



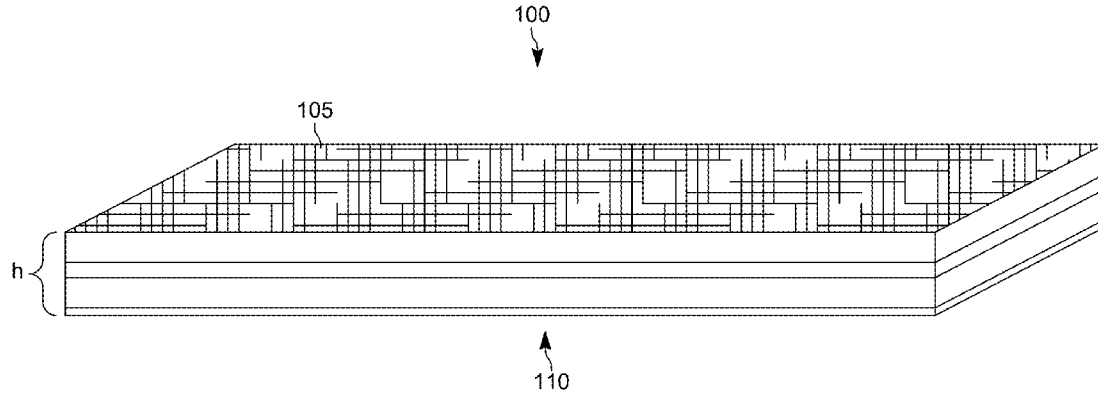
US 20140349084A1

(19) **United States**(12) **Patent Application Publication**
Patki et al.(10) **Pub. No.: US 2014/0349084 A1**(43) **Pub. Date: Nov. 27, 2014**(54) **COMPOSITE TILE SYSTEMS AND METHODS**(71) Applicant: **Mohawk Carpet Corporation**,
Calhoun, GA (US)(72) Inventors: **Rahul Patki**, Dallas, TX (US); **Jason Abercrombie**, Dallas, TX (US)(73) Assignee: **Mohawk Carpet Corporation**,
Calhoun, GA (US)(21) Appl. No.: **14/287,532**(22) Filed: **May 27, 2014****Related U.S. Application Data**

(60) Provisional application No. 61/827,498, filed on May 24, 2013.

Publication Classification(51) **Int. Cl.**
E04C 2/26 (2006.01)
E04B 1/82 (2006.01)(52) **U.S. Cl.**CPC ... **E04C 2/26** (2013.01); **E04B 1/82** (2013.01);
E04B 2001/8461 (2013.01)USPC **428/189**; 428/411.1; 428/426; 428/688;
428/446; 428/702; 428/354; 428/215; 428/332;
428/213(57) **ABSTRACT**

Composite tile systems and methods are disclosed. Embodiments of this disclosure can comprise a composite floor tile having a ceramic upper layer with one or more reinforcing layers. The reinforcing layer or layers can comprise a reinforcing material, such as fiberglass, and an adhesive. An under layer can be disposed under, or integrated with, the reinforcing layer, and can comprise a ceramic or a polymer laminate. A bottom layer can comprise a pressure sensitive adhesive, or other adhering system, that attaches to various substrates. Embodiments of this disclosure can improve ease of installation of tile, improve strength of tile, and reduce the weight of tile, among other advantages.



