MODULAR CARPET SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/482,336, filed May 4, 2011, and U.S. Provisional Application No. 61/505,160, filed July 7, 2011, both of which are incorporated by reference herein in their entirety.

TECHNICAL FIELD

This disclosure generally relates to modular carpet systems (i.e., carpet tile systems). More particularly, this disclosure relates to modular carpet systems that are suitable for use in a wide variety of installation environments.

BACKGROUND

Modular carpet systems (i.e., carpet tile systems) are often sought to be installed in a wide range of environments. Unfortunately, such environments often expose such systems to adverse elements, such as standing water, alkaline conditions, high humidity, and other potentially challenging conditions. Conventional modular carpet systems are generally not able to withstand such conditions, and therefore, tend to loosen, buckle, shrink, and/or warp over time. Thus, there is a need for a modular carpet system that can be used in adverse installation conditions without degradation or failure.

SUMMARY

This disclosure is directed generally to a modular carpet (e.g., carpet tile) system for use in a wide variety of installation environments. In particular, the modular carpet system may be suitable for use even in adverse installation conditions.

The modular carpet system generally includes a carpet tile, and an adhesive for securing the carpet tiles in a desired position (e.g., in a side-by-side relationship with other carpet tiles) on an installation surface. The carpet tile may generally resist deformation or warping, even in adverse installation conditions. Such conditions may include installation on a floor having a moisture vapor emission rate (MVER) of at least about 1.8 kg/24 hr/93 sq. m ~~4 lb/24 hr/1000 sq. ft.~~, an in situ relative humidity (RH) in the floor of at least about 80%, a surface moisture pH of at least about 8, or any combination thereof. Likewise, the adhesive may resist failure or substantial loss of adhesion, even in adverse installation conditions.

The carpet tile may generally include a face comprising woven or tufted face yarns, and a backing (commonly referred to as a "secondary backing") for being positioned in a facing relationship with the installation surface. In one example, the backing may comprise a polymer or polymeric material that is at least 50% amorphous, for example, polyvinyl butyral (PVB). The

adhesive may comprise any suitable adhesive, for example, a silicone-based adhesive or a polyurethane-based adhesive. However, numerous other materials may be suitable. The adhesive component may be provided as an adhesive coating, a fastener (e.g., an adhesive tape or unsupported adhesive), or in any other suitable manner.

Although these systems are suitable for use in adverse environments, they can also be used in standard environments which do not have adverse conditions. Further, the systems may be used on any suitable installation surface. For example, the installation surface may comprise a floor or flooring surface (e.g., concrete, wood, etc.) that may be primed, painted, or coated with other materials, or may comprise an underlayment (e.g., for cushioning or waterproofing) or other material disposed between the actual floor or flooring surface and the carpet tile. For convenience, the terms "floor", "flooring", "surface", "flooring surface", and "installation surface" are used herein interchangeably.

Other features, aspects, and embodiments will be apparent from the following description.

DESCRIPTION

This disclosure is directed generally to a modular carpet (e.g., carpet tile) system for use in a wide variety of installation environments, including adverse installation environments. The modular carpet system of this disclosure generally includes a modular carpet (e.g., carpet tile) that can remain dimensionally stable (i.e., such that it resists both deformation in the x, y, and z directions and deviation from a planar state), even in adverse installation conditions, and an adhesive that can resist substantial loss in adhesion, even in adverse installation conditions.

In sharp contrast, a carpet tile that is not dimensionally stable may begin to buckle, warp, or curl, thereby pulling away from the adhesive and/or the installation surface, while an unstable adhesive may begin to lose adhesion, thereby releasing the carpet tile from its secured position. Thus, if the stability of either the tile or the adhesive is significantly impaired by the adverse condition, the tiles may undesirably shift or move from their desired edge-to-edge (e.g., side-by-side) configuration.

The modular carpet system of this disclosure may be able to withstand (i.e., remain stable in) a variety of adverse conditions. For example, the modular carpet system may generally be stable when installed on a floor having a moisture vapor emission rate (MVER) of at least about 1.8 kg/24 hr/93 sq. m ~~4 lb/24 hr/1000 sq. ft.~~, at least about 2.3 kg/24 hr/93 sq. m ~~5 lb/24 hr/1000 sq. ft.~~, at least about 2.7 kg/24 hr/93 sq. m ~~6 lb/24 hr/1000 sq. ft.~~, at least about 3.2 kg/24 hr/93 sq. m ~~7 lb/24 hr/1000 sq. ft.~~, at least about 3.6 kg/24 hr/93 sq. m ~~8 lb/24 hr/1000 sq. ft.~~, at least about 4.1 kg/24 hr/93 sq. m ~~9 lb/24 hr/1000 sq. ft.~~, at least about 4.5 kg/24 hr/93 sq. m ~~10 lb/24 hr/1000 sq. ft.~~, at least about 5.0 kg/24 hr/93 sq. m ~~11 lb/24 hr/1000 sq. ft.~~, at least about 5.4 kg/24 hr/93 sq. m ~~12 lb/24 hr/1000 sq. ft.~~, at least about 5.9 kg/24 hr/93 sq. m ~~13 lb/24 hr/1000 sq. ft.~~, at least

about 6.3 kg/24 hr/93 sq. m ~~14 lb/24 hr/1000 sq. ft.~~, at least about 6.8 kg/24 hr/93 sq. m ~~15 lb/24 hr/1000 sq. ft.~~, or at least about 7.3 kg/24 hr/93 sq. m ~~16 lb/24 hr/1000 sq. ft.~~, as measured using ASTM F1869-04 or any other suitable test method.

As another example, the modular carpet system may be stable when installed on a floor having an in situ relative humidity of at least about 80%, at least about 85%, at least about 90%, or at least about 95%, as measured for example, using ASTM F2170-02 or any other suitable test method. In one specific example, the modular carpet system may be stable when installed on a floor having an in situ relative humidity of 100%, as measured using ASTM F2170-02 or any other suitable test method.

As still another example, the modular carpet system may be stable when installed on a floor having a surface pH (e.g., surface moisture pH) of at least about 8, at least about 9, at least about 10, at least about 11, at least about 12, or at least about 13, as measured using ASTM F710-05 or any other suitable test method.

As yet another example, the modular carpet system may be stable when installed on a floor having any combination of the above features.

The present inventors have discovered that the use of a tile that remains dimensionally stable, even when exposed to adverse conditions, in combination with an adhesive that can withstand adverse conditions without a substantial loss in adhesion provides substantial benefits that previously had not been able to be achieved by known tile systems. Specifically, by using these components in combination, the system may be installed in many environments that would previously have been considered entirely unsuitable. Thus, the present system fills a substantial void in the marketplace.

Turning now to the individual components of the system, a carpet tile that is dimensionally stable generally exhibits little or no change in its length, width, or thickness, or deviation from a planar state, in response to various environmental factors, so the entire tile is able to remain in a substantially facing relationship (e.g., an opposing, contacting face-to-face relationship) with the installation surface over time. The dimensional stability of a carpet tile therefore includes both components of linear stability (i.e., change in length or width (MD or CD), for example, growth or shrinkage) and planar stability (i.e., a deviation from a planar / flat / level / even) state, for example, doming or curling, which also often indicates a change in z-directional thickness).

Linear stability may generally be characterized as exhibiting a change in length or width of the carpet tile of less than about 0.15%, for example, less than about 0.14%, less than about 0.13%, less than about 0.12%, less than about 0.11%, less than about 0.10%, less than about 0.09%, less than about 0.08%, less than about 0.07%, less than about 0.06%, less than about 0.05%, less than about 0.04%, less than about 0.03%, less than about 0.02%, or less than about

0.01%, after exposure to adverse conditions, as measured using ISO 2551 or any other suitable test method. This corresponds to a change in less than about 0.069 cm ~~0.027 in.~~ for ~~an~~ a 46 cm x 46 cm ~~18 in. x 18 in.~~ tile (i.e., no more than +/- 0.069 cm ~~0.027 in.~~), less than about 0.091 cm ~~0.036 in.~~ for a ~~an~~ 61 cm x 61 cm ~~24 in. x 24 in.~~ tile (i.e., no more than +/- 0.091 cm ~~0.036 in.~~), or less than about 0.137 cm ~~0.054 in.~~ for ~~an~~ a 91 cm x 91 cm ~~36 in. x 36 in.~~ tile (i.e., no more than +/- 0.137cm ~~0.054 inch~~), for example, as measured using ISO 2551 or any other suitable test method.

Planar stability may generally be characterized exhibiting a planar deviation of less than about 0.20 cm ~~0.078 in.~~, less than about 0.19 cm ~~0.075 in.~~, less than about 0.18 cm ~~0.070 in.~~, less than about 0.16 cm ~~0.065 in.~~, less than about 0.15 cm ~~0.060 in.~~, less than about 0.14 cm ~~0.055 in.~~, less than about 0.13 cm ~~0.050 in.~~, less than about 0.11 cm ~~0.045 in.~~, less than about 0.10 cm ~~0.040 in.~~, less than about 0.09 cm ~~0.035 in.~~, less than about 0.08 cm ~~0.030 in.~~, less than about 0.06 cm ~~0.025 in.~~, less than about 0.05 cm ~~0.020 in.~~, less than about 0.04 cm ~~0.015 in.~~, or less than about 0.03 cm ~~0.010 in.~~, as measured for example, before and/or after heating according to ISO 2551 or other suitable test method.

