used. Similar ways for connection which can be routinely adapted for use in the present disclosure are set forth in U.S. Patents 7,770,350, 7,866,115, 8,099,919, and 8,875,465 and Published U.S. Patent Application Nos. 2003/0024199, 2004/0016196 and 2005/0097860, teachings of which are incorporated herein by reference. with a connection system to connect to an adjacent engineered plank. In this nonlimiting embodiment, the composite core is flexible and soft enough for the joints to seal when assembled.

[00055] The engineered planks of the present disclosure may further comprise a second attachment system on the core composite on the side opposite to the hard tile with an underlayment layer optionally adhered to it. Nonlimiting second attachment systems may be magnetic or may comprise adhesives such as described herein. Nonlimiting examples of underlayment layers include cork, rubber, foam and paper layers. Such underlayment layers may be added to provide gripping effect of the plank to the surface to which it is being applied as well as sound dampening effect.

[00056] Planks of the present disclosure are engineered by adhering hard tile to the core composite via the attachment system. Optionally, a second attachment system may be applied to

the core composite on the side opposite to the tile for adherence to an underlayment layer. Planks of the present disclosure can be engineered into various shapes and sizes. In one nonlimiting embodiment, the plank is rectangular in shape with a thickness of up to about 1.25 inches, a width from about 2 to about 12 inches and a length from about 4 to 96 inches. Alternatively, the planks may be square, polygonal such as pentagonal, hexagonal or joined together in, for example, but not limited to, a herringbone pattern or French pattern.

[00057] Two or more of the planks can then be easily connected via the connection system thus providing an easy to install system for covering floors, walls and other hard surfaces.

[00058] Accordingly, the present disclosure also provides systems for covering floors, walls and other hard surfaces comprising two or more of the engineered planks connected adjacently via the connection system. The engineered planks can be cut to size and shape by well known methods used to cut ceramic, porcelain or natural stone or metals. Equipment for cutting ceramic, porcelain or natural stone tiles include wet/dry saws such as SKIL 7" wet table top saw or Ryobi 4" hand held wet tile saw, or BOSCH Multi-X tool. Metal tiles can be cut with bench shears, power saws or hack saw.

[00059] In one nonlimiting embodiment, systems of the present disclosure may comprise beveled hard tile.

[00060] In one nonlimiting embodiment, the hard tile is inset from the edge of the composite core to provide a gap when connected to an adjacent engineered plank.

[00061] In one nonlimiting embodiment, the connected planks are then grouted using, for example, an acrylic, urethane, epoxy or cementitious grout. In one nonlimiting embodiment, the grooves between connected tiles are filled with a removable caulk or sealant, such as, for example an acrylic latex, silicone, butyl rubber, oil based asphalt caulk, polyurethane, caulking cord or cementitious grout. In this embodiment, when the gaps are filed in with grout, caulk or sealant, it prevents water from above reaching click joints, potentially penetrating joints and reaching subfloors, thus preventing mold/mildew and odor issues. If replacement or movement of a plank or planks is required, the caulk/sealant can be removed by prying out from the grout line, the click joints can be dismantled, and any plank or planks needing replacement or movement can be removed and/or replaced or reassembled.

[00062] In the case of magnetic assembly between the hard tile and the composite core, replacement or movement of the hard tile of the engineered plank or planks can be easily

facilitated by pulling the hard tile off from the magnetic assembly and replacing with a new hard tile. Alternatively, the entire engineered plank or planks may be removed by prying out from the grout line and dismantling the connection system that connects to the adjacent planks.

[00063] The engineered planks and systems of the present disclosure are just as easy to install as Luxury Vinyl with click or grip lock stick technologies and do not require skilled labor which is ordinarily needed for installing grouted ceramic and stone floor. Assemblies such as shown in FIGs 3-5 and FIG. 7 may be mixed and matched for a large surface coverage. It will be understood that either uniform or different hard tiles may be mixed and matched for the desired flooring pattern or aesthetics, look and finish. Further, the planks and system comprising the hard tile, as well as the composite core and connecting system, are highly resistant to water, thus providing a cost-effective, durable covering for floors, wall and other surfaces.