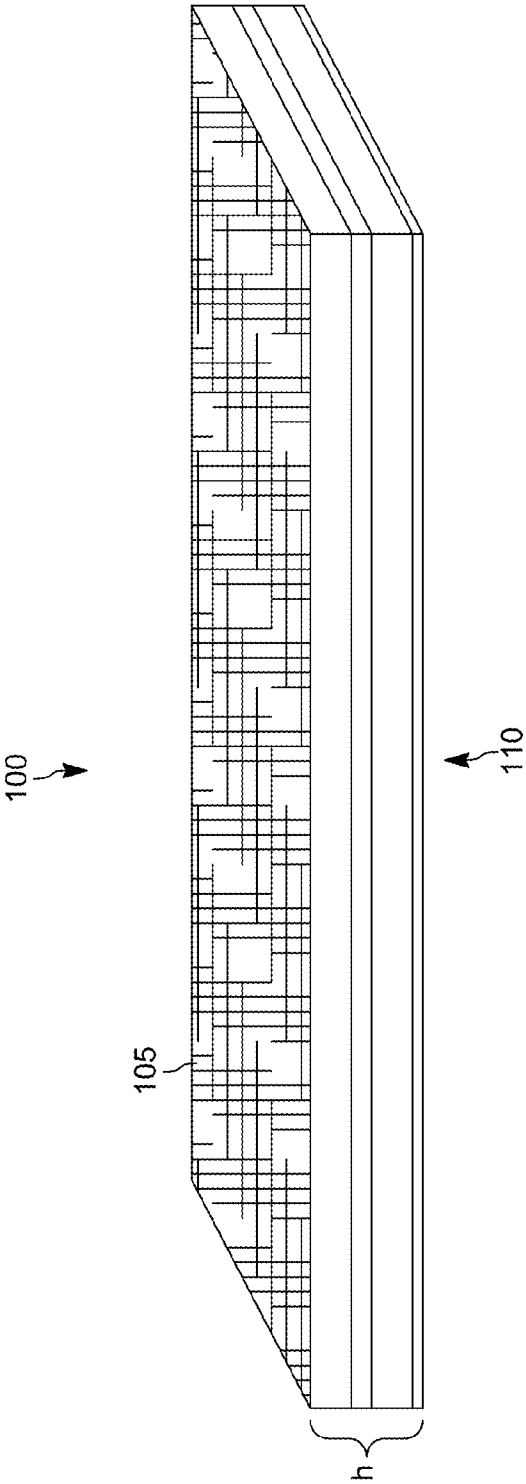


Fig. 1

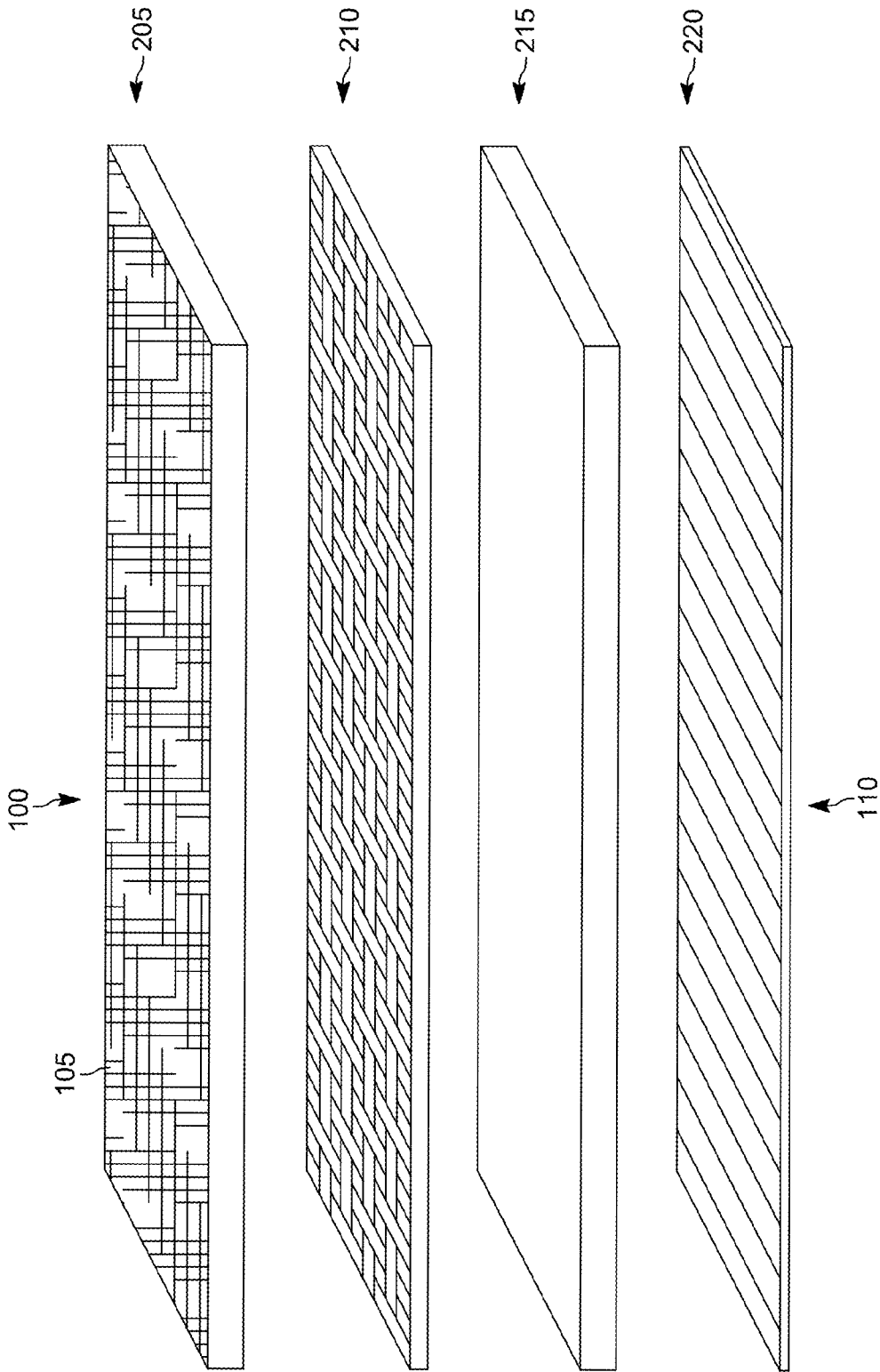


Fig. 2

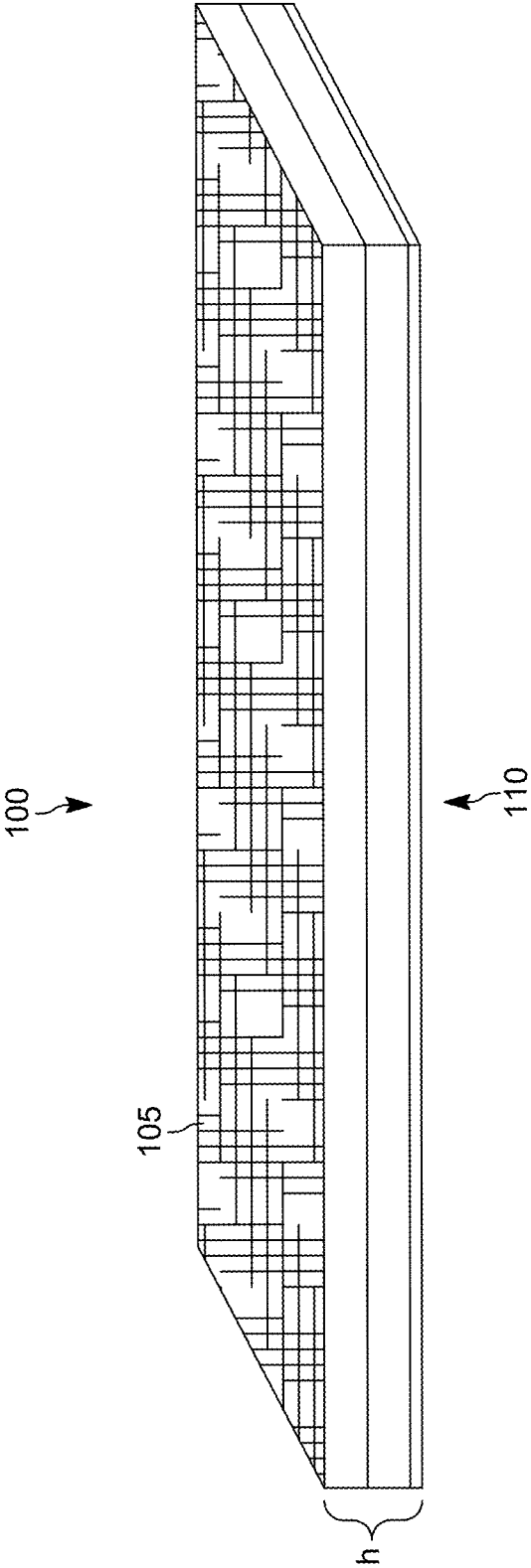


Fig. 3

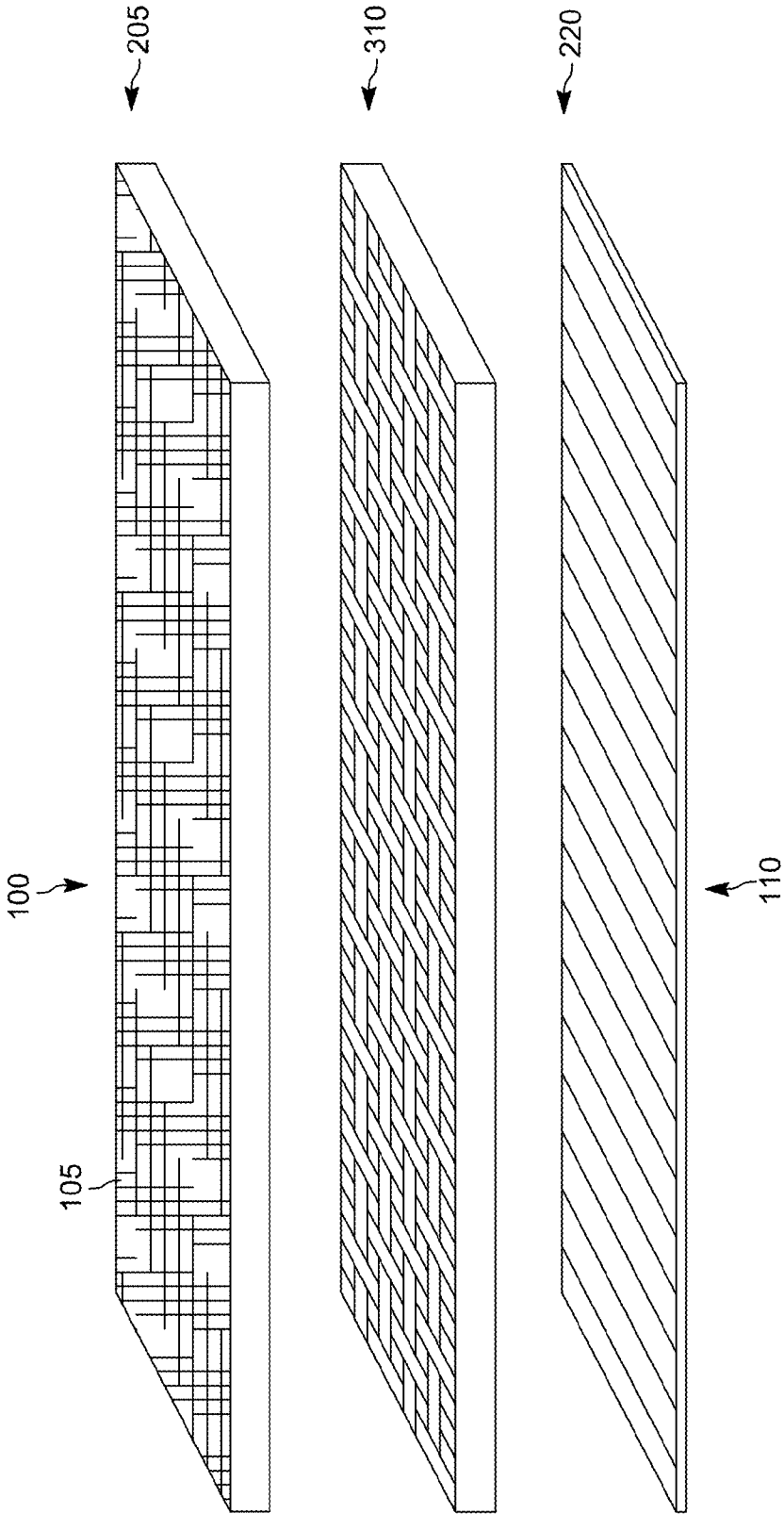
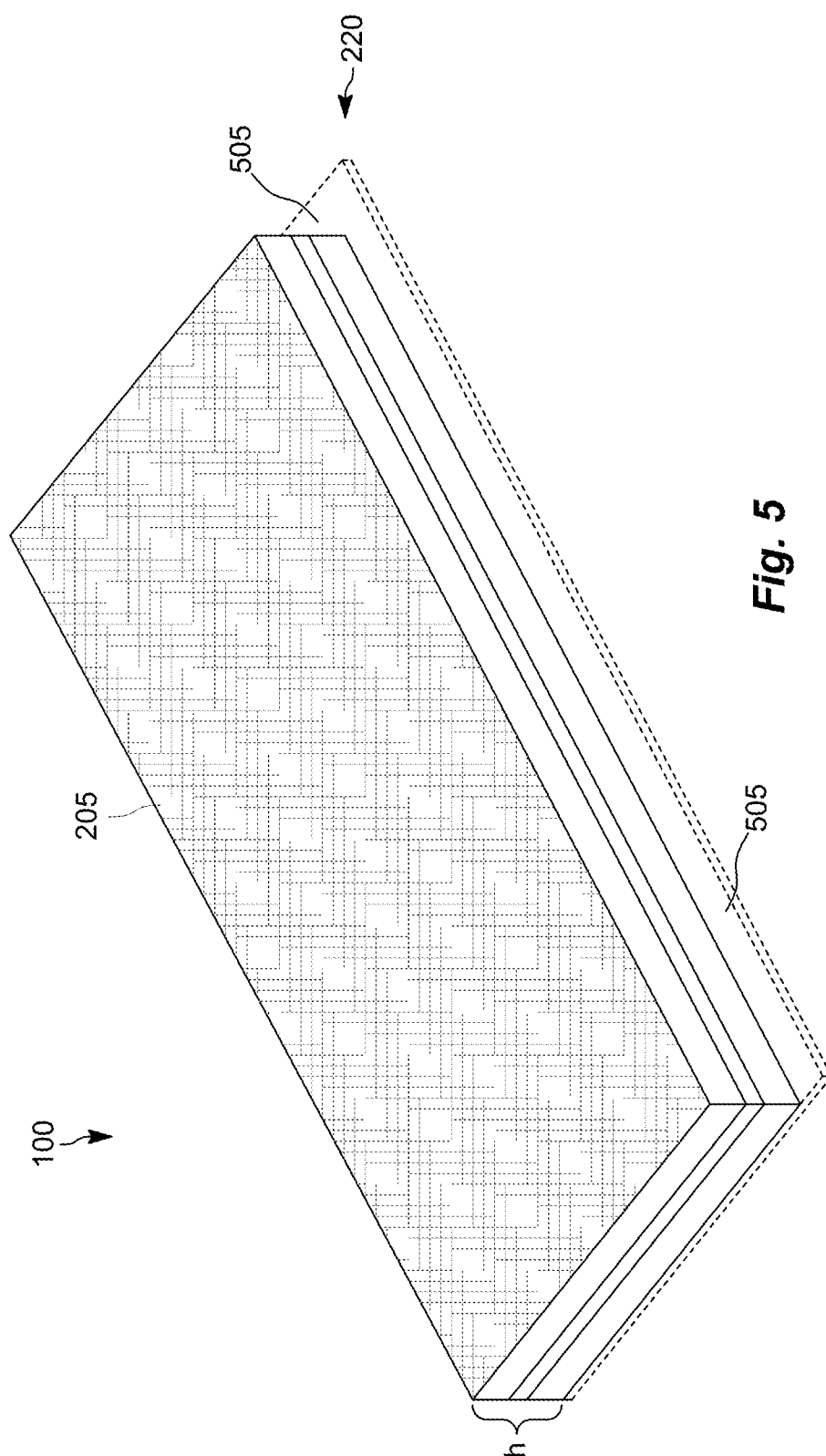


Fig. 4



600

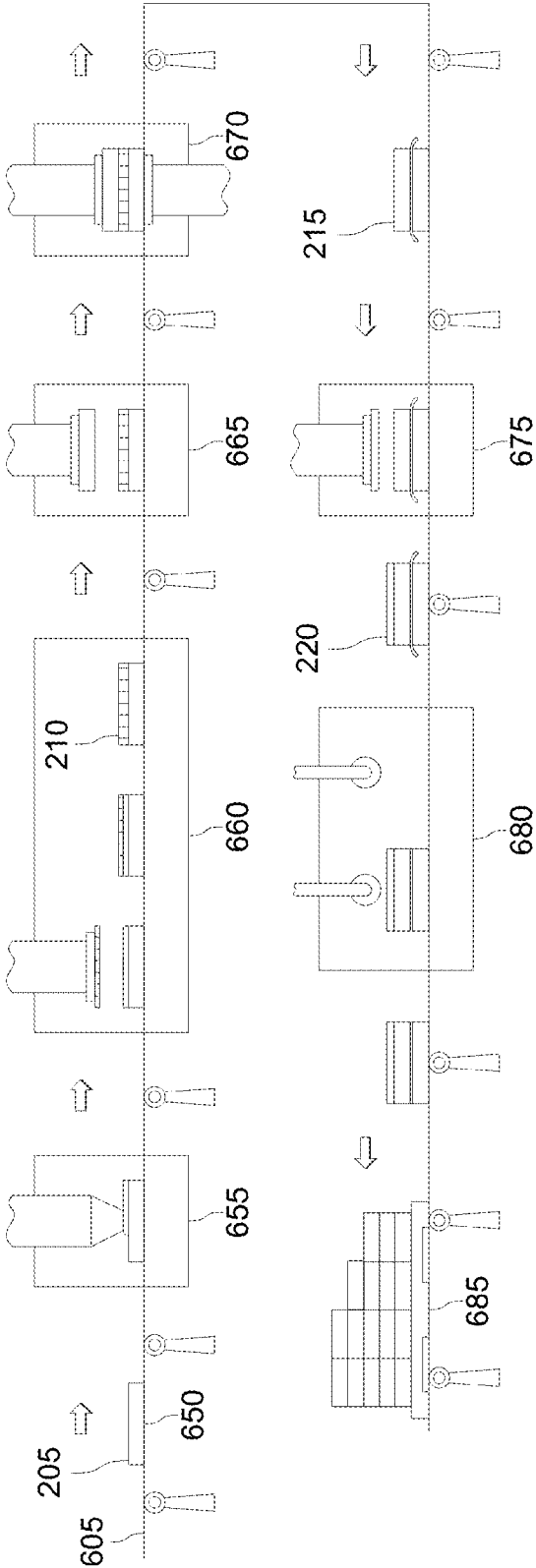


Fig. 6

COMPOSITE TILE SYSTEMS AND METHODS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application Ser. No. 61/827,498, filed 24 May 2013 and entitled Composite Tile Systems and Methods, the entire contents and substance of which is hereby incorporated by reference as if fully set forth below.

BACKGROUND

[0002] 1. Field of the Invention

[0003] Embodiments of this disclosure relate to tile systems and methods, and more particularly, to composite tile systems and methods.