The present inventors have recognized that the characteristics of the backing (i.e., secondary backing) of the carpet tile may substantially determine whether a particular carpet tile is dimensionally stable, even in adverse conditions. More particularly, the present inventors have discovered that a backing that is somewhat flexible tends to lie more flat on the installation surface, which assists with resisting dimensional changes when exposed to adverse conditions.

In one aspect, the backing may comprise a polymer having an amorphous content of at least about 50%. While not wishing to be bound by theory, it is believed that having at least 50% amorphous polymer content in the backing allows the polymer in the backing to "flow" and adapt more readily to the conditions of the installation environment. In each of various examples, the polymer of the backing may have an amorphous content of at least about 50 wt%, at least about 55 wt%, at least about 60 wt%, at least about 65 wt%, at least about 70 wt%, at least about 75 wt%, at least about 80 wt%, at least about 85 wt%, at least about 90 wt%, at least about 95 wt%. In another example, the polymer of the backing may have an amorphous content of 100%.

In one example, the polymer of the backing may comprise polyvinyl butyral (PVB). The present inventors have discovered that a backing comprising PVB may be particularly suitable for use for providing stability in a modular carpet system, even in adverse conditions. While not wishing to be bound by theory, it is believed that the completely amorphous (i.e., 100% amorphous) nature of PVB imparts an inherent flexibility to the backing. Additionally, it is believed that the molecular weight of the PVB polymer is sufficiently high to resist attack by moisture, plasticizers, and caustic environments. Still other possibilities are contemplated. One example of a commercially available backing including a polymer that is at least 50% amorphous is ETHOS® tile backing, commercially available from Tandus Flooring, Inc. The Ethos® carpet

tile, which comprises PVB, has been found to be dimensionally stable in adverse conditions, as will be discussed further below.

In other examples, the polymer of the backing may comprise modified polycarbonate, ultra high molecular weight polyethylene (UHMWPE), atactic polypropylene (a-PP), silicone elastomers, thermoplastic polyolefins, thermoplastic elastomers, bitumen, or any combination thereof. All of such polymers may be at least 50% amorphous.

If desired, the backing may include a filler in an amount of from about 40 to about 75 wt% of the backing. While not wishing to be bound by theory, it is believed that the presence of filler at this level imparts a degree of dimensional stability to the backing that allows the tile to remain substantially flat, even in adverse conditions. Further, it is believed that the filler also assists with stabilizing the amorphous polymer, which can sometimes exhibit poor cold flow performance (i.e., the distortion, deformation, or dimensional change that takes place in materials under continuous load at ambient temperatures). Accordingly, the backing may be better able to maintain its shape and dimensional stability, even in adverse conditions.

Thus, in each of various independent examples, the backing may comprise, for example, from about 42 to about 65 wt%, from about 44 to about 60 wt%, from about 45 to about 55 wt%, for example, about 48%, or about 48.5 wt% filler, with the remainder comprising polymer or polymeric materials, such as the at least 50% amorphous polymers described above. Any filler may be used, for example, calcium carbonate, coal fly ash, barium sulfate, talc, any other suitable material, or any combination thereof.

Further, if desired, the backing may include a plasticizer (i.e., may be externally plasticized). While countless plasticizers may be suitable, in one example, the plasticizer may comprise a C8 (eight carbons) or greater alcohol based ester plasticizer.

In other examples, the backing may comprise a polymer that may be less than 50% amorphous. For example, the polymer may be less than 40% amorphous, less than 30% amorphous, less than 20% amorphous, or less than 10% amorphous. Stated alternately, the polymer may be at least about 10% amorphous, at least about 20% amorphous, at least about 30% amorphous, or at least about 40% amorphous. Examples of such polymers may include, but are not limited to, polyethylene terephthalate, thermoplastic polyurethane, poly(trimethylene terephthalate), polylactic acid, polyvinylidene chloride, ethylene vinyl acetate, thermoplastic polyolefin or other polyolefin, thermoplastic elastomer, acrylonitrile-styrene-butadiene, nylon, styrene-butadiene, styrene-butadiene-styrene, styrene-butadiene-rubber, acrylic, vinyl acrylic, styrene acrylic, vinyl acetate ethylene copolymer, cork, or rubber. Still countless other possibilities are contemplated. Fillers may also be used with such materials, as described above.

Numerous adhesives may likewise be suitable for use with the modular carpet system, provided that the adhesive is stable, even when exposed to adverse installation conditions, as set forth above. The adhesive may also be suitable for use with externally plasticized backings.

In one exemplary embodiment, the adhesive may be silicone-based (e.g., may comprise a silicone-based polymer, silicone elastomer, modified silicone elastomer, silicone-based elastomer, etc.). Some examples of suitable silicone-based adhesives have been evaluated in connection with various commercially available adhesive tapes including, but not limited to SR336R release coated polyester silicone tape (commercially available from Specialty Tapes Manufacturing, Franksville, WI), Tesa 50600 polyester tape with silicone-based adhesive (commercially available from Tesa SE), ARclad 6370 polyester tape with silicone-based adhesive (commercially available from Adhesives Research, Glen Rock, PA), and SC-4075 polyester tape with silicone-based adhesive (commercially available from Custom Adhesive Products, Racine, WI), each of which is described in greater detail below. Countless other silicone-based adhesives may also be suitable.

In another exemplary embodiment, the adhesive may be urethane-based (e.g., may comprise polyurethane, castor oil based urethane, urethane hot melt, polyurethane reactive, etc.). Examples of urethane-based adhesives that may be suitable for use with the modular carpet system are Hauthane L2183 and Hauthane L3378, both commercially available from Hauthaway Corporation, Lynn, MA). However, countless others may be suitable.

In still other exemplary embodiments, the adhesive may be acrylic-based, modified acrylic, styrene-based (e.g., styrene-butadiene, styrene-butadiene-styrene, styrene-butadiene-rubber, styrene-acrylic), hot melt based (e.g., rubber based hotmelt, EVA, EVA based hotmelt, urethane based hotmelt), butadiene-based (e.g., styrene-butadiene, styrene-butadiene-styrene, styrene-butadiene-rubber), epoxy-based, rubber based (e.g., natural or synthetic rubber), modified rubber, cyanoacrylate, PVB, biopolymer-based (e.g., vinyl acetate ethylene copolymers or castor oil based urethane). Further, any combination or copolymer of any of the above adhesives (including the silicone-based and urethane adhesives) may be suitable.

Prior to being exposed to adverse conditions (e.g., as set forth above), the adhesive may generally have an adhesive tack that is greater than 10 N ~~2.3 lb-f~~, for example, at least about 11 N ~~2.5 lb-f~~, for example, at least about 13 N ~~3 lb-f~~, at least about 16 N ~~3.5 lb-f~~, at least about 18 N ~~4 lb-f~~, at least about 20 N ~~4.5 lb-f~~, at least about 22 N ~~5 lb-f~~, at least about 24 N ~~5.5~~, at least about 27 N ~~6 lb-f~~, at least about 29 N ~~6.5 lb-f~~, at least about 31 N ~~7 lb-f~~, at least about 33 N ~~7.5 lb-f~~, at least about 36 N ~~8 lb-f~~, at least about 38 N ~~8.5 lb-f~~, at least about 40 N ~~9 lb-f~~, at least about 42 N ~~9.5 lb-f~~, at least about 44 N ~~10 lb-f~~, or at least about 47 N ~~10.6 lb-f~~, as measured using ASTM D2979 or any other suitable test method. (To convert the adhesive tack values throughout this specification into N/sq. cm ~~lb-f/sq. in~~, the value can be divided by the probe area of 4.26 sq. cm ~~0.66 sq. in.~~).

After about one day, about 7 days, or about 14 of exposure to one or more adverse conditions, as set forth above, the adhesive tack may generally be greater than 5.8 N ~~1.3 lb-f~~, for example, at least about 6.7 N ~~1.5 lb-f~~, at least about 8.9 N ~~2 lb-f~~, at least about 11 N ~~2.5 lb-f~~, at least about 13 N ~~3 lb-f~~, at least about 16 N ~~3.5 lb-f~~, at least about 18 N ~~4 lb-f~~, at least about 20 N ~~4.5 lb-f~~, at least about 22 N ~~5 lb-f~~, at least about 24 N ~~5.5 lb-f~~, at least about 27 N ~~6 lb-f~~, at least about 29 N ~~6.5 lb-f~~, at least about 31 N ~~7 lb-f~~, at least about 33 N ~~7.5 lb-f~~, at least about 36 N ~~8 lb-f~~, at least about 38 N ~~8.5 lb-f~~, at least about 40 N ~~9 lb-f~~, at least about 42 N ~~9.5 lb-f~~, or at least about 44 N ~~10 lb-f~~, as measured using ASTM D2979 or any other suitable test method. However, other adhesive tack values and ranges thereof are contemplated, depending on the adhesive used and the conditions to which the adhesive is exposed.

For example, after about 1 day, about 7 days, or about 14 days of being immersed in water, the adhesive tack may be greater than 5.8 N ~~1.3 lb-f~~, for example, at least about 6.7 N ~~1.5 lb-f~~, at least about 8.9 N ~~2 lb-f~~, at least about 10.6 N ~~2.4 lb-f~~, at least about 11 N ~~2.5 lb-f~~, at least about 13 N ~~3 lb-f~~, at least about 15.6 N ~~3.5 lb-f~~, at least about 16 N ~~3.6 lb-f~~, at least about 17.8 N ~~4 lb-f~~, at least about 18.2 N ~~4.1 lb-f~~, at least about 20 N ~~4.5 lb-f~~, at least about 22 N ~~5 lb-f~~, at least about 23.6 N ~~5.3 lb-f~~, at least about 24.5 N ~~5.5 lb-f~~, at least about 27 N ~~6 lb-f~~, at least about 29 N ~~6.5 lb-f~~, at least about 31 N ~~7 lb-f~~, at least about 33 N ~~7.5 lb-f~~, or at least about 36 N ~~8 lb-f~~, as measured using ASTM D2979 or any other suitable test method.