[00064] The following Test Methods and Examples demonstrate the present disclosure and its capability for use. The disclosure is capable of other and different embodiments, and its several details are capable of modifications and/or substitution in various apparent respects, without departing from the spirit and scope of the present disclosure. Accordingly, the Examples are to be regarded as illustrative in nature and non-limiting.

Test Methods

[00065] The following are standard tests well known to professionals in hard surfaces industry.

[00066] Long term dent test ASTM F970 – Simulates denting potentially caused by furniture or static loads.

[00067] Short term dent test ASTM F1914 – Simulates denting caused by high loading applied in a small area (e.g. high heels, pointed objects).

[00068] Chair castor joint integrity test EN425 – Simulates stress due to moving loads and its impact on click joints of assembled panels.

[00069] Water absorption test ASTM EN13329 Annex G – Measures thickness swelling due to water exposure. Any significant swelling could create distortion and warping of panel assemblies.

[00070] Edge Curl test ASTM F2199: This test method is used to measure the ability of floor tile to retain its original dimensions following exposure to heat simulating a long service

life at reasonable and expected temperatures.

[00071] Dimensional stability test EN 434 - Dimensional stability after exposure to heat.

[00072] Additional tests as given below are specifically designed to evaluate certain flooring properties:

[00073] Temperature cycling test: Assembled small panels are installed in an Environmental chamber and cycled through a temperature range of 40 deg F to 120 deg F, as an example, to confirm ability of such assembled flooring to withstand variations in temperature indoors without warping and distortion.

[00074] Mohs Hardness test : The Mohs scale of mineral hardness is a qualitative ordinal scale characterizing scratch resistance of various minerals through the ability of harder material to scratch softer material. Scale is in the range 1 to 10.

[00075] Installation test: This test is used to determine relative ease of installation. Time to install flooring by a professional installer is measured for both test and control samples. Relative ease of cutting control as well as test samples is also recorded.

EXAMPLES

Example 1

[00076] A short-term dent test was performed on a commercially available composite core product, having a polymer core, PVC print layer and wear layer on top.

[00077] FIG. 1 is a cross-sectional photograph showing results of the short-term dent test. As shown, significant denting of the polymer core occurred within 10-15 minutes of load application. Such denting would be a significant problem if a hard tile such as stone or ceramic tile was used on top of this polymer core.

[00078] FIG. 2 is a photograph showing a cross-sectional view showing results of the short term dent test on a commercially available polymer core product with PVC print layer and wear layer on top several days after the test. Significant denting of the polymer core was still observed 5 days after the initial denting. While the top PVC layers recovered, the core did not recover. This denting again would present a significant problem if a hard tile such as stone or ceramic was used on top, particularly at joints, of such polymer cores.

Example 2

[00079] An engineered plank of the present disclosure was prepared. Hard tile of ceramic 6.9"x 19.7"x 9 mm thickness in size (Addison Oak wood plank ceramic tile commercially available from Floor & Décor) was assembled on to a core composite of Traffic Master Allure Ultra 7.5"x47.6"x 5mm thick vinyl plank (commercially available from Home Depot) using double sided adhesive tape (See FIG. 3). The ceramic tile was removed by pulling from the top without difficulty. As will be understood by the skilled artisan upon reading this disclosure, however, alternative adhesives including hot melt adhesives such as ethylene vinyl acetate copolymer, ethylene acrylate copolymer, ethylene n-butyl acrylate, ethylene acrylic acid, ethylene ethyl acetate, polyurethanes, and amorphous polyolefins; pressure sensitive adhesives such as styrene-ethylene/propylene, styrene-isoprene-styrene (SIS), acrylate polymer, biobased acrylates, thermo plastic elastomer, natural rubber, silicone rubber; and moisture resistant adhesives such as a commercially available EnviroSTIX™ adhesive product made by Base King in Dalton, GA, polyvinyl acetate, epoxy resin, resorcinol-formaldehyde, and polyurethane can be used. Removable adhesives made of acrylic copolymer emulsions such as Covinax 211-15, Covinax 211-01, Covinax 225-00, and removable pressure sensitive adhesive such as Covinax SMA-01 made by Franklin International, Columbus, Ohio are suitable when removal of tiles is desired. Removable hot melt adhesive such as 3M 3798 LM made by 3M, St Paul, MN are also suitable.