[0004] 2. Description of Related Art

[0005] A variety of tile systems and methods are known. In general, tile is a manufactured material used for covering floors, walls, roofs, and other similar areas. In many situations, tile can provide a desirable appearance, texture, feel, or other surface characteristic that is difficult or impossible to achieve by other means. Tiles are commonly made from ceramic materials, although they can be made from a variety of other materials such as wood, stone, metal, and glass.

[0006] Although ceramic tile has existed for some time, there exists a need to improve the current state of the art in ceramic tile across several general areas. First, installation of ceramic tile should be made easier. Traditional tile installation methods involve mixing, spreading, and curing of adhesives such as thinset, mortar, and grout. These processes are time consuming and laborious, and require an excessive amount of cleaning. While there are available interlocking tile systems that eliminate adhesives and setting materials, these tiles are less durable and prone to fracture, among other problems.

[0007] Second, the impact resistance of ceramic tile should be improved. This is true for all tiles, and especially true for easy installing or thin floor tile. Porcelain, a commonly used tile material, is a high strength, high modulus of elasticity material, which is true of many materials used to manufacture tile. However, like many conventional tile materials, such as various ceramics, porcelain is brittle and susceptible to breaking during manufacturing, transportation, and use. In fact, porcelain's fracture toughness and impact resistance are significantly weaker than other flooring materials like laminate, hardwood, and luxury vinyl.

[0008] Third, it would be beneficial to reduce the weight of ceramic tile. As mentioned above, Porcelain is a common ceramic used in tiles, but standard porcelain tiles have a minimum thickness of 8 mm and a density of between 2.2 and 3.0 g/cm³. Thus, these tiles are relatively heavy, which increases transportation costs and makes installing and handling the tiles more difficult. While there are thinner porcelain tiles available on the market today, with thicknesses below 8 mm, the thinner profile comes at significant cost as these tiles are less durable and prone to fracture.

[0009] Moreover, traditional porcelain tiles have inferior walking comfort and acoustic insulation compared to other floor covering materials such as laminates, carpet, hardwood, and vinyl. Accordingly, these characteristics should also be improved.

[0010] What is needed, therefore, is a tile that is easy to install, has high impact resistance, and is lightweight. The tile should also be comfortable to walk on and have improved acoustic insulation. It is to these needs that embodiments of this disclosure are primarily directed.

SUMMARY

[0011] Briefly described, composite tile systems and methods that may address at least one or all of the shortcomings discussed above are taught by this disclosure. More specifically, embodiments of this disclosure comprise a composite floor tile having a first, upper layer and one or more second, reinforcing layers below the material of the upper layer. The upper layer can comprise a ceramic, such as porcelain. The reinforcing layer can comprise fiberglass and hot melt adhesive. A third, under layer can be disposed below the reinforcing layer and can comprise a ceramic, similar to or the same as the upper layer, or can comprise a polymer laminate. The tile can also comprise a fourth, bottom layer that can be an adhesive layer.

[0012] In some embodiments, the tile comprises a plurality of porcelain tiles or layers with a thin, reinforcing layer of polymer glue and/or fiberglass therebetween, creating a durable periodic structure. The reinforcing layer can be produced from inorganic fibers and/or organic polymer materials. Such fiber and/or polymer materials generally may have a high strength to weight ratio, lower elastic modulus, and a higher thermal expansion coefficient than the ceramic used in the tile. The reinforcing layer can comprise a woven fiberglass layer, a non-woven fiberglass layer, a knit fiberglass layer, or can comprise randomly oriented short fiberglass strands. The reinforcing layer can also comprise a hot melt adhesive, such as hot melt glue.

[0013] The fourth, bottom layer, can comprise a pressure sensitive adhesive that bonds with various substrates, such as concrete or wood, and can eliminate the need to use thinset adhesive or mortar. In some embodiments, for example, the bottom layer can comprise a double sided pressure sensitive adhesive tape. In other embodiments the fourth, bottom layer can comprise a cork-polymer layer that creates a physical friction bond with various substrates. The fourth, bottom layer can also comprise a tack fast loop fabric, such as a loop and hook fabric (such as Velcro®), that interlocks with an underlayment on the subfloor.

[0014] In some embodiments, the third, under layer can comprise a polymer laminate instead of a ceramic. In some embodiments, the polymer laminate can comprise filling materials. Moreover, in some embodiments, the second, reinforcing layer and the third, under layer can be combined into an integrated second layer that provides advantages of the two separate layers.

[0015] In some embodiments, the reinforcing layer can be adhered to, or integrated into, the upper layer or the under layer or both. If the reinforcing layer is adhered to the upper layer or the under layer, it can be directly adhered thereto or adhered via intermediate layers.

[0016] Traditionally, thin ceramic tile, such as porcelain tiles less than 6 mm thick, or similar, do not exceed the 250 pound-force breaking strength that is commonly required for floor installation. Conventionally, these tiles also have low impact resistance, poor walking comfort, etc. This disclosure addresses these problems by integrating reinforcing materials, situated in layers, or being one or more layers themselves, close to the upper surface of the composite tile, such as on the

bottom side of the upper layer. These materials can be capable of absorbing and dissipating impact energy and vibration, thereby improving the strength, walking comfort, and acoustic properties of the tile. In this manner, tiles with desirable qualities can be produced.

[0017] Accordingly, the composite tile systems and methods of this disclosure may combine the durability of thicker ceramic tile with the comfort, light-weight, and impact resistance of non-ceramic materials. Moreover, the systems and methods of this disclosure can add a self-adhering feature for ease of installation.

[0018] Embodiments of this disclosure can comprise a composite tile comprising an upper layer defining the top of the tile, an under layer disposed under the upper layer, and a reinforcing layer disposed between the upper layer and the under layer. In some embodiments, the reinforcing layer can comprise fiberglass. In some embodiments, the reinforcing layer can further comprise an adhesive. In some embodiments, the reinforcing layer can comprise at least one of fiberglass, short strand fibers, carpet fibers, and carbon fibers. In some embodiments, the upper layer and the under layer can comprise a ceramic and the reinforcing layer can comprise fiberglass and a hot melt adhesive. In some embodiments, the upper layer and the under layer can have the same thickness and the reinforcing layer can be thinner than the upper layer and the under layer. In some embodiments, the upper layer can comprise a ceramic and the under layer can comprise a polymer laminate. In some embodiments, the polymer laminate can have an embedded filler and the filler can comprise at least one of cork, crumb rubber, carpet fibers, and chalk. In some embodiments, the polymer laminate can be a rigid polymer laminate. In some embodiments, the upper layer can comprise porcelain that includes at least one of mullite, kyanite, calcined alumina, and high temperature refractory materials. In some embodiments, the composite tile can further comprise a bottom layer disposed under the under layer and the bottom layer can comprise at least one of a pressure sensitive adhesive, a cork-polymer, and an interlocking fabric. In some embodiments, the composite tile can further comprise a bottom layer disposed under the under layer and the bottom layer can comprise a pressure sensitive double-sided tape. In some embodiments, the composite tile can further comprise a bottom layer disposed under the under layer and the bottom layer can comprise extended edges that extend horizontally beyond the upper layer. In some embodiments, the upper layer can comprise porcelain and can be about 3 mm thick, the under layer can comprise porcelain and can be about 3 mm thick, and the reinforcing layer can comprise fiberglass and can be about 1 mm thick. In some embodiments, the reinforcing layer is about 1 mm or less thick.

[0019] Embodiments of this disclosure can comprise a composite tile comprising a first, upper layer defining the top of the tile and a second, reinforcing layer under the upper layer. In some embodiments, the second layer can comprise fiberglass and a polymer laminate. In some embodiments, a bottom layer can be disposed under the second, reinforcing layer and the bottom layer can comprise at least one of a pressure sensitive adhesive, a cork-polymer, and an interlocking fabric.