After being immersed in water for about 1 day, about 7 days, or about 14 days, the decrease in adhesive tack may be less than about 42.8% or less than about 43%, for example, less than about 40%, less than about 35%, less than about 30%, less than about 28%, less than about 27.6%, less than about 25%, less than about 20%, less than about 15%, less than about 11%, less than about 11.3%, less than about 10%, less than about 7%, less than about 6.6%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after immersion in water for the specified period of time.

After about 1 day, about 7 days, or about 14 days of being immersed in a pH 12 solution, the adhesive tack may be greater than 6.7 N ~~1.5 lb-f~~, for example, at least about 7.1 N ~~1.6 lb-f~~, at least about 8.9 N ~~2 lb-f~~, at least about 11 N ~~2.5 lb-f~~, at least about 12 N ~~2.7 lb-f~~, at least about 13 N ~~3 lb-f~~, at least about 14 N ~~3.2 lb-f~~, at least about 15.6 N ~~3.5 lb-f~~, at least about 16 N ~~3.6 lb-f~~, at least about 17.8 N ~~4 lb-f~~, at least about 18.2 N ~~4.1 lb-f~~, at least about 20 N ~~4.5 lb-f~~, at least about 22 N ~~5 lb-f~~, at least about 24 N ~~5.5 lb-f~~, at least about 27 N ~~6 lb-f~~, at least about 29 N ~~6.5 lb-f~~, at least about 31 N ~~7 lb-f~~, at least about 33 N ~~7.5 lb-f~~, or at least about 36 N ~~8 lb-f~~, as measured using ASTM D2979 or any other suitable test method.

Prior to being exposed to adverse conditions (e.g., as set forth above), the adhesive may generally have a shear (i.e., lap shear) strength of from about 579~~130~~ to about 890 N ~~200 lb-f~~, for example, from about 623 140 to about 756 N ~~170 lb-f~~, for example, about 667 N ~~150 lb-f~~, when

adhered to various surfaces and measured using ASTM D3654 (as modified herein) or any other suitable test method. (To convert the lap shear adhesion values throughout this specification into N/sq. cm ~~lb-f/sq. in~~, the value can be divided by the contact area of 38.7 sq. cm ~~6 sq. in.~~). In other embodiments, the shear strength of the adhesive may be at least about 578 N ~~130 lb-f~~, for example, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 725 N ~~163 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method, prior to exposure to adverse conditions.

After about one day of exposure to one or more adverse conditions, as set forth above, the shear strength of the adhesive may be greater than 436 N ~~98 lb-f~~, for example, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 7 days of exposure to one or more adverse conditions, as set forth above, the shear strength of the adhesive may be greater than 374 N ~~84 lb-f~~, for example, at least about 400 N ~~90 lb-f~~, for example, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, for example, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, or at least about 801 N ~~180 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 14 days of exposure to one or more adverse conditions, as set forth above, the shear strength of the adhesive may be greater than 472 N ~~106 lb-f~~, for example, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, for example, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, or at least about 801 N ~~180 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. However, other shear strength values and ranges thereof are contemplated, depending on the adhesive used and the conditions to which the adhesive is exposed.

For example, after about one day of being immersed in water, the shear strength may be greater than 485 N ~~109 lb-f~~, for example, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 703 N ~~158 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about one day of being immersed in water, the shear strength may decrease less than 27.4%, for example, less than about 27%, less than about 25%, for example, less than about 20%, less than about 15%, less

than about 10%, less than about 6.9%, less than about 5.1%, less than about 5%, or less than about 4%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being immersed in water for about one day.

After about 7 days of being immersed in water, the shear strength may be greater than 374 N ~~84 lb-f~~, for example, at least about 400 N ~~90 lb-f~~, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 543 N ~~122 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 703 N ~~158 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 818 N ~~184 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 7 days of being immersed in water, the shear strength may decrease less than 43.9%, for example, less than about 43%, less than about 40%, less than about 35%, less than about 30%, less than about 25%, less than about 20%, less than about 18.9%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being immersed in water for about 7 days.

After about 14 days of being immersed in water, the shear strength may be greater than 198 N ~~112 lb-f~~, for example, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 636 N ~~143 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 832 N ~~187 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 14 days of being immersed in water, the shear strength may decrease less than 25.6%, for example, less than about 25%, less than about 20%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being immersed in water for about 14 days.

As another example, after about one day of being immersed in a high pH solution (e.g., about 12), the shear strength of the adhesive may be greater than 436 N ~~98 lb-f~~, for example, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 703 N ~~158 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 787 N ~~177 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about one day of being immersed in a high pH solution (e.g., about 12), the decrease in shear strength may be less than 35.1%, for example, less than about 35%, less than about 30%, less than about 25%, less than about 20%, less than about 18.9%, less than about 15%, less than about 10%, less than about 8.7%, less than about 5.4%, or less than about 5%. In some examples, there may

be no loss of adhesion or there may be an increase in adhesion after being immersed in a high pH solution for about one day.

After about 7 days of being immersed in a high pH solution (e.g., about 12), the shear strength of the adhesive may be greater than 396 N ~~89 lb-f~~, for example, at least about 400 N ~~90 lb-f~~, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 552 N ~~124 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, at least about 863 N ~~194 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 7 days of being immersed in a high pH solution (e.g., about 12), the decrease in shear strength may be less than 41.1%, for example, less than about 41%, less than about 40%, less than about 35%, less than about 30%, less than about 25%, less than about 20%, less than about 18.7%, less than about 17.8%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being immersed in a high pH solution for about 7 days.

After about 14 days of being immersed in a high pH solution (e.g., about 12), the shear strength of the adhesive may be greater than 472 N ~~106 lb-f~~, for example, at least about 489 N ~~110 lb-f~~, at least about 520 N ~~117 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, at least about 667 N ~~150 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 836 N ~~188 lb-f~~, at least about 845 N ~~190 lb-f~~, at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 14 days of being immersed in a high pH solution (e.g., about 12), the decrease in shear strength may be less than 29.5%, for example, less than about 29%, less than about 25%, less than about 22.1%, less than about 20%, less than about 15.3%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being immersed in a high pH solution for about 14 days.

As another example, after about one day of exposure to water vapor (e.g., 100% relative humidity), the shear strength of the adhesive may be greater than 689 N ~~155 lb-f~~, for example, at least about at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 787 N ~~177 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 7 or 14 days of exposure to water vapor (e.g., 100% relative humidity), the shear strength of the adhesive may be at least about 400 N ~~90 lb-f~~, for example, at least about 445 N ~~100 lb-f~~, at least about 472 N ~~106 lb-f~~, at least about 494 N ~~111 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, or at least about 667 N

~~150 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about one day, about 7 days, or about 14 days of exposure to water vapor (e.g., 100% relative humidity), the decrease in shear strength may less than about 35%, for example, less than about 30%, less than about 29.8%, less than about 25.9%, less than about 25%, less than about 20%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being exposed to water vapor for the specified amount of time.

As another example, after about one day of exposure to high alkaline vapor (e.g., pH of 12), the shear strength of the adhesive may be at least about 667 N ~~150 lb-f~~, at least 685 N ~~154 lb-f~~, at least 689 N ~~155 lb-f~~, at least about 712 N ~~160 lb-f~~, at least about 756 N ~~170 lb-f~~, at least about 801 N ~~180 lb-f~~, at least about 845 N ~~190 lb-f~~, or at least about 890 N ~~200 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about 7 or 14 days of exposure to high alkaline vapor (e.g., pH of 12), the shear strength of the adhesive may be at least about 400 N ~~90 lb-f~~, for example, at least about 445 N ~~100 lb-f~~, at least about 489 N ~~110 lb-f~~, at least about 507 N ~~114 lb-f~~, at least about 520 N ~~117 lb-f~~, at least about 534 N ~~120 lb-f~~, at least about 578 N ~~130 lb-f~~, at least about 623 N ~~140 lb-f~~, or at least about 667 N ~~150 lb-f~~, as measured using ASTM D3654 (as modified herein) or any other suitable test method. After about one day, about 7 days, or about 14 days of exposure to high alkaline vapor (e.g., pH of 12), the decrease in shear strength may less than about 35%, for example, less than about 30%, less than about 25%, less than about 24.1%, less than about 22%, less than about 20%, less than about 15%, less than about 10%, or less than about 5%. In some examples, there may be no loss of adhesion or there may be an increase in adhesion after being exposed to water vapor for the specified amount of time.

The adhesive component of the system may be provided in a variety of different ways and/or may be provided using various carriers or vehicles, some of which are described herein.

In one embodiment, the adhesive may comprise a portion of a fastener, for example, an adhesive tape. The fastener, for example, tape, may generally be operative for maintaining the tiles in a connected or joined condition, even when the tiles are installed in an adverse installation environment, as described above.

The tape may generally include a plurality of layers in a superposed, facing relationship with one another. The tape may have a first side (e.g., face or surface) of the tape is for being in contact with the bottom surface (i.e., underside) of one or more tiles, and a second side (e.g., face or surface) of the tape is for being proximate to the floor (e.g., in contact with the floor or any underlayment disposed on the floor).