[00080] The core composite had a connection system of click joints. The gap between ceramic tile was maintained evenly across all sides to create space for caulking. Two planks were assembled together to create a two-plank assembly first (See FIG. 4). Two such assemblies were made and joined together with click joints to form a four-plank assembly and the space between clicked joints in this assembly was filled with DAP 3.0 Advanced All-Purpose Sealant/caulk (suitable for 20 to 120 deg F temperature range) and allowed to dry (See FIG. 5).

[00081] After 24 hours, the four-plank assembly of FIG. 5 was tested for any joint leakage by applying a small puddle of water at the joints. No leakage was observed.

[00082] The four-plank assembly of FIG. 5 was kept indoors to observe any changes due to dimensional stability issues that would be typical of a home installation. Upon visual inspection from the start of this test up to sixteen (16) months, no visible cracks or swelling of the caulk nor any distortion, or warping of the assembly was observed. This testing demonstrates dimensional stability of the planks and systems.

[00083] A large surface coverage can be obtained by similarly connecting multiples of such plank assemblies of FIG. 5. It will be understood that either uniform or different ceramic, porcelain or natural stone tiles may be mixed and matched for the desired flooring pattern or aesthetics, look and finish.

Example 3:

[00084] Various commercially available flooring samples were tested for dent resistance. ASTM F970 for long-term dent resistance and ASTM F1914 for short-term dent resistance tests were conducted and results along with connection types are shown in Table 1. Substrates as cores with the dent resistance of less than 0.005 inches would be preferred for the purposes outlined in the present disclosure.

TABLE 1 : Samples

Item number	Flooring Sample Description	Core	Measured Thickness of core (mm)	Dent depth (in inches)		Connection type
				Long term dent ASTM F970	Short term dent ASTM F1914	
Ex. 2	Traffic Master Allure Ultra	Vinyl	5.0	0.003	0.004	Click lock
3(A)	Home Depot Life Proof	Vinyl	6.55	0.0045	0.0125	Click lock
3(B)	Armstrong Biofloor	Biobased polyester	3.07	0	0.01	Groutable
3(C)	Armstrong Alterra	Vinyl	4.24	0.004	0.009	Click lock
3(D)	Armstrong Pryzm	Vinyl	6.35	0.0075	0.0025	Click Lock
3(E)	Congoleum Durastone	vinyl	4.09	0.003	0.0115	Groutable
3(F)	Congoleum Duraceramic	Vinyl	4.14	0.0035	0.007	Groutable
3(G)	Mannington Natures Path	Vinyl	2.48	0.0005	0.0165	Gluedown
3(H)	Mannington City Scope	Vinyl	5.47	0.004	0.0025	Click lock
3(I)	Interface LV plank	Vinyl	4.3	0.003	0.05	Floating with Tac Tiles®
3(J)	CBC Flooring plank	Polyester	2.5	0.001	0.0075	Glue down
3(K)	Style selections peel and stick	Vinyl	1.81	0.003	0.012	Peel and Stick

3(L)	Armstrong Peel and stick Durango	Vinyl	2.01	0.002	0.014	peel and stick
3(M)	Traffic Master Allure	Vinyl	3.62	0.003	0.007	Locking and glue
3(N)	Mannington Adura Glue down	Vinyl	1.96	0.002	0.011	Glue Down
3(O)	Shaw Floorte' Premio	WPC	6.83	0.051	0.049	Click lock
3(P)	Shaw Floorte' Classico	WPC	6.72	0.02	0.024	Click lock
3(Q)	US Floors Smartcore	WPC	5.61	0.035	0.035	Click lock
3(R)	Classen Neo	Polyolefin	4.6	0.0025	0.003	Click lock
3(S)	Classen Sono	Polyolefin	4.66	0.001	0.0013	Click lock
3(T)	Classen Vario	Polyolefin	3.29	0.0005	0.002	click lock
3(U)	STAINMASTER® Washed Oak	Vinyl	4.0	0.002	0.001	click lock
3(V)	STAINMASTER® Light Brown stone	Vinyl	2.5	0.003	0.003	Peel and stick