[0020] Embodiments of this disclosure can comprise a method of manufacturing composite tile comprising providing an upper layer, providing a reinforcing layer on a bottom side of the upper layer, and hot pressing the upper layer and the reinforcing layer together. In some embodiments, the

method can further comprise providing an under layer on a bottom side of the reinforcing layer, and the hot pressing of the upper layer and the reinforcing layer together can include hot pressing the upper layer, the reinforcing layer, and the under layer together. In some embodiments, providing a reinforcing layer can comprise providing an adhesive and providing a reinforcing material onto and into the adhesive.

[0021] These and other aspects of this disclosure are described in the Detailed Description below and the accompanying figures. Other aspects and features of embodiments of this disclosure will become apparent to those of ordinary skill in the art upon reviewing the following description of embodiments of this disclosure in concert with the figures. While features of this disclosure may be discussed relative to certain embodiments and figures, all embodiments of this disclosure can include one or more of the features discussed herein. While one or more embodiments may be discussed as having certain advantageous features, one or more of such features may also be used with the various embodiments of the invention discussed herein. In similar fashion, while exemplary embodiments may be discussed below as system or method embodiments, it is to be understood that such exemplary embodiments can be implemented in various devices, systems, and methods of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Various features and advantages of this disclosure may be more readily understood with reference to the following Detailed Description taken in conjunction with the accompanying drawing figures, wherein like reference numerals designate like structural elements, and in which:

[0023] FIG. 1 depicts a perspective view of a tile, in accordance with some embodiments of this disclosure.

[0024] FIG. 2 depicts an exploded view of the tile of FIG. 1, in accordance with some embodiments of this disclosure.

[0025] FIG. 3 depicts a perspective view of a tile, in accordance with some embodiments of this disclosure.

[0026] FIG. 4 depicts an exploded view of the tile of FIG. 3, in accordance with some embodiments of this disclosure.

[0027] FIG. 5 depicts a perspective view of a tile, in accordance with some embodiments of this disclosure.

[0028] FIG. 6 depicts a method of manufacturing a tile, in accordance with some embodiments of this disclosure.

DETAILED DESCRIPTION

[0029] To facilitate an understanding of the principles and features of the various embodiments of the invention, various illustrative embodiments are explained below. Although exemplary embodiments of the invention are explained in detail as being composite tile systems and methods, it is to be understood that other embodiments are contemplated, such as embodiments employing other types of tiles, tile manufacturing methods, or tile installation methods. Accordingly, it is not intended that the invention is limited in its scope to the details of construction and arrangement of components set forth in the following description or examples. The invention is capable of other embodiments and of being practiced or carried out in various ways. Also, in describing the exemplary embodiments, specific terminology will be resorted to for the sake of clarity.

[0030] It must also be noted that, as used in the specification and the appended claims, the singular forms "a," "an" and "the" include plural references unless the context clearly

dictates otherwise. For example, reference to a component is intended also to include composition of a plurality of components. References to a composition containing “a” constituent is intended to include other constituents in addition to the one named.

[0031] Also, in describing the exemplary embodiments, terminology will be resorted to for the sake of clarity. It is intended that each term contemplates its broadest meaning as understood by those skilled in the art and includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

[0032] Ranges may be expressed herein as from “about” or “approximately” or “substantially” one particular value and/or to “about” or “approximately” or “substantially” another particular value. When such a range is expressed, other exemplary embodiments include from the one particular value and/or to the other particular value.

[0033] By “comprising” or “containing” or “including” is meant that at least the named compound, element, particle, or method step is present in the composition or article or method, but does not exclude the presence of other compounds, materials, particles, method steps, even if the other such compounds, materials, particles, method steps have the same function as what is named.

[0034] It is also to be understood that the mention of one or more method steps does not preclude the presence of additional method steps or intervening method steps between those steps expressly identified. Similarly, it is also to be understood that the mention of one or more components in a composition does not preclude the presence of additional components than those expressly identified.

[0035] The materials described as making up the various elements of the invention are intended to be illustrative and not restrictive. Many suitable materials that would perform the same or a similar function as the materials described herein are intended to be embraced within the scope of the invention. Such other materials not described herein can include, but are not limited to, for example, materials that are developed after the time of the development of the invention.

[0036] To facilitate an understanding of the principles and features of this disclosure, various illustrative embodiments are explained below. In particular, various embodiments of this disclosure are described as composite tile systems and methods. Some aspects of the invention, however, may be applicable to other contexts, and embodiments employing these aspects are contemplated. For example and not limitation, some aspects of the invention may be applicable to various types of coverings, floor decoration, or wall decoration. Accordingly, where terms such as “floor tile” or “tile” or related terms are used throughout this disclosure, it will be understood that other devices, entities, objects, or activities can take the place of these in various embodiments of the invention.

[0037] As described above, a problem with existing ceramic tile systems and methods is that the tiles are heavy, susceptible to damage from impact, and difficult to install. In addition, traditional ceramic tiles have inferior walking comfort and acoustic insulation compared to many other flooring materials. Embodiments of this disclosure, however, can overcome one or more of these deficiencies.

[0038] As shown in FIG. 1, in some embodiments, this disclosure can comprise a composite tile 100, such as a composite floor tile, wall tile, ceiling tile, roof tile, or the like. The tile 100 can have a top side 105 and a bottom side 110. In

addition, the tile can have a thickness h measured from the top side 105 of the tile 100 to the bottom side 110 of the tile 100.

[0039] As shown in FIGS. 1-4, the tile 100 can comprise a plurality of layers. The multi-layered configuration can enable the tile 100 to have improved features, including some or all of being light, strong, easy to install, comfortable to walk on, and acoustically insulating. FIGS. 1-2 show that, in certain embodiments, the tile 100 can comprise four layers, while FIGS. 3-4 show that, in some embodiments, the tile 100 can comprise three layers.

[0040] FIG. 2 is an exploded view of the tile of FIG. 1. As shown in FIG. 2, embodiments of this disclosure can comprise a tile 100 with an upper layer 205. The upper layer 205 can comprise the top side 105 of the tile 100, which can provide a desirable exposed surface for a floor, wall, ceiling, roof, or the like. As illustrated in FIG. 2, the upper layer 205 can provide a decorative or desired appearance. In some embodiments, the upper layer 205 can comprise a durable, wear resistant material such as porcelain or stone. The upper layer 205 can also comprise other types of ceramics or other materials such as, for example, glass or metal.

[0041] In some embodiments, the upper layer 205 can be thinner than conventional tiles. For example, in some embodiments, the upper layer 205 can have a thickness from about 1 mm to about 7.5 mm, including from about 2 mm to about 4 mm. The thickness of the upper layer 205 can be at about 3 mm or about 2 mm. The thickness can be less than about 8 mm, less than about 7 mm or less than about 6 mm. In some embodiments, the thickness can be about 3 mm to about 6 mm, from about 3 mm to about 5 mm, or from about 3 mm to about 4.5 mm. Thus, the upper layer 205 can have a thickness less than 8 mm, which is a standard thickness of conventional porcelain tiles. The use of a thinner upper layer 205 can therefore reduce the weight of the upper layer 205 compared to the weight of a conventional tile. This reduction in weight, combined with other reductions in weight mentioned herein, can enable the tile to be easier to handle and install, and can reduce shipping costs and environmental impact, among other advantages.

[0042] In embodiments comprising a ceramic upper layer 205, such as a porcelain layer, the upper layer 205 can have properties that are enhanced by the ceramic's body formula. The ceramic, for example, can comprise raw materials that can be used to provide exceptional strength. This blend can include mullite, kyanite, calcined alumina, and/or ground up high temperature refractories materials, along with typical ceramic/porcelain ingredients. The ceramic can also comprise recycled bulb glass. In some instances, the tile of this disclosure can allow the use of other materials that might be otherwise cost-prohibitive in a standard tile, but which can be used in a tile with less ceramic material. In some instances, the materials described above can be used to “seed” the ceramic and form a unique crystal structure. That unique structure can be capable of superior fired strength and elasticity as compared to a traditional porcelain ceramic layer of the same thickness.