For example, in a first embodiment, the tape may comprise a single-sided adhesive tape, in which the adhesive (e.g., adhesive material) is disposed or supported on one side (e.g., a first,

tile contacting side) of a substrate. In use, the tape may be positioned so that adhesive side of the tape is facing upwardly with the adhesive in contact with the underside (i.e., the backing) of the tiles. The tape may generally span across at least one seam between two or more tiles (or at the abutting corners of two or more tiles, for example, four tiles) to connect or join the tiles to one another to provide sufficient stability to withstand normal foot traffic without adhering the tile to the underlying surface. The adjoined tiles generally serve as a unitary textile or "rug" that "floats" on the floor, such that the adjoined tiles may be collectively repositioned on the floor. Further, when needed or desired, one or more individual tiles may be repositioned, replaced, reconfigured, or otherwise altered without causing damage to the surface of the floor.

The adhesive may comprise any suitable adhesive, such as those described above. The level of adhesion may be semi-permanent (releasable with some effort) or non-permanent (i.e., readily releasable), such that the adhesive is sufficiently strong to adhere the tape to the backing of the tile, but not so strong that the tape cannot be separated from the tile and/or repositioned without destruction or delamination of the tape (i.e., the loss of adhesion between the adhesive and the substrate). In other embodiments, the level of adhesion may be permanent (not releasable).

The adhesive material may be a substantially continuous layer, or may be a discontinuous layer (e.g., a random or non-random pattern of adhesive). In this and other embodiments, the adhesive may have any suitable coat weight or thickness, for example, from about 0.00064 cm ~~0.25 mil~~ to about 0.013 cm ~~5 mil~~, for example, from about 0.0025 cm ~~1 mil~~ to about 0.010 cm ~~4 mil~~, for example, from about 0.0064 cm ~~2.5 mil~~ to about 0.0089 cm ~~3.5 mil~~. However, other suitable thicknesses and ranges thereof may be used.

In this and other embodiments, the substrate may generally comprise a polymer film, paper, foil, or any other suitable material. In one exemplary embodiment, the substrate may comprise a polyester film (e.g., polyethylene terephthalate). In other embodiments, the substrate may comprise thermoplastic polyurethane, polyvinyl butyral, poly(trimethylene terephthalate), polystyrene, polylactic acid, ethylene vinyl acetate, polyvinyl chloride, thermoplastic polyolefin or other polyolefin, polyvinylidene chloride, and/or polypropylene. Countless other possibilities are contemplated. Further, the substrate may have any suitable thickness, for example, from about 0.00064 cm ~~0.25 mil~~ to about 0.017 cm ~~7 mil~~, for example, from about 0.0025 cm ~~1 mil~~ to about 0.013 cm ~~5 mil~~, for example, from about 0.0076 cm ~~3 mil~~ to about 0.010 cm ~~4 mil~~, for example, about 0.0089 cm ~~3.5 mil~~. However, other suitable thicknesses and ranges thereof are contemplated.

Thus, in one exemplary embodiment, the tape may comprise about 0.0064 cm ~~2.5 mil~~ silicone adhesive disposed on an about 0.010 cm ~~4 mil~~ polyester film substrate. In another exemplary embodiment, the tape may comprise about 0.0089 cm ~~3.5 mil~~ silicone adhesive

disposed on an about 0.010 cm ~~4 mil~~ polyester film substrate. However, numerous variations are contemplated.

In general, the substrate should have a tensile strength that is sufficient to resist stretching under typical loads. In one example, the substrate may have a tensile strength of from about 89 ~~20~~ to about 178 N ~~40 lb-f~~, for example, from about 111 ~~25~~ to about 142 N ~~32 lb-f~~, for example, about 120 N ~~27 lb-f~~ of force as measured using ASTM D882. However, other possibilities are contemplated.

In another exemplary embodiment, the tape of the first embodiment may include a slip resistant material on a second, floor-contacting side of the tape. The slip resistant material may generally be operative for preventing movement of the tape (and any carpet tiles joined to the tape) on the installation surface, so the carpet tiles remain substantially in position without the need for a permanent adhesive, even in adverse installation conditions. While the weight of the carpet tiles (and any items placed on the tiles) may provide sufficient resistance to undesired movement of the adjoined tiles, it is contemplated that additional slip resistance may desirable in some installations.

The slip resistant material may have any suitable composition. Suitable slip resistant materials may generally be characterized as having a sufficiently high coefficient of friction so that a carpet tile positioned on a flooring surface resists lateral movement when subjected to foot traffic, but also does not substantially adhere to the flooring surface. For example, suitable slip resistant materials may have a coefficient of friction of at least about 0.5, at least about 0.6, at least about 0.7, or at least about 0.8. The slip resistant material should also generally resist picking up dirt or other substances from the flooring surface that may impede the slip resistance of the carpet tile. In this manner, the carpet tiles remain in position during normal use, but can be readily lifted from the flooring surface and repositioned repeatedly without a substantial decrease in slip resistance. Further, in some embodiments, the slip resistant coating may be able to be wiped off or rinsed to remove any minimal debris or particulate before drying and replacing the carpet tile.

Examples of materials that may be suitable include, but are not limited to, a low-tack, non-permanent adhesive (such as those described above), a natural or synthetic polymeric material having a sufficiently high coefficient of friction (such as, for example, polyolefin coatings, natural rubber coatings, acrylic coatings, any other suitable material, or any combination thereof), a protective material, a foam or other cushioning material, any other suitable material, or any combination of materials. Any such material ideally should also be able to withstand any adverse conditions in which the tape is installed.

The slip resistant material may be continuous or discontinuous and may be disposed on all or a portion of the backing. In some embodiments, a primer (where needed) may be disposed between the slip resistant material and the backing.

In yet another exemplary embodiment, the adhesive may be disposed on the second, floor contacting side of the tape, and the slip resistant (e.g., non-skid or similar material) may be disposed on the first, tile-contacting side of the tape. The slip resistant material may comprise any suitable material operative for restricting the motion of the tile relative to the tape and to any other tile that the tape is in contact with (i.e., any adjoined tile), such as those described in connection with the second embodiment. Any such material ideally should also be able to withstand any adverse conditions in which the tape is installed. In this example, the tape could be positioned along the seams or may be spaced from the seams beneath the tile.

In still another exemplary embodiment, the tape may comprise a double-sided adhesive tape, in which adhesive is disposed on both the first side and the second side of the substrate. The adhesive on each side may be the same or may differ, as needed for a particular application. For example, the peel strength and/or shear strength of the adhesive in contact with the tile may be greater than the peel strength and/or shear strength of the adhesive in contact with the floor. As another example, the peel strength and/or shear strength of the adhesive in contact with the tile may be less than the peel strength and/or shear strength of the adhesive in contact with the floor. The adhesive in contact with the floor may be permanent, semi-permanent, or may be non-permanent, so that the tiles can be removed and/or repositioned without damaging the floor. The tape may be positioned along the seams or may be spaced from the seams beneath the tile.

It will be appreciated that the above embodiments are exemplary only, and that various other embodiments contemplated by this disclosure may have fewer or more layers, as needed for a particular application.

Examples of tapes that may be suitable in forming any of the above embodiments include, but are not limited to (the values of noted properties being approximate):

SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI),

Tesa 50600 polyester tape with silicone-based adhesive (0.0079 cm ~~3.1 mil~~s total thickness, 0.407 kg/cm ~~36.5 oz/in~~. 180 degree peel to steel, 110% elongation, 7.34 kg/cm ~~41.1 lb/in~~ tensile strength, as provided by the manufacturer) (commercially available from Tesa SE),

ARclad 6370 polyester tape with silicone-based adhesive (0.0069-0.0076 ~~cm 2.7-3 mil~~ silicone-based adhesive on ~~1 mil~~ polyester film, for a total thickness of 0.0094-0.010 cm ~~3.7-4 mil~~) (commercially available from Adhesives Research, Glen Rock, PA), and

SC-4075 polyester tape with silicone-based adhesive (0.0038 cm ~~1.5 mil~~ silicone-based adhesive on 0.0051 cm ~~2 mil~~ polyester film, for a total thickness of 0.0089

~~3.5 mil~~, having 0.446 kg/cm~~40 oz/in.~~ 180 degree peel to steel, 170% elongation, 9.82 kg/cm ~~55 lb/in~~ tensile strength, as provided by the manufacturer) (commercially available from Custom Adhesive Products, Racine, WI).

If desired, the tape may be provided with a release liner on one or both sides of the tape, for example, where one or both of layers comprise an adhesive or tacky material. Although countless materials may be used for such liners, in one exemplary embodiment, one or both liners may comprise a coated paper, for example, a polyolefin or fluoropolymer coated paper. In still other examples, one or both of release liners may comprise a polymer film with or without a release coating, for example, a PET film coated with a fluoropolymer. Alternatively still, one or both of release liners may be omitted in some embodiments.

The tape may be provided in any suitable manner or configuration. In one embodiment, the tape may be wound into a roll. The tape may be provided with one or more release layers, as described above, or may be self-wound, such that no release layer is used. In one example, the tape may be self-wound using an untreated polyester film substrate. In another example, the tape may be self-wound using a release treated polymer film substrate.

The tape may be provided with areas of weakening, for example, lines of perforation or scoring that facilitate separation of pieces of tape having predetermined dimensions.