Example 4

[00085] Hard tile of ceramic sized 6.9"x 19.7"x 9 mm thickness (Addison Oak wood plank ceramic tile commercially available from Floor & Décor) was assembled with a peel and stick magnetic receptive layer (MBR030S004PS - MagneBuild PS Receptive) supplied by Magnetic Building Solutions LLC, Dalton GA (see FIG. 6). A composite core of Traffic Master Allure Ultra 7.5"x47.6"x 5mm thick vinyl plank (commercially available from Home Depot) was covered on top with a piece of 1.0 mm thick magnetic underlayment (MBU100R100 - MagneBuild Underlayment (Base) supplied by Magnetic Building Solutions LLC, Dalton GA with double sided tape.

[00086] The ceramic tile with magnetic receptive layer of FIG. 6 was placed on top of the vinyl plank with magnetic underlayment creating a robust and stable magnetic attachment. This one plank assembly, wherein the ceramic tile is uniformly inset from the plank edges, is shown in FIG. 7. It was observed that the ceramic tile was securely attached through the magnetic underlayment. It was possible to detach the ceramic tile from the core below thereby demonstrating ability to replace or move the tile when needed.

[00087] In this embodiment, the individual vinyl planks have click joints and more than one such plank assembly (as in FIG. 7) may be connected together via a connection system to

connect to an adjacent engineered plank. See for example, similar assemblies in FIGs 3-5. The gap between ceramic tiles can be maintained evenly across all sides to create space for caulking. Two planks as in FIG. 7 may be assembled together to create a two-plank assembly first (as in FIG. 4). Two such assemblies may be made and joined together with click joints to form a four-plank assembly. The space between clicked joints in such assembly may be grouted, caulked, or sealed. The grout, caulk or sealant may be selected from the group consisting of acrylic, urethane, epoxy, acrylic latex, silicone, butyl rubber, oil based asphalt caulk, polyurethane, caulking cord and cementitious grout. An example is DAP 3.0 Advanced All-Purpose Sealant/caulk (suitable for 20 to 120 deg F temperature range). The four-plank assembly may be allowed to dry to obtain a larger surface coverage as in a similar example of FIG. 5. A large surface coverage can be obtained by similarly connecting multiples of such plank assemblies of FIG. 7

CLAIMS:

1. An engineered plank comprising:

a) hard tile with a top and bottom, said hard tile comprising mineral or metal with a Mohs hardness scale rating of 4 or greater;

b) a composite core with a top and bottom, said composite core having a Mohs hardness scale rating of less than 4;

c) an attachment system which attaches (a) to (b); and

d) a connection system to connect adjacent engineered planks

2. The engineered plank of claim 1 wherein the hard tile comprises ceramic, porcelain, natural stone, glass, metal or metal alloy.

3. The engineered plank of claim 1 wherein the hard tile thickness is 3 mm to 30 mm.

4. The engineered plank of claim 1 wherein the hard tile thickness is 3 mm to 25 mm.

5. The engineered plank of claim 1 wherein the hard tile thickness is 3 mm to 15 mm.

6. The engineered plank of claim 1 wherein the attachment system is a removable attachment system.

7. The engineered plank of claim 6 wherein the removable attachment system comprises a removable adhesive.

8. The engineered plank of claim 7 wherein the removable adhesive is selected from a removable hot melt adhesive, a pressure sensitive adhesive, a moisture resistant adhesive, and combinations thereof.

9. The engineered plank of claim 8 wherein the removable adhesive is a removable hot melt adhesive selected from the group consisting of ethylene vinyl acetate copolymer, ethylene acrylate copolymer, acrylic copolymer emulsion, ethylene n-butyl acrylate, ethylene acrylic acid, ethylene ethyl acetate, polyurethanes, and amorphous polyolefins.

10. The engineered plank of claim 8 wherein the removable adhesive is a removable pressure sensitive adhesive selected from the group consisting of vinyl acrylic copolymer emulsion, acrylic, modified acrylic, styrene-ethylene/propylene, styrene-isoprene-styrene (SIS), acrylate polymer, biobased acrylates, thermo plastic elastomer, natural rubber and silicone rubber.