[0043] In some embodiments, to improve other properties of the composite tile and related methods, such as the impact resistance, acoustic insulation, and ease of installation, the tile 100 can comprise additional layers.

[0044] In some embodiments, for example, the tile 100 can comprise a second layer 210. The second layer 210 can be a reinforcing layer that strengthens and increases the impact resistance of the tile 100. In some embodiments, a composite

tile **100** comprising at least a first layer **205** being a ceramic or porcelain upper layer **205** with a thickness of about 3 to 5 mm and a second layer **210** being a reinforcing layer comprising fiberglass and glue, for example, may provide improved impact resistance.

[0045] In some embodiments, as mentioned above, the reinforcing second layer **210** can comprise a reinforcing fibrous material, such as woven fiberglass. In other embodiments, the second layer **210** can comprise a non-woven fiberglass mat, knit fiberglass, or can comprise other materials, such as randomly oriented short strand fiber, for example glass fiber or recycled carpet fibers or carbon fiber or combinations of any of the above. The second layer **210** can also include an adhesive, such as a hot melt adhesive, and as an example, hot melt glue. The adhesive can be a polymer adhesive and can form an integrated structure with the fiberglass, or other reinforcing material. In some embodiments, the adhesive can comprise a moisture cured polyurethane, an ambient or heat cured epoxy, or a thermoplastic hot melt glue, such as EVA hot melt.

[0046] In addition to improving impact resistance, walking comfort, acoustic properties, etc., the second layer **210** can hold pieces of the tile **100** together if the tile **100** should break. In other words, since the second layer **210** can be attached to the layers above and below it with an adhesive (or since the second layer **210** can be integrated into one or more of the layers), and since second layer **210** is unlikely to fracture if and when the tile **100** breaks, the second layer **210** can retain the broken pieces of tile. Accordingly, the second layer **210** can serve as a shatter proofing mechanism for the tile **100**. The second layer **210** can therefore prevent sharp pieces of broken tile from spreading across a work area or floor, and can help prevent injury.

[0047] In some embodiments, the second layer **210** can have a thickness from about 0.05 mm to about 2 mm, from about 0.1 mm to about 1.1 mm, from about 0.1 mm to about 0.6 mm, or from about 0.2 mm to about 0.3 mm. In some embodiments, the second layer can be about 1.25 mm thick, about 1 mm thick, about 0.5 mm thick, or about 0.25 mm thick. In addition, the second layer **210** can be less dense and therefore lighter than the upper layer **205**. Incorporation of the second layer **210** can therefore help reduce the weight of the tile **100** compared to a conventional tile of the same or similar thickness.

[0048] In some embodiments, the second layer **210** can be press laminated to the bottom of the upper layer **205** using a structural adhesive such as conventional glue, epoxy, polyurethane, acrylic, or one of several adhesives, mentioned above, that can be integrated into the second layer **210** or applied separately. In some embodiments, the second layer **210** can also be compression molded to the bottom of the upper layer **205** or reaction injection molded to the bottom of the upper layer **205** using a thermoset polymer. In such embodiments, the molding process can be used to shape a third layer as well. In some embodiments, the second layer **210** can be attached to the bottom of the upper layer **205** by conventional glue, epoxy, polyurethane, acrylic, or one of several thermoplastic adhesives, and/or by hot pressing.

[0049] As discussed above, the second layer **210** can improve properties of the tile **100**, such as impact resistance, acoustic insulation, etc. To further improve the impact resistance, bending strength, acoustic insulation, and various other

properties, however, a third, under layer **215** can be disposed on the bottom of the second layer **210** or incorporated with the second layer **210**.

[0050] In some embodiments, the third, under layer **215** can be similar to the first, upper layer **205**. Thus, in some embodiments, the third layer **215** can comprise a ceramic, such as a porcelain that can have the same or similar composition as the first layer **205**, or the third layer **215** can comprise another material such as, for example, glass, metal, or stone. In some embodiments, the third layer **215** can have approximately the same thickness, or range of thicknesses, as the first layer **205**. The third layer **215**, therefore, in combination with the first and second layers **205**, **210**, can create a periodic structure of two layers with a thin reinforcing layer in between. Such a periodic structure can be dispersive in nature to the transmission of mechanical shock waves through the tile **100** when the tile **100** is impacted by a dropped object. This can result in exceptionally high impact strength of the composite tile **100**, as shown for example in Table 1 below.

[0051] In other embodiments, the third layer **215** can comprise a polymer laminate, such as a plastic laminate. In some embodiments, the polymer laminate can be rigid such that it is not easily deformable. In some embodiments, the polymer laminate can comprise a thermoplastic such as polyethylene, polypropylene or polyvinylchloride, or a thermoset material such as polyurethane. In some embodiments, moreover, the polymer laminate can comprise one or more fillers incorporated therein. The filler can be a resilient and elastic material. The filler can be, for example, cork, recycled crumb rubber, waste carpet fibers, chalk, wood particles, and/or plastic particles from recycled waste plastics, such as from waste PET bottles. The filler can provide additional acoustic insulation, noise absorption, and thermal insulation properties. The resilient, elastic nature of the polymer laminate and/or filler can also improve the walking comfort of the tile **100**.

[0052] Cork is an advantageous material to incorporate into the third layer **215** because cork is a well-suited, naturally occurring sound insulator and vibration dampener. This is due, at least in part, to cork's cellular structure. Using about 5 to about 20 percent cork, or about 15 percent cork, for example, in polyurethane sheets or other polymer sheets, especially thermoplastic sheets, can significantly increase the sound and vibration damping properties of a polymer laminate, making the polymer laminate more desirable for acoustic insulation and vibration isolation. These desirable properties can also be achieved at higher cork concentrations from about 20 percent to about 80 percent. In addition, one advantage of incorporating polyurethane into the third layer **215** in some embodiments is that, due to polyurethane's inherent polarity and adhesive nature, it may bond well with the second layer **210**, thereby eliminating the need for a separate adhesive.

[0053] The third layer **215** can also act as a moisture barrier, preventing any fluid that may seep up from cracks in the subfloor from permeating the tile **100**. The third layer **215** can also prevent fluid from contacting the second layer **210**.

[0054] The third layer **215** can either be fabricated independently and glued to the bottom of the second layer **210** or processed in-situ. Thus, in some embodiments, conventional glue, epoxy, polyurethane, acrylic, or one of several thermoplastic adhesives can be used to adhere the third layer **215** to the bottom of the second layer **210**. In other embodiments, the polymer laminate and/or filler can be placed onto the bottom of the second layer **210**. Heat and pressure can then be applied

to cause the polymer laminate and filler to melt and fuse to the second layer **210**, thereby attaching the third layer **215** (and also the first layer **205**) in situ by hot pressing.

[0055] In some embodiments, such as embodiments employing a ceramic third layer **215**, the third layer **215** can have the same thickness, or range of thicknesses, as the first layer **205**, as discussed above. In some embodiments, such as embodiments employing a polymer laminate third layer **215**, the third layer **215** can have a thickness from about 0.5 mm to about 6 mm, from about 1 mm to about 5 mm, or from about 2 mm to about 4 mm. In some embodiments, such as embodiments employing a polymer laminate, the third layer **215** can also be less dense and therefore lighter than the upper layer **205**. Incorporation of the third layer **215** can therefore help reduce the weight of the tile **100** compared to a conventional tile of the same or similar thickness, which, as described above, makes installation easier and reduces shipping costs.