In another embodiment, the tape may be provided in the form of a sheet. The sheet may include one or more release layers, as described above. The sheet may be provided with areas of weakening in the tape and/or release layer(s), for example, lines of perforation or scoring that facilitate separation of the sheet into pieces of tape having predetermined dimensions.

In still another embodiment, the tape may be pre-cut into pieces having specified dimensions. Such pieces may have any suitable shape, for example, circles, rectangles, squares, crosses, and so on. The tape pieces may be provided with one or more release layers, as described above, or may be configured without a release layer.

In yet another embodiment, the tape may be at least partially pre-joined to the carpet tiles. For example, sheets or disks of tape may be at least partially attached to a modular flooring tile using pressure, adhesive, ultrasonic frequency welding, radio frequency welding, heat, electron beam radiation, UV radiation, laser, or plasma treatment.

In still another embodiment, the substrate may be provided in any wound, sheet, pre-cut, and/or pre-attached form, and the adhesive and/or slip resistant material(s) may be applied or formed in situ using a brush, roller, spray bottle, squeeze tube, hand-held mixing unit, gun, or any suitable device or technique, as the carpet tiles are installed.

In another embodiment, the adhesive may be self-supporting or self-supported (i.e., unsupported), such that it does not need to be supported or mounted on a polymer film or other substrate in use (the adhesive may be provided on a temporary carrier sheet as a means of

providing it to the user). The self-supported adhesive fastener may generally comprise a double-sided adhesive, with one side or portion that contacts the underside of the carpet tile, and one side or portion that contacts the installation. Any suitable adhesive may be used, such as those described above. Both sides of the unsupported adhesive fastener may comprise the same material or different materials and/or may have different levels of tackiness or adhesion.

The self-supported adhesive fastener may have a rectangular shape, circular or "dot" shape, oval shape, zigzag shape, or any other suitable shape or configuration. The self-supported adhesive may be for use with one tile or more than one tile, so that the self-supported adhesive may be used to join the carpet tile to the installation surface, and optionally to one another (e.g., by extending across the seams or corners of adjacent carpet tiles). Any number and/or configuration of such fasteners may be used, depending on the size and shape of the fastener. In one example, the adhesive may comprise dots having a diameter of from about 0.63 ~~0.25~~ to about 5 cm ~~2 in.~~, for example, from about 1.3 ~~0.5~~ to about 2.5 cm ~~1 in~~. However, countless other possibilities are contemplated. A release liner may be provided to protect the adhesive.

In still another embodiment, the adhesive may be provided as a pre-applied coating on all or a portion of the tile backing. Any suitable adhesive may be used, such as those described above. While countless possibilities are contemplated, in some embodiments, the dry coat weight may be from 8.8 g/sq. m ~~0.25 oz/sq yd~~ to 170 g/sq. m ~~5 oz/sq yd~~, for example, from about 51 g/sq. m ~~1.5~~ to 68 g/sq. m ~~2 oz/sq yd~~. If desired, a release liner may be provided to protect the adhesive.

The present invention may be understood further in view of the following examples, which are not intended to be limiting in any manner. All values are approximate unless noted otherwise. When a sample was not tested, the data is represented in the tables with "NT". When a product could not be tested due to failure or otherwise, the data is represented in the tables with an asterisk (*).

EXAMPLE 1

The dimensional stability of various carpet tile backings was evaluated under various adverse conditions. Three types of backings were evaluated: (1) Ethos® PVB carpet tile backing (Tandus Flooring, Inc.), (2) ER3® PVC carpet tile backing (Tandus Flooring, Inc.), and (3) modified ER3® PVC carpet tile backing (made with alternate recycled carpet content) (Tandus Flooring, Inc.).

The backings were cut into about 5 cm x 5 cm ~~2 in. x 2 in.~~ squares. The weight and thickness of each sample was recorded. The experimental samples were subjected to the Water Immersion Test n=5), Water Vapor Exposure Test (n=4), High Alkaline Immersion Test (n=4), and High Alkaline Vapor Exposure Test (n=4), as follows:

High Alkaline Immersion Test / Water Immersion Test: Samples were placed into an about 32 cm x 29 cm x 13 cm ~~12.75 in. x 11.5 in. x 5 in.~~ container. The container was filled with about 5 cm ~~2 in.~~ of either (1) a solution having a pH of about 12 (prepared by dissolving sodium hydroxide in tap water) (for the high alkaline immersion test), or (2) water (for the water immersion test). The container was filled with sufficient liquid to cover the samples. The samples were weighed down using an about 25 cm x 4.4 cm x 0.41 cm ~~9.75 in. x 1.75 in. x 0.16 in.~~ piece of aluminum. The container was then covered tightly with plastic wrap. The container was kept at ambient temperature during testing.

High Alkaline Vapor Exposure Test / Water Vapor Exposure Test: Large sponges (about 19 cm x 13 cm x 5 cm ~~7.5 in. x 5 in. x 2 in.~~) were placed inside an about 32 cm x 29 cm x 13 cm ~~12.75 in. x 11.5 in. x 5 in.~~ container. The container was filled with about 5 cm ~~2 in.~~ of either (1) a solution having a pH of 12 (prepared by dissolving sodium hydroxide in tap water) (for the high alkaline vapor exposure test), or (2) water (for the water vapor exposure test). Samples were placed on top of the sponges to prevent any direct contact with the liquid. The container was then covered tightly with plastic wrap. The container was kept at ambient temperature during testing. Due to the large amount of condensation on the plastic covering film, the relative humidity within the container is believed to be 100%.

The control samples (n=2) were maintained at ambient conditions. The weight of each sample was measured after 1, 7, and 14 days of exposure, after which the sample was returned to its respective test environment for further evaluation. The results (averages) are presented in **Tables 1-3**. Comparative date for the various backings after exposure to each adverse condition is presented in **Tables 4-7**. In general, dimensionally stable materials may exhibit no more than about 10% loss in mass, and no more than about 5% gain in mass. However, it is contemplated that some materials may fall outside of this range and still be dimensionally stable.

Table 1 – Dimensional stability of Ethos® PVB carpet tile backing

Test	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Control	7.6	7.7	1.2	7.7	2.1	7.7	2.2
Water immersion	8.7	8.8	1.5	9.0	2.7	8.9	2.5
Water vapor	7.7	7.8	1.2	7.9	2.1	7.8	1.5
pH 12 immersion	7.8	7.9	1.5	8.0	3.0	8.1	3.7
pH 12 vapor	7.6	7.7	1.2	7.7	2.1	7.7	2.2

Table 2 – Dimensional stability of ER3® PVC carpet tile backing

Test	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Control	8.6	8.6	0.0	8.7	0.1	8.6	-0.1
Water immersion	8.5	8.7	1.7	8.9	4.7	9.1	6.7
Water vapor	8.4	8.5	0.8	8.6	2.0	8.5	1.0
pH 12 immersion	8.4	8.5	2.0	8.8	5.6	9.0	7.8
pH 12 vapor	8.5	8.5	0.6	8.7	2.6	8.8	3.8

Table 3 – Dimensional stability of modified ER3® PVC carpet tile backing

Test	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Control	9.1	8.8	-3.7	9.1	0.1	9.1	-0.1
Water immersion	9.0	9.2	2.3	9.6	7.3	9.9	10.8
Water vapor	9.1	9.2	1.0	9.4	2.8	9.3	2.1
pH 12 immersion	9.4	9.7	2.8	10.2	8.0	10.6	12.0
pH 12 vapor	9.3	9.4	1.1	9.6	3.1	9.7	4.2

Table 4 – Dimensional stability of various backings after immersion in water

Backing	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Ethos® PVB	8.7	8.8	1.5	9.0	2.7	8.9	2.5
ER3® PVC	8.5	8.7	1.7	8.9	4.7	9.1	6.7
Modified ER3® PVC	9.0	9.2	2.3	9.6	7.3	9.9	10.8

As shown in **Table 4**, the PVB backing showed some initial increase in mass after 7 days of immersion in water, but leveled out afterwards. In sharp contrast, the PVC backings continued to increase in mass over time, which typically leads to curling of the backing, and subsequent failure of the installation.

Table 5 – Dimensional stability of various backings after immersion in pH 12 solution

Backing	Initial	1 day		7 days		14 days	
	g	g~~G~~	% Δ	g	% Δ	g	% Δ
Ethos® PVB	7.8	7.9	1.5	8.0	3.0	8.1	3.7
ER3® PVC	8.4	8.5	2.0	8.8	5.6	9.0	7.8
Modified ER3® PVC	9.4	9.7	2.8	10.2	8.0	10.6	12.0

As indicated in **Table 5**, the PVB backing showed very little initial increase in mass after 14 days of immersion in water. In sharp contrast, the PVC backings showed a sharp increase in mass after 7 days and continued to increase in mass at 14 days. Overall, the PVB sample absorbed significantly less pH 12 solution than the PVC samples.

Table 6 – Dimensional stability of various backings after exposure to water vapor

Backing	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Ethos® PVB	7.7	7.8	1.2	7.9	2.1	7.8	1.5
ER3® PVC	8.4	8.5	0.8	8.6	2.0	8.5	1.0
Modified ER3® PVC	9.1	9.2	1.0	9.4	2.8	9.3	2.1

As shown in **Table 6**, the percent change in mass was similar for each of the three samples. This is not entirely unexpected due to the relatively short duration of the test and the relatively low mass of water vapor the samples were exposed to. However, it is noted that even with this relatively low increase in mass, the PVC samples curled upwardly, while the PVB backing samples remained flat.