11. The engineered plank of claim 8 wherein the removable adhesive is a removable moisture resistant adhesive selected from the group consisting of polyvinyl acetate, epoxy resin, resorcinol-formaldehyde, polyacrylic polymer, acrylic, modified acrylic and polyurethane.

12. The engineered plank of claim 1 wherein the attachment system is magnetic.

13. The engineered plank of claim 12 wherein the magnetic attachment system comprises magnetic properties built into the hard tile and the composite core and/or an underlayer.

14. The engineered plank of claim 12 wherein the magnetic attachment system comprises a peel-and-stick polymeric sheet material attached to the bottom of the hard tile and either the top of the composite core, the bottom of the composite core or to an underlayment layer.

15. The engineered plank of claim 1 wherein the composite core is a water resistant high density or medium density fiber board.

16. The engineered plank of claim 1 wherein the composite core has a density ranging from 1.0 to 2.4 gm/cc.

17. The engineered plank of claim 1 wherein the composite core has a density ranging from 1.3 to 2.1 gm/cc.

18. The engineered plank of claim 1 wherein the composite core has a coefficient of expansion of core ranging from 5 $x10^{-6}$ to 30$x10^{-6}$ inch/inch/deg F.

19. The engineered plank of claim 1 wherein the composite core has a dent resistance such that long term denting per ASTM F970 is less than 0.005 inches.

20. The engineered plank of claim 1 wherein the composite core has a dent resistance such that short term denting per ASTM F1914 is less than 0.005 inches.

21. The engineered plank of claim 1 wherein the composite core has a dent resistance such that long term denting per ASTM F970 is less than 0.005 inches and short term denting per ASTM F1914 is less than 0.005 inches.

22. The engineered plank of claim 1 wherein the composite core comprises a polymer selected from high density polyethylene, polypropylene, polyethylene, low density polyethylene, polyamide, polyester, poly vinyl chloride, polylactic acid or any copolymer, recycled polymer or blend thereof.

23. The engineered plank of claim 22 wherein the composite core further comprises a filler.

24. The engineered plank of claim 23 wherein the filler is selected from limestone, talc, calcium carbonate, wood dust, bamboo dust, cork, perlite, glass fiber, polyamide fiber, cellulosic fiber, wood fiber, polymeric fiber, glass, sand, synthetic fiber, fly ash, flax fiber, hemp fiber, Kaolin clay, Mica, Wollastonite ($CaSiO_3$), carbon black or any combination thereof.

25. The engineered plank of claim 23 with a filler to polymer ratio ranging from 5:95 to 95:5 by weight.

26. The engineered plank of claim 22 wherein the composite core further comprises an additive.

27. The engineered plank of claim 26 wherein the additive is selected from a colorant, anti-UV agent, UV absorber, fire retardant, anti-fungal agent, antimicrobial agent, coupling agent, reinforcing agent, interfacial adhesion promoting agent, stabilizer, antioxidants, lubricant, plasticizer and recycled additive or any combination thereof.

28. The engineered plank of claim 1 wherein the hard tile are inset from an edge of the

composite core b) to provide a gap when connected to an adjacent engineered plank.

29. The engineered plank of claim 1 wherein the connection system to connect to an adjacent engineered plank comprises a grip lock strip technology or a click lock technology.

30. The engineered plank of claim 1 further comprising a second attachment system beneath the composite core of the plank for adherence of an underlayment layer.

31. The engineered plank of claim 30 wherein the second attachment system is magnetic or comprises an adhesive.

32. The engineered plank of claim 30 further comprising an underlayment layer adhered to the additional adhesive layer.

33. The engineered plank of claim 32 wherein the underlayment layer comprises cork, rubber, foam or paper.

34. The engineered plank of claim 1 wherein the hard tile comprises a non-rectified ceramic or porcelain or stone tile.

35. The engineered plank of claim 1 wherein the hard tile has a beveled edge.

36. A system for covering floors, walls and other surfaces, said system comprising two or more engineered planks of any of claims 1 through 35 connected adjacently via the connection system to connect to an adjacent engineered plank.