[0056] To improve ease of installation and other qualities of the tile **100**, a fourth, bottom layer **220** can be attached to the bottom of the third layer **215**. As discussed above, traditional tile installation requires the mixing, spreading, and curing of adhesives, such as thinset, mortar, and grout. These processes are extremely time consuming and laborious, and require an excessive amount of cleaning.

[0057] To alleviate these problems, the bottom layer **220** can comprise a pressure sensitive adhesive, such as a pressure sensitive, double-sided adhesive tape. The bottom layer **220** can therefore enable a user to quickly and easily adhere the tile **100** to a surface, such as a subfloor, wall, or roof, eliminating the problems caused by use of thinset, mortar, and grout. In other embodiments, the bottom layer **220** can comprise a cork-polymer layer that creates a physical friction bond with the subfloor, wall, or roof. Alternatively, the bottom layer **220** can comprise a tack fast loop fabric, such as a loop and hook fabric (such as Velcro®), that interlocks with an underlayment on the subfloor, wall, or roof.

[0058] In some embodiments, as shown in FIG. 5, the composite tile **100** comprises a bottom layer **220** that can maintain spacing between the upper layers **205** of adjacently installed tiles **100**. This can increase ease of installation, and create a conventional look. In some embodiments, the spacing can be maintained by one or more extended edges **505** of the bottom layer **220**, and/or the under layer **215**, that extend horizontally beyond the edges of the upper layer **205**. Thus, after installing the tiles **100** adjacent to one another, the extended edges **505** can cause the bottom layers **220** (and/or the under layers **215**) of the adjacent tiles **100** to abut, but a space to be present between adjacent upper layers **205**. This space can then be filled with a grouting material, preferably a polymeric grouting material, for creating a grout joint. The grout may serve additional purposes, such as the creation of a watertight joint between two adjacent composite tiles **100** and/or providing a conventional appearance.

[0059] In some embodiments, the bottom layer **220** can have a thickness from about 0.01 mm to about 4 mm. In some embodiments, the bottom layer **220** can have a thickness of about 1 mm or about 2 mm. In some embodiments, like the second layer **210** and, optionally, the third layer **215**, the bottom layer **220** can also be less dense and therefore lighter than the upper layer **205**, making the tile **100** easier to install and cheaper to ship than other tiles of the same thickness.

[0060] As shown in FIGS. 3-4, embodiments of this disclosure can also comprise a tile **100** with three layers. In such embodiments, the upper layer **205** and bottom layer **220** can

be substantially the same as the upper layer **205** and bottom layer **220** described with reference to the four layer embodiment shown in FIGS. 1-2. For some three layer embodiments, however, this disclosure can include an integrated second layer **310**. The integrated second layer **310** can optionally comprise a combination of the second layer **210** and third layer **215** of the embodiment shown in FIGS. 1-2, as shown in FIG. 4.

[0061] In some embodiments, for example, the integrated second layer **310** can comprise reinforcing materials, such as the reinforcing materials incorporated in the second layer **210** (fiberglass, etc.), as discussed above. In addition, the integrated second layer **310** can also comprise a resilient, elastic material, such as the resilient, polymer laminate optionally incorporated in the third layer **215**, as also discussed above. These various materials can be combined in any number of configurations to produce the integrated second layer **310**. In some embodiments, for example, a fiberglass mat can be disposed within a mixture comprising polymer laminate and filler to yield the integrated second layer **310**. In other embodiments, a layer of polymer laminate and filler can be sandwiched between two layers of fiberglass mat to yield the integrated second layer **310**. The adhesive of the second layer **215** can also be included in the integrated second layer **310**. The make-up of the integrated second layer **310**, however, is not limited to the materials incorporated into the second layer **210** and third layer **215**.

[0062] In some embodiments, the integrated second layer **310** can be attached to the upper layer **205** and bottom layer **220** in the same manner as described with regard to attaching the upper layer **205** to the second layer **210** or the second layer **210** to the third layer **215**, above. Accordingly, a variety of adhesives and attachment methods can be employed to attach the integrated second layer **310** to the upper layer **205** and bottom layer **220**, for example, hot melt adhesives and hot pressing.

[0063] Embodiments of this disclosure can comprise tiles **100** and tile layers with varying thicknesses h (as shown in FIGS. 1 and 3). In some embodiments, the tile **100** can have a thickness h of about 2 mm to 18 mm, of about 3 mm to about 15 mm, of about 4 mm to about 12 mm, of about 5 mm to 8 mm, or of about 6 mm to about 8 mm. The tile thickness h can be less than about 15 mm, less than about 12 mm, less than about 10 mm, or less than about 8 mm. In some embodiments, the tile **100** can have a thickness h of about 7.5 mm, of about 7 mm, of about 6.5 mm, or of about 6 mm. Accordingly, embodiments of this disclosure comprise tiles **100** that can be thinner than common 8 mm porcelain tiles, the same thickness as conventional tiles, or thicker than conventional tiles. Moreover, embodiments of this disclosure comprise tiles having different thicknesses, the different thicknesses being available according to the particular needs of a given tile application. In fact, the thickness of each layer, as well as the material comprising each layer, can be optimized for any number of given tile applications.

[0064] Embodiments of this disclosure can also comprise tiles **100** with varying length and width dimensions. In some embodiments, for example, the length and width dimensions are about 12 inches by about 24 inches, which are common dimensions for residential tile products and applications. However, larger sizes up to about 40 inches by about 120 inches may be produced for other applications, such as commercial installations.

[0065] Table 1 below provides information related to the impact resistance of some embodiments of this disclosure as compared to existing tiles. Specifically, Table 1 provides the impact resistance of certain tiles in a standard steel ball drop test wherein a steel ball with a 38 mm diameter and a mass of approximately 225 grams is dropped on each type of tile multiple times from various heights. The maximum height from which the ball does not fracture the tile was recorded for various iterations of the test, and the results are provided in Table 1. Specifically, Table 1 provides the average maximum height from which the ball does not fracture each type of tile and the standard deviation of the height for each tile type. This height is the “impact resistance” for purposes of Table 1. The greater the impact resistance, the stronger and more resilient the tile.

[0066] As shown in Table 1, the types of tiles tested were: Tile 1—a standard 8 mm porcelain tile; Tile 2—a standard 8 mm porcelain tile (installed on a subfloor with setting material); Tile 3—a 3 mm porcelain tile or tile layer such as the first layer 205 or third layer 215 described above; Tile 4—a 3 mm porcelain tile or tile layer such as the upper layer 205 described above with a fiberglass and polymer adhesive backing such as the second layer 210 described above; and Tile 5—a tile with a porcelain upper layer 205, a fiberglass and polymer adhesive second layer 210, and a porcelain under layer 215, as described above, with a total thickness h of 7.0 mm. Tile 5 was produced by selecting a 3 mm thick porcelain tile with a decorative face as the first layer 205, a woven fiberglass mat and adhesive as the 1 mm thick second layer 210, and for the third layer 215 a second porcelain tile of approximately the same thickness as the first layer 205. Except as noted above with regard to Tile 2, the tested samples were kept free floating on a flat concrete floor during the test. In this regard, it is noteworthy that installing a tile with setting material can add to the impact resistance of the tile.

[0067] In Table 1 it can be seen that Tile 5 had the highest impact resistance during the tests. In fact, the impact resistance is significantly higher than all other tiles, including Tile 2 (the standard tile installed), even though Tile 5 was free floating. Moreover, Tile 4, which does not have under layer 215, had higher impact resistance than standard Tile 1.