Table 7 – Dimensional stability of various backings after exposure to pH 12 vapor

Backing	Initial	1 day		7 days		14 days	
	g	g	% Δ	g	% Δ	g	% Δ
Ethos® PVB	7.6	7.7	1.2	7.7	2.1	7.7	2.2
ER3® PVC	8.5	8.5	0.6	8.7	2.6	8.8	3.8
Modified ER3® PVC	9.3	9.4	1.1	9.6	3.1	9.7	4.2

As indicated in **Table 7**, the PVB backing showed very little initial increase in mass after 14 days of immersion in water. The PVC backings exhibited a greater increase in mass after 14 days. The PVC samples also curled upwardly during the test, while the PVB backing samples remained flat.

EXAMPLE 2

The dimensional stability of various carpet tiles was evaluated using International Standard ISO 2551 (“Machine made textile floor coverings – Determination of dimensional changes due to the effects of varied water and heat conditions”) (also referred to as the “Aachen test”), in which the samples are heated in a 60°C ~~140°F~~ oven for 2 hours, submerged in water for 2 hours, then heated in a 60°C ~~140°F~~ oven again for 2 hours. Before and after testing according to ISO 2551, the samples were also evaluated for planar stability, which entails taking eight measurements of the distance the tile is offset from a horizontal surface, averaging the results, and rating the results according to the following scale:

0 = flat

0.0025- 0.19 ~~0.001-0.078~~ = 4 curl/6 dome

0.20-0.39 ~~0.079-0.156~~ = 3 curl/7 dome

0.40-0.59 ~~0.157-0.234~~ = 2 curl/8 dome

0.60 ~~0.235~~ or more = 1 curl/9 dome

The target for the planar stability test is less than or equal to 0.20 cm ~~0.078 in~~.

Ethos® PVB backed carpet tile (Tandus Flooring, Inc.) (n=100) was evaluated. The results were averaged, as presented in **Table 8**. The Ethos® PVB backed carpet tile samples remained substantially flat, even after being subjected to adverse conditions.

Table 8 – Dimensional changes and planar stability of Ethos® PVB backed carpet tile

ISO 2551 (Δ cm ~~in.~~)						Planar stability			
MD			CD			Before heating in a 60°C ~~140°F~~ oven		After heating in a 60°C ~~140°F~~ oven	
East	Center	West	East	Center	West	Planar	Dome / curl	Planar	Dome / curl
0.025 ~~0.01~~	0.018 ~~0.007~~	0.005 ~~10.002~~	0	-0	-0.0254 ~~-0.01~~	0.18 ~~0.071~~	16 ~~6.39~~	0.079 ~~0.031~~	13 ~~5.08~~
Avg = 0.025 ~~0.01~~			Avg = 0						

EXAMPLE 3

The dimensional stability of various carpet tile backings was evaluated under high humidity conditions using a controlled humidity chamber in which the relative humidity both below and above the sample is controlled. The samples (n=2) were exposed to both about 90 and about 97% relative humidity below the tile (in different tests) and about 50% relative humidity above the tile for at least 6 months.

Two types of carpet tiles were evaluated: (1) Ethos® PVB backed carpet tile (Tandus Flooring, Inc.), and (2) ER3® PVC backed carpet tile (Tandus Flooring, Inc.). The Ethos® PVB backed carpet tile exhibited no planar curling, while the ER3® PVC backed carpet tile began to show planar curling (e.g., curl of greater than 0.20 cm ~~0.078 in.~~ per the planar stability test set forth in Example 2) after 3 to 7 days.

EXAMPLE 4

The dimensional stability of various carpet tile backings was evaluated using a simulated wet floor test in which a metal tray is filled with tap water and sponges are placed in the water bath so that they are about half submerged. The samples are seated on the wet sponge, but are not in contact with the water bath so that the relative humidity was about 100%. The water level is

refilled daily to the same level to overcome loss by evaporation. The samples (n=2) are observed over a period of 134 days.

Three types of carpet tiles were evaluated: (1) Ethos® PVB backed carpet tiles (Tandus Flooring, Inc.), (2) ER3® PVC backed carpet tiles (Tandus Flooring, Inc.), and (3) GlasBac® PVC backed carpet tiles. The Ethos® PVB backed carpet tiles exhibited no planar curling after 134 days. In sharp contrast, the ER3® PVC backed carpet tiles began to curl within 4 to 30 days and the GlasBac® PVC backed carpet tile began to show planar curling within 2 days.

EXAMPLE 5

The adhesive tack of various adhesive tapes was evaluated after exposure to various adverse conditions. Two adhesive tapes were evaluated: (1) SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI), and (2) Tactiles™ carpet tile tape pieces (believed to be an acrylic adhesive on a polyester film) (commercially available from Interface, Inc.). Additionally, Hauthane L2183 urethane-based adhesive with 1.5 wt% XR 5508 crosslinker (commercially available from Stahl, Peabody, MA) was coated directly onto the back of Ethos® PVB with a #15 Meyer rod and evaluated.

The samples were subjected to the Water Immersion Test (n=3), Water Vapor Exposure Test (n=3), High Alkaline Immersion Test (n=3), and High Alkaline Vapor Exposure Test (n=3), as described above in Example 1. The control samples (n=3) were maintained at ambient conditions. To prevent the contact of the adhesive layer of tape with any surface, the tape was bent into a cylindrical shape with adhesive layer inside, and the extreme outer edge was adhered to the inside of a tongue depressor (about 15 cm x 1.9 cm ~~6 in. x 0.75 in~~).

After 1, 7, and 14 days of exposure, the adhesive tack of each sample was measured according to ASTM D2979 - 01(2009) and the results were averaged. For the tape samples, the Instron probe was set to compress at a rate of 10 mm/sec until a force of 0.001 KN was reached. The resultant pressure was held constant for 1.0 sec, and the probe was then extended away from the sample at a rate of 10.008 mm/sec. For the Hauthane L2183, the Instron probe was set to compress at a rate of 10 mm/sec until a force of 0.45 ~~-~~KN. The resultant pressure was held constant for 10 sec, and the probe was then extended away from the sample at a rate of 10.008 mm/sec. The results are presented in N ~~lb-f~~. (To convert to N/sq. cm ~~lb-f/sq. in~~, divide N ~~lb-f~~ by 4.26 sq. cm ~~0.66 sq in.~~, which was the area of the probe. For example, an adhesive tack of about 5.8 N ~~1.3 lb-f~~ corresponds to about 1.36 N/sq. cm ~~2.0 lb-f~~/sq in., an adhesive tack of about 6.7 N ~~1.5 lb-f~~ corresponds to about 1.57 N/sq. cm ~~2.7 lb-f/sq in.~~, an adhesive tack of about 10 N ~~2.3 lb-f~~ corresponds to about 2.35 N/sq. cm ~~3.5 lb-f/sq in.~~, and an adhesive tack of about 22 N ~~5 lb-f~~ corresponds to about 5.16 N/sq. cm ~~7.6 lb-f/sq in~~.)

The effect of plasticizer migration was also evaluated for the Hauthane L2183 sample by placing the sample in a 60°C ~~140°F~~ oven for 1 day.

The results are presented in **Tables 9-11**. Any observations regarding edge crawl (i.e., the progressive weakening of the adhesive from the outer edges of the adhesive tape inwardly and/oozing from the weakened areas) were also noted.

Table 9 – Adhesive tack of SR336R tape

Test	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
Control	22.2 ~~5.0~~	33.8 ~~7.6~~	53.5~~%~~	26.2 ~~5.9~~	18.7~~%~~	28.9 ~~6.5~~	30.8~~%~~
Water immersion	22.2 ~~5.0~~	24.5 ~~5.5~~	11.3~~%~~	23.6 ~~5.3~~	6.6~~%~~	16.0 ~~3.6~~	-27.6~~%~~
Water vapor	22.2 ~~5.0~~	34.2 ~~7.7~~	54.9~~%~~	22.7 ~~5.1~~	2.6~~%~~	24.0 ~~5.4~~	8.7~~%~~
pH 12 immersion	22.2 ~~5.0~~	14.2 ~~3.2~~	-34.8~~%~~	22.2 ~~5.0~~	0.6~~%~~	7.12 ~~1.6~~	-67.8~~%~~
pH 12 vapor	22.2 ~~5.0~~	22.2 ~~5.0~~	0.6~~%~~	28.5 ~~6.4~~	28.8~~%~~	23.6 ~~5.3~~	6.6~~%~~

Table 10 – Adhesive tack of Hauthane L2183 adhesive on Ethos® PVB tile

Test	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
Control	47.2 ~~10.6~~	36 ~~8.1~~	-23.6	37.9 ~~8.5~~	19.8	NT	NT
Water immersion	47.2 ~~10.6~~	10.7 ~~2.4~~	-77.4	18.2 ~~4.1~~	61.3	NT	NT
Water vapor	47.2 ~~10.6~~	40.5 ~~9.1~~	-14.2	27.1 ~~6.1~~	42.5	NT	NT
pH 12 immersion	47.2 ~~10.6~~	12.0 ~~2.7~~	-74.5	18.2 ~~4.1~~	61.3	NT	NT
pH 12 vapor	47.2 ~~10.6~~	39.1 ~~8.8~~	-17.0	36.5 ~~8.2~~	22.6	NT	NT
140°F oven	47.2 ~~10.6~~	24.0 ~~5.4~~	49.1	NT	NT	NT	NT

Table 11 – Adhesive tack of Tactiles™ tape

Test	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
Control	10.2 ~~2.3~~	10.7 ~~2.4~~	6.6	NT	NT	NT	NT
Water immersion	10.2 ~~2.3~~	5.78 ~~1.3~~	-42.8	*	*	*	*
Water vapor	10.2 ~~2.3~~	9.79 ~~2.2~~	-3.9	NT	NT	NT	NT
pH 12 immersion	10.2 ~~2.3~~	6.67 ~~1.5~~	-32.8	*	*	*	*
pH 12 vapor	10.2 ~~2.3~~	10.7 ~~2.4~~	6.1	NT	NT	NT	NT

No edge crawl was observed for any of the SR336R tape tests. Thus, it would be expected that the SR336R tape would withstand adverse conditions over time. However, the Tactiles™ tape samples exhibited substantial edge crawl and were not able to be tested using the water immersion test or pH 12 immersion test after 1 day because the adhesive delaminated from the backing.