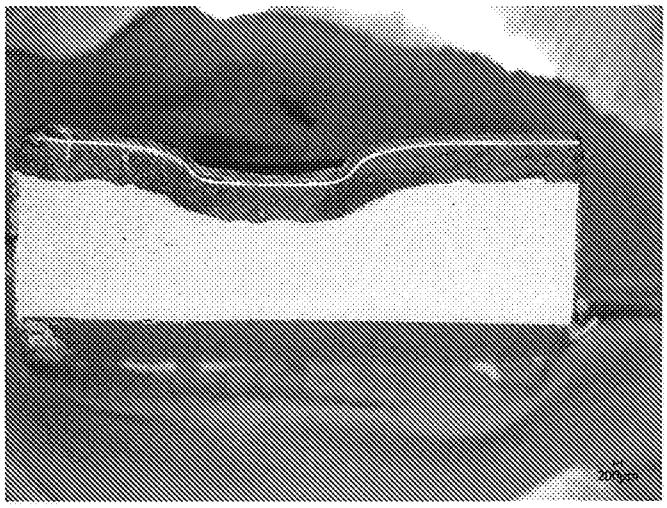
37. The system of claim 36 wherein hard tile of the engineered plank is inset from an edge of the composite core to provide a gap when connected to an adjacent engineered plank.

38. The system of claim 36 or 37 wherein the connected engineered planks are caulked, or sealed.

39. The system of claim 38 wherein the caulk or sealant is selected from the group consisting of acrylic, urethane, epoxy, acrylic latex, silicone, butyl rubber, oil based asphalt caulk,

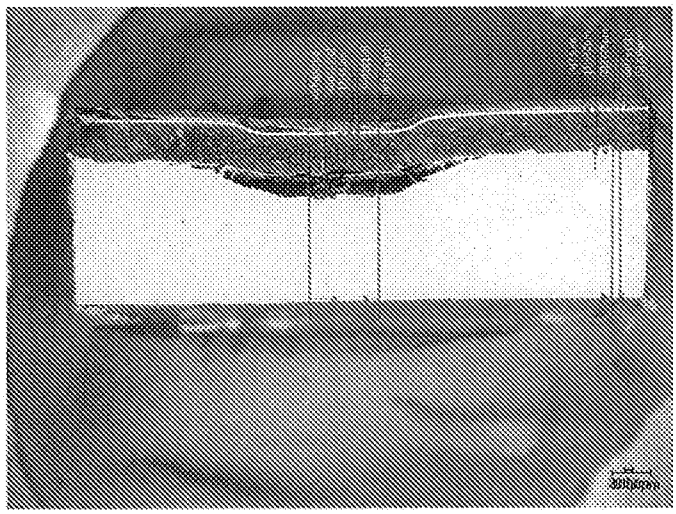
polyurethane, and caulking cord.