TABLE 1

Tile	Impact Resistance (avg. inches $\pm$ std. dev.)
Tile 1 - Standard 8 mm porcelain tile	8.0 $\pm$ 1.0
Tile 2 - Standard 8 mm porcelain tile (installed)	20.0 $\pm$ 3.0
Tile 3 - 3 mm tile/tile layer	6.0 $\pm$ 1.8
Tile 4 - 3 mm tile upper layer plus fiberglass/adhesive reinforcing layer	11.3 $\pm$ 2.3
Tile 5 - 3 mm tile upper layer plus 1 mm fiberglass/adhesive reinforcing layer plus 3 mm tile under layer; total thickness of 7.0 mm	46.0 $\pm$ 2.0

[0068] While the table and discussion above discloses that embodiments of this disclosure are, or are useful for, producing stronger thin tiles, embodiments of the present invention are, or are useful for, producing stronger standard thickness tiles as well as stronger, thicker tiles. For example, while some embodiments of this disclosure are stronger tiles that are less than 8 mm in thickness, some tiles of this disclosure are 8 mm in thickness or more than 8 mm in thickness, and are

stronger than conventional tiles of the same or similar thicknesses regardless of their thickness. Thus, Table 1 illustrates that some specific tiles 100 have improved impact resistance over other specific tiles, but also illustrates conceptually that embodiments of this disclosure provide improved impact resistance over similar conventional tiles generally.

[0069] As described above, embodiments of the present invention can comprise methods related to composite tiles 100, such as methods of manufacturing or installing composite tiles 100. FIG. 6 shows an exemplary method 600 of manufacturing composite tiles. As shown in FIG. 6, in some embodiments, a first layer 205 of a tile can be placed on a conveyor 605. In some embodiments, the first layer 205 can be placed with the top side 105 facing down at step 650.

[0070] In some embodiments, at step 655, a feeder can deposit an adhesive layer onto the upward facing side of first layer 205 (since the top side 105 is facing down, the upward facing side is actually the bottom of the first layer). Then, at step 660, a reinforcing material, such as a fiberglass mat, for example, can be deposited onto and into the adhesive layer. In other words, in some embodiments, the reinforcing material can be deposited onto the adhesive layer and can integrate with the adhesive layer. In some embodiments, the reinforcing material and adhesive can form the second layer 210. In some embodiments, the reinforcing layer can be applied before the adhesive layer, i.e., steps 655 and 660 can be reversed to form the second layer 210.

[0071] In some embodiments, at step 665, a third, under layer 215 can be deposited onto the bottom side of the second layer 210 (which is facing upward, since the composite tile is upside down). The layers can then be hot pressed together at step 670. The hot pressing can cause some adhesive, and/or other materials, to protrude from the sides of the tile, as shown.

[0072] In some embodiments, at step 675, a fourth, bottom layer 220 can be deposited on the upward facing side of the third layer 215 (which is the bottom of the third layer 215). Then, at step 680, an edge trimming device can trim the edges of the tile, thereby determining the final dimensions of the tile 100 and cutting away any excess material squeezed from the composite tile 100 during hot pressing. At step 685, the tile can be packaged for shipment.

[0073] In some embodiments, the first and third layers 205, 215 can be preheated before being introduced into the assembly process. In this manner, the layers 205, 215 can facilitate hot pressing and prevent premature drying of the adhesive.

[0074] During manufacturing of embodiments comprising three layers, such as embodiments with an integrated second layer 310, the integrated second layer 310 can be formed by introducing a reinforcing material into a polymer laminate. This can be accomplished by using the polymer laminate as an adhesive and embedding the reinforcing layer within the polymer laminate, similar to the method described above with regard to steps 655 and 660. Alternatively, the integrated second layer 310 can be formed separately and adhesive can be used to adhere the integrated second layer 310 to the top layer 205 and the bottom layer 220. In all embodiments, hot pressing can be employed to secure two or more of layers 205, 310, and 220 together, similarly to the methods shown in FIG. 6.

[0075] After reading this disclosure in conjunction with the figures, those skilled in the art will understand that the tiles 100 disclosed herein can be thinner than conventional tiles, while also being easier to install, less susceptible to damage

from impact, and lighter. In addition, the tiles **100** disclosed herein can provide superior walking comfort and acoustic insulation compared to conventional tiles. It shall be understood by those skilled in the art that each of the layers disclosed herein are optional, and that embodiments omitting certain layers, or adding additional layers, are envisioned. Moreover, the order of the layers can be changed, as this disclosure is not limited to the orders described above. For example, in some embodiments, the third layer **215** can be above the second layer **210**.

[0076] While certain systems and methods related to composite tile systems and methods have been disclosed in some exemplary forms, many modifications, additions, and deletions may be made without departing from the spirit and scope of the system, method, and their equivalents. The embodiments disclosed herein are further capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purposes of description and should not be regarded as limiting the claims.

[0077] Accordingly, those skilled in the art will appreciate that the conception upon which the application and claims are based may be readily utilized as a basis for the design of other devices, methods, and systems for carrying out the several purposes of the embodiments and claims presented herein. It is important, therefore, that the claims be regarded as including such equivalent constructions.

What is claimed is:

1. A composite tile comprising:
an upper layer defining the top of the tile;
an under layer disposed under the upper layer; and
a reinforcing layer disposed between the upper layer and the under layer.
2. The composite tile of claim 1, the reinforcing layer comprising fiberglass.
3. The composite tile of claim 2, the reinforcing layer further comprising an adhesive.
4. The composite tile of claim 1, the reinforcing layer comprising at least one of fiberglass, short strand fibers, carpet fibers, and carbon fibers.
5. The composite tile of claim 1, the upper layer and the under layer comprising a ceramic and the reinforcing layer comprising fiberglass and a hot melt adhesive.
6. The composite tile of claim 5, the upper layer and the under layer having the same thickness and the reinforcing layer being thinner than the upper layer and the under layer.
7. The composite tile of claim 1, the upper layer comprising a ceramic and the under layer comprising a polymer laminate.

8. The composite tile of claim 7, the polymer laminate having an embedded filler, the filler comprising at least one of cork, crumb rubber, carpet fibers, and chalk.

9. The composite tile of claim 7, the polymer laminate being a rigid polymer laminate.

10. The composite tile of claim 1, the upper layer comprising porcelain that includes at least one of mullite, kyanite, calcined alumina, and high temperature refractory materials.

11. The composite tile of claim 1, further comprising a bottom layer disposed under the under layer, the bottom layer comprising at least one of a pressure sensitive adhesive, a cork-polymer, and an interlocking fabric.

12. The composite tile of claim 1, further comprising a bottom layer disposed under the under layer, the bottom layer comprising a pressure sensitive double-sided tape.

13. The composite tile of claim 1, further comprising a bottom layer disposed under the under layer, the bottom layer comprising extended edges that extend horizontally beyond the upper layer.

14. The composite tile of claim 1, wherein the upper layer comprises porcelain and is about 3 mm thick, the under layer comprises porcelain and is about 3 mm thick, and the reinforcing layer comprises fiberglass and is about 1 mm thick.

15. The composite tile of claim 1, wherein the reinforcing layer is about 1 mm or less thick.

16. A composite tile comprising:

- a first, upper layer defining the top of the tile;
 - a second, reinforcing layer under the upper layer, the second layer comprising fiberglass and a polymer laminate.
17. The composite tile of claim 16, further comprising:
a bottom layer disposed under the second, reinforcing layer, the bottom layer comprising at least one of a pressure sensitive adhesive, a cork-polymer, and an interlocking fabric.

18. A method of manufacturing composite tile comprising:
providing an upper layer;
providing a reinforcing layer on a bottom side of the upper layer;
hot pressing the upper layer and the reinforcing layer together.

19. The method of claim 18, further comprising providing an under layer on a bottom side of the reinforcing layer, and wherein the hot pressing of the upper layer and the reinforcing layer together includes hot pressing the upper layer, the reinforcing layer, and the under layer together.

20. The method of claim 18, wherein providing a reinforcing layer comprises providing an adhesive and providing a reinforcing material onto and into the adhesive.

* * * * *