EXAMPLE 6

The lap shear strength of various modular carpet (i.e., carpet tile) systems was evaluated after exposure to various adverse conditions. Two systems were evaluated: (1) SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI) joined to Ethos® PVB backed carpet tile (Tandus Flooring, Inc.), and (2) Tactiles™ carpet tile tape pieces (believed to be an acrylic adhesive on a polyester film) (commercially available from Interface, Inc.) joined to a PVC backing (commercially available from Tandus Asia). (PVC backing was used in this instance because it is believed that the Tactiles™ tape pieces are sold in connection with PVC-backed tiles.) The SR336R release coated polyester silicone tape and Tactiles™ carpet tile tape pieces were also evaluated on steel plates.

To prepare the tape-steel samples, a steel plate (8.9 cm x 15 cm ~~3.5 in. x 6 in.~~) was cleaned with isopropyl alcohol. An about 7.6 cm x 10 cm ~~3 in. x. 4 in.~~ tape sample was then placed on the steel so that about 5 cm ~~2 in.~~ of the tape was in contact with the steel, and the remainder of the tape was not in contact with any surface. Pressure was applied (about 0.794 kg ~~1.75 lb~~) to the area in which the tape was in contact with the substrate. The tape-carpet samples were prepared in a similar manner, except that an about 7.6 cm x 10 cm ~~3 in. x 4 in.~~ piece of carpet was used instead of a steel plate. The tape was adhered to the backing of the carpet.

The samples were subjected to the Water Immersion Test (n=3), Water Vapor Exposure Test (n=3), High Alkaline Immersion Test (n=3), and High Alkaline Vapor Exposure Test (n=3), as described above in Example 1. The control samples (n=3) were maintained at ambient conditions. After 1, 7, and 14 days of exposure, the lap shear strength of each sample was measured according to ASTM D3654 / D3654M - 06(2011), except that the force to failure (in N ~~lb-f~~) was recorded instead of time to failure. The results were averaged and are presented in **Tables 12** and **13**. The results are presented in N ~~lb-f~~. (To convert to N/ sq. cm ~~lb-f/sq. in~~, divide N ~~lb-f~~ by 38.7 sq. cm ~~6 sq in.~~ (the contact area with the sample). For example, a lap shear value of about 578 N ~~130 lb-f~~ corresponds to about 14.9 N/sq. cm ~~21.7 lb-f/sq in.~~, a lap shear value of about 667 N ~~150 lb-f~~ corresponds to about 17.2 N/sq. cm ~~25 lb-f/sq in.~~, a lap shear value of about 725 N ~~163 lb-f~~ corresponds to about 18.7 N/sq.cm ~~27.2 lb-f/sq in.~~, and a lap shear value of about 890 N ~~200 lb-f~~ corresponds to about 23.0 N/sq. cm ~~33.3 lb-f/sq in~~.) Any observations regarding edge crawl were also noted.

Table 12 – Lap shear strength of SR336R tape/Ethos® backing

Test	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
Control	667 ~~150~~	672 ~~151~~	0.6	649 ~~146~~	-3.1	632 ~~142~~	-5.7
Water immersion	667 ~~150~~	703 ~~158~~	5.1	543 ~~122~~	-18.9	636 ~~143~~	-4.7
Water vapor	667 ~~150~~	698 ~~157~~	4.5	494 ~~111~~	-25.9	472 ~~106~~	-29.8
pH 12 immersion	667 ~~150~~	703 ~~158~~	5.4	552 ~~124~~	-17.8	520 ~~117~~	-22.1
pH 12 vapor	667 ~~150~~	685 ~~154~~	2.3	520 ~~117~~	-22.0	507 ~~114~~	-24.1

As will be evident from **Table 12**, the SR336R /Ethos® backing system showed virtually no loss in lap shear strength after being immersed in water for 14 days.

Although there was some loss in lap shear strength under the remaining tests, it will be appreciated that the nature of these tests is far more extreme than typical adverse installation conditions. (However, it will be noted that even in these extreme conditions, no edge crawl was observed.) Further, these tests may exhibit a high degree of variability under some circumstances. Finally, it will also be noted that even where there is a loss in adhesion under these extreme tests, such loss in adhesion may not be considered an adhesive failure that would render the tape or system unsuitable for use. Thus, while the absolute values of the data might not be directly indicative of actual performance, this data may be highly useful for comparison with the performance of other systems (see **Tables 13-17**).

Table 13 – Lap shear strength of Tactiles™ tape/PVC backing

Test	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
Control	667 ~~150~~	NT	NT	NT	NT	NT	NT
Water immersion	667 ~~150~~	485 ~~109~~	-27.4	374 ~~84~~	-43.9	498 ~~112~~	-25.6
Water vapor	667 ~~150~~	689 ~~155~~	3.9	NT	NT	NT	NT
pH 12 immersion	667 ~~150~~	436 ~~98~~	-35.1	396 ~~89~~	-41.1	472 ~~106~~	-29.5
pH 12 vapor	667 ~~150~~	876 ~~197~~	31.4	NT	NT	NT	NT

The Tactiles™ tape samples exhibited substantial edge crawl after 1 day. Accordingly, the tests were aborted because it was believed that the samples would delaminate (**Table 13**).

Table 14 – Lap shear strength for various systems after immersion in water

System	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
SR336R / Ethos®	667 ~~150~~	703 ~~158~~	5.1	543 122	-18.9	636 ~~143~~	-4.7
Tactiles™ / PVC	667 ~~150~~	485 ~~109~~	-27.4	374 ~~84~~	-43.9	498 ~~112~~	-25.6
SR336R / steel	725 ~~163~~	756 ~~170~~	4.0	818 ~~184~~	12.8	832 ~~187~~	14.5
Tactiles™ / steel	867 ~~195~~	805 181	-6.9	939 ~~211~~	8.4	952 ~~214~~	9.8

As will be evident from **Table 14**, the Tactiles™ / PVC backing system showed significantly more loss in lap shear strength than the SR336R /Ethos® backing system.

As regards the steel plate tests, the lap shear strength values set forth above were recorded when the film substrate of the tape broke, rather than when there was an adhesive failure. Since the initial adhesion of both tapes was significantly stronger, as compared with their respectively evaluated carpet backings, it is believed that it would have taken a significantly longer period of time than 14 days to achieve an adhesive failure. Since the SR336R tape had a backing thickness of 0.0076 cm~~3 mil~~s, and the Tactiles™ tape had a backing of 0.010 cm~~4 mil~~s, it is not surprising that that the Tactiles™ / steel system appeared to outperform the SR336R / steel system. However, due to the level of edge crawl exhibited by the Tactiles™ tape (as compared with none observed with the SR336R tape), it is believed that the Tactiles™ tape would have eventually failed, while the SR336R tape would not have.

Similar observations can be made with respect to the pH 12 immersion test, as set forth in **Table 15** below.

Table 15 – Lap shear strength for various systems after immersion in pH 12 solution

System	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
SR336R /Ethos®	667 ~~150~~	703 ~~158~~	5.4	552 ~~124~~	-17.8	520 ~~117~~	-22.1
Tactiles™ / PVC	667 ~~150~~	436 ~~98~~	-35.1	396 ~~89~~	-41.1	472 ~~106~~	-29.5
SR336R /steel	725 ~~163~~	787 ~~177~~	8.7	863 ~~194~~	18.7	836 ~~188~~	15.3
Tactiles™ / steel	867 ~~195~~	810 ~~182~~	-6.6	1010 ~~227~~	16.6	970 ~~218~~	12.1

As shown in **Tables 16** and **17** below, the SR336R /Ethos® backing system exhibited no edge crawl and was able to be tested even after 14 days.

Table 16 – Lap shear strength for various systems after exposure to water vapor

System	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
SR336R /Ethos® Tactiles™ / PVC	667 ~~150~~	698 ~~157~~	4.5	494 ~~111~~	-25.9	472 ~~106~~	-29.8
	667 ~~150~~	689 ~~155~~	3.9	NT	NT	NT	NT

Table 17 – Lap shear strength for various systems after exposure to pH 12 vapor

System	Initial	1 day		7 days		14 days	
	N ~~lb-f~~	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ	N ~~lb-f~~	% Δ
SR336R /Ethos® Tactile®/ PVC	667 ~~150~~	685 ~~154~~	2.3	520 ~~117~~	-22.0	507 ~~114~~	-24.1
	667 ~~150~~	876 ~~197~~	31.4	NT	NT	NT	NT

EXAMPLE 7

The plasticizer migration resistance of various modular carpet (i.e., carpet tile) systems was evaluated. The following tapes were evaluated: (1) SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI), (2) Hauthane L2183 urethane-based adhesive plus 1.5 wt% X5800 crosslinker (commercially available from Stahl, Peabody, MA) (coated directly onto the back of Ethos® PVB tile), (3) Tactiles™ carpet tile tape pieces (believed to be an acrylic adhesive on a polyester film) (commercially available from Interface, Inc.), (4) Ecosticker (commercially available from Carpet Tiles 1, Australia), (5) China White (acrylic adhesive based tape, commercially available from Shanghai ZhengHuan Adhesive Products Co., Ltd., Shanghai, China), and (6) China Yellow (acrylic adhesive based tape, commercially available from Shanghai ZhengHuan Adhesive Products Co., Ltd., Shanghai, China). Each tape was evaluated in connection with two backings: 1) Ethos® PVB carpet tile backing (Tandus Flooring, Inc.), and (2) PVC carpet tile backing (Tandus Asia).