FIG. 1



PRIOR ART

FIG. 2



PRIOR ART

FIG. 3

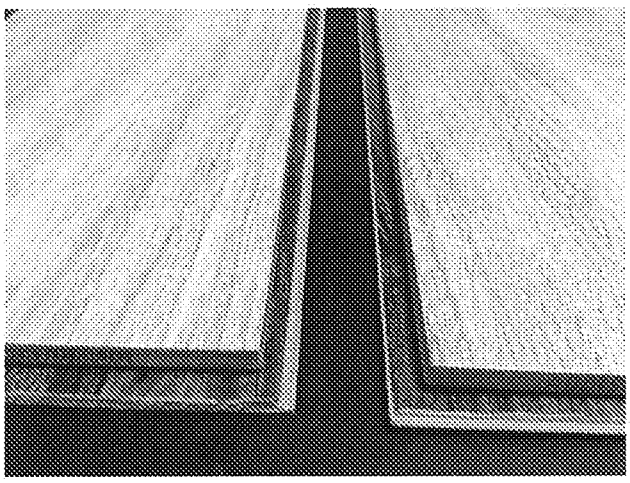


FIG. 4

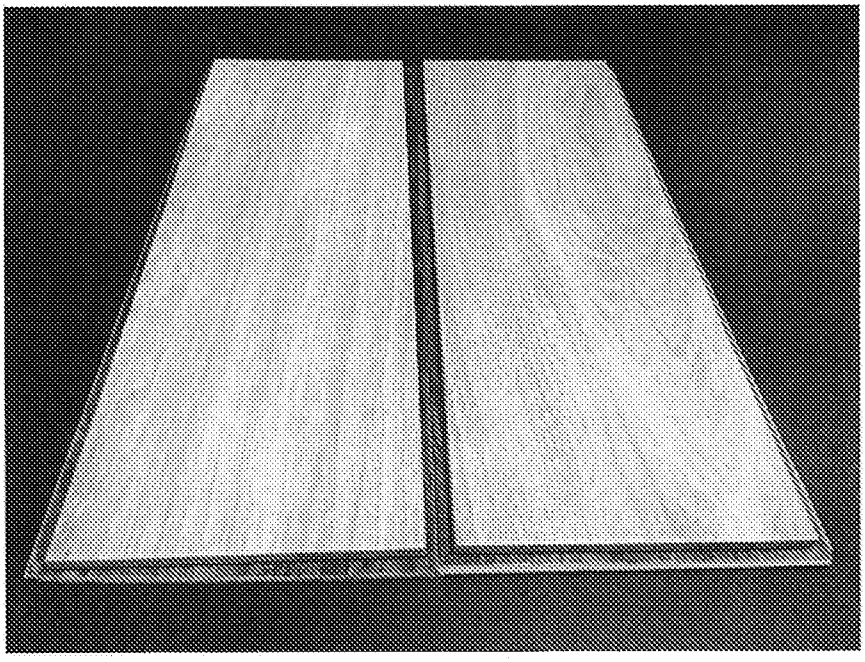


FIG. 5

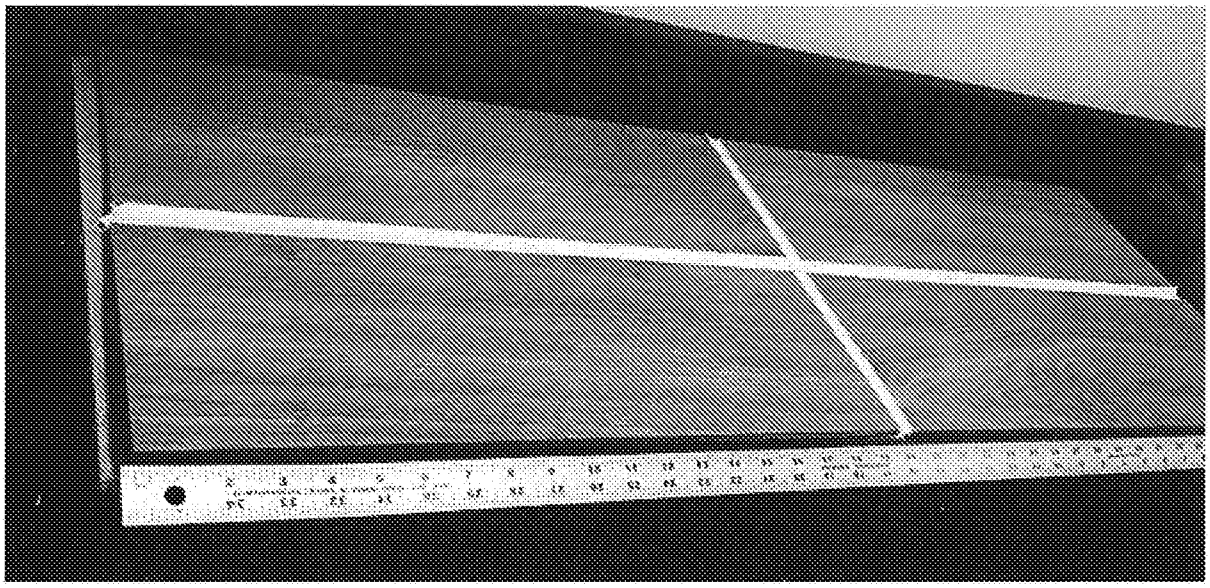


FIG. 6

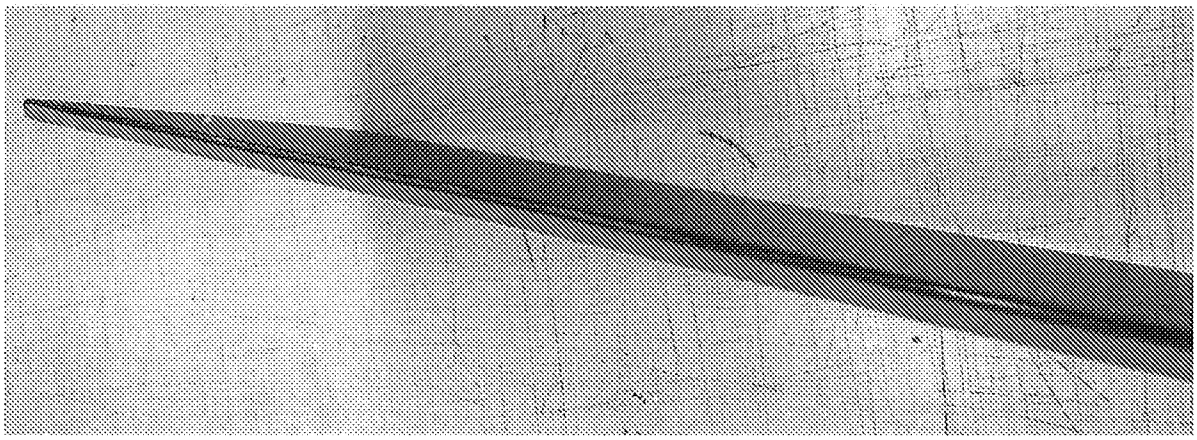
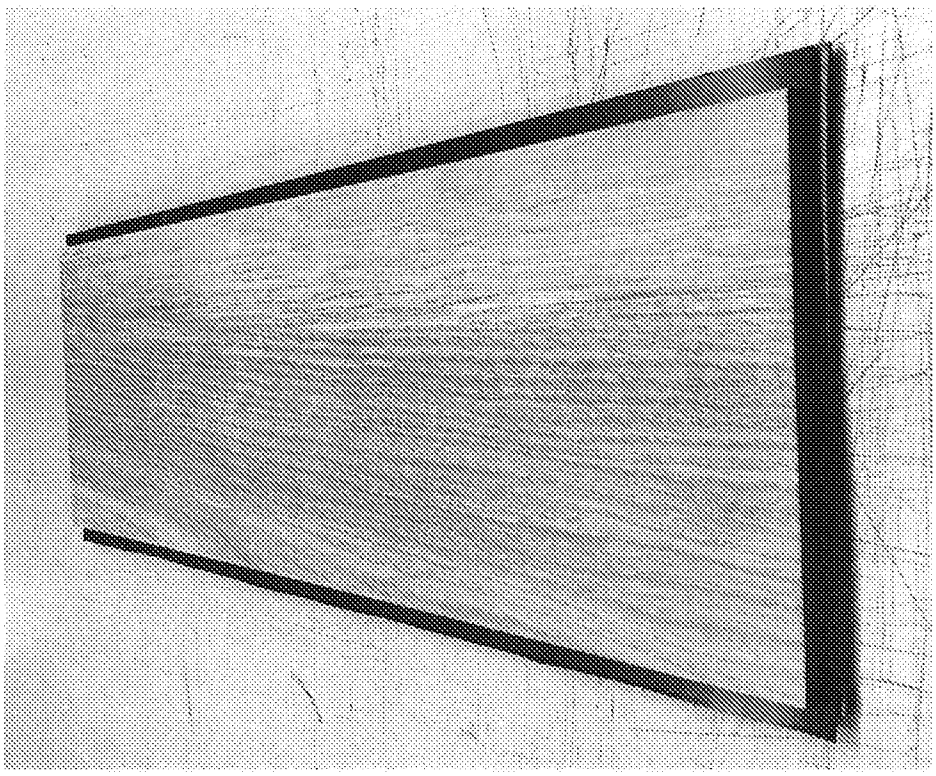


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/027848

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04F15/06 E04F15/08 E04F15/02
ADD.

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

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	figures 1-4, 13-14 paragraph [0046] - paragraph [0049] paragraph [0061] paragraph [0068] paragraph [0072]	6-14, 16-27, 30-33

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	figures 2,5 paragraph [0051] paragraph [0057]	

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2018	28/06/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Estorgues, Marlène

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Form PCT/ISA/210 (second sheet) (April 2005)

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