A sample of each tape was placed on each backing. A control sample was left at room temperature, while the experimental sample was placed into an oven at 82°C ~~180°F~~. After two hours, the experimental sample was removed from the oven and allowed to cool to room temperature. The tape was then pulled away by hand from the backing. The composition of the adhesive and tape was evaluated using the following scale (where “legs” refer to strings of adhesive):

0-No change

1-Slight difference adhesive has not softened and no legs are noticeable

2-Noticable change legs have begun to form

3-Legs are present and some adhesive has transferred from the film to the carpet

4-Adhesive transfer and delamination from film, adhesive has softened

5-Severly compromised, complete adhesive delamination, long legs, very soft adhesive

For the Hauthane L2183 sample, which was coated directly onto the back of Ethos® PVB with a #15 Meyer rod, the sample was evaluated by dragging a finger across the sample. The results are presented in **Table 18**.

Table 18 – Plasticizer migration resistance of various adhesive tapes

Tape	Backing	Plasticizer migration resistance			
		Immediate		Aged 1 month	
		Control	Oven	Control	Oven
SR336R tape	PVC	0	1	0	1
	Ethos® PVB	1	1	1	1.5
Hauthane L2183	Ethos® PVB	0	1	NT	NT
Tactiles™ tape	PVC	1	4	2	5
	Ethos® PVB	0	5	0	5
Ecosticker	PVC	0	3.5	NT	NT
	Ethos® PVB	1	4	NT	NT
China White	PVC	0	4	3	4
	Ethos® PVB	0	5	1	4
China Yellow	PVC	0	2	0	2
	Ethos® PVB	0	1	0	1

Notably, the Tactiles™, Ecosticker, and China White tapes all exhibited rather immediate plasticization of the adhesive when attached to both PVC and PVB backed carpets. The SR336R tape exhibited virtually no plasticization, even after one month of aging in an oven.

EXAMPLE 8

The plasticizer migration resistance of various modular carpet (i.e., carpet tile) systems was evaluated. The following systems were evaluated: (1) SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI) joined to Ethos® PVB carpet tile backing, and (2) Tactiles™ carpet tile tape pieces (believed to be an acrylic adhesive on a polyester film) (commercially available from Interface, Inc.) joined to a PVC carpet tile backing (commercially available from Tandus Asia).

A sample of each tape was placed on each backing. A control sample was left at room temperature, while the experimental sample was placed into an oven at 80°C ~~140°F~~. The samples were observed every 2-3 days until failure, i.e., until the adhesive is softened and the tape is readily removed from the backing. The Tactiles™ tape on PVC backing failed after about 5 days. In sharp contrast, the SR336R tape on PVB was stable for 45 days, after which the test was discontinued.

EXAMPLE 9

The adhesive tack of various tapes used in connection with various backings was evaluated after exposure to high pH and moisture.

The following tapes were evaluated: (1) SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI), (2) Tactiles™ carpet tile tape pieces (believed to be an acrylic adhesive on a polyester film) (commercially available from Interface, Inc.), (3) Ecosticker (commercially available from Carpet Tile 1, Australia), (4) China White (acrylic adhesive based tape, commercially available from Shanghai ZhengHuan Adhesive Products Co., Ltd., Shanghai, China), and (5) China Yellow (acrylic adhesive based tape, commercially available from Shanghai ZhengHuan Adhesive Products Co., Ltd., Shanghai, China). Each tape was evaluated in connection with two backings: 1) Ethos® PVB carpet tile backing (Tandus Flooring, Inc.), and (2) PVC carpet tile backing (Tandus Asia).

A piece of tape was placed on a 10 cm x 10 cm ~~4 in. x 4 in.~~ square piece of tile so that only about half of the tape was on the tile (the other half was not in contact with anything). The samples were then soaked in a pH 11.5 solution for 4 days. Control samples were maintained at ambient conditions. The adhesive tack of each sample was then measured according to ASTM D2979 - 01(2009) and the results were averaged. The results are presented in **Table 19**. Any observations regarding edge crawl was also noted.

Table 19 – Adhesive tack of various adhesive tapes / backings

Tape	Backing	Adhesive tack (N ~~lb f~~)			
		Control	Experimental	Δ (%)	Edge crawl
SR336R tape	PVC	436.8 ~~98.2~~	243.3 ~~54.7~~	197.1 ~~44.3~~	none
	Ethos® PVB	669.5 ~~150.5~~	657.9 ~~147.9~~	7.6 ~~1.7~~	none
Tactiles™ tape	PVC	665.0 ~~149.5~~	366.1 ~~82.3~~	199.7 ~~44.9~~	severe
	Ethos® PVB	745.5 ~~167.6~~	657.9 ~~147.9~~	52.5 ~~11.8~~	slight
Ecosticker	PVC	490.2 ~~110.2~~	342.1 ~~76.9~~	134.3 ~~30.2~~	some
	Ethos® PVB	703.3 ~~158.1~~	629.0 ~~141.4~~	47.2 ~~10.6~~	some
China White	PVC	613.4 ~~137.9~~	378.1 ~~85~~	170.8 ~~38.4~~	some
	Ethos® PVB	888.3 ~~199.7~~	653.0 ~~146.8~~	117.9 ~~26.5~~	some
China Yellow	PVC	594.7 ~~133.7~~	273.1 ~~61.4~~	240.6 ~~54.1~~	some
	Ethos® PVB	785.6 ~~176.6~~	707.7 ~~159.1~~	44.0 ~~9.9~~	some

The SR336R tape samples exhibited virtually no edge crawl, while the Tactiles™ tape samples exhibited severe (PVC) or slight (Ethos® PVB) edge crawl, indicating that the Tactiles™ tape would likely fail over time. Similarly, the Ecosticker, China White, and China Yellow tapes all exhibited some edge crawl. Thus, such tapes would also likely fail over time.

EXAMPLE 10

Various tapes were used to secure Tandus Flooring, Inc. Ethos® PVB-backed tile to a concrete floor under adverse installation conditions (about 1 kg/24 hr/93 sq. m ~~2.2 lb/24 hr/1000 sq. ft.~~ MVER, about 11-11.5 pH, and about 65.5% RH) in an environment subject to electric pallet jacks carrying a full payload and heavy foot traffic. Prior to installation, the floor was primed with C56 Primer, available from Tandus Flooring, Inc. The following tapes from Specialty Tapes Manufacturing were used to join the tiles to one another (with the adhesive facing upwardly):

about 0.0064 cm ~~2.5 mil~~ silicone adhesive on one side of about 0.010 cm ~~4 mil~~ polyester (PET) film;

about 0.0089 cm ~~3.5 mil~~ silicone adhesive on one side of about 0.010 cm ~~4 mil~~ polyester (PET film;

about 0.0089 cm ~~3.5 mil~~ silicone adhesive on one side of about 0.0076 cm 3 ~~mil~~ polyester (PET) film; and

about 0.0038 cm ~~1.5 mil~~ silicone adhesive on about 0.0051 cm ~~2 mil~~ polyester (PET) film.

All of the tapes were used to install the tiles successfully. The performance of the tape was monitored for about one year with no visible movement of tiles or loss of tape adhesion.

EXAMPLE 11

Tape was used to secure Tandus Flooring, Inc. Ethos® PVB-backed tile on a concrete floor under adverse installation conditions (about 1.1 kg/24 hr/93 sq. m ~~2.4 lb/24 hr/1000 sq. ft.~~ MVER, about 9.5-10 pH, and about 86.5% RH). Prior to installation, the floor was primed with C56 Primer, available from Tandus Flooring, Inc.

The tape (obtained from Specialty Tape Manufacturers) comprised about 0.0089 cm ~~3.5 mil~~ silicone adhesive on one side of an about 0.010 cm ~~4 mil~~ polyester (PET) film. The tape was provided as a 7.6 cm ~~3 in.~~ wide roll with perforations about every 9.8 cm ~~3.875 in~~. The tape pieces were applied to the corners of adjacent tiles with the adhesive facing up. 61 cm x 61 cm ~~24 in. x 24 in.~~ square tiles were used.

Tiles were kicked with standard foot pressure after the installation was complete to look for movement. Little to no movement was noted across the installation. The installation was observed for about one year with no visible movement of tiles or loss of tape adhesion.

EXAMPLE 12

Tape was used to secure Tandus Flooring, Inc. Ethos® PVB-backed tile on a residential concrete floor under adverse installation conditions (about 2.3 kg/24 hr/93 sq. m ~~5.1 lb/24 hr/1000 sq. ft.~~ MVER and about 10.5 pH).

The tape was obtained from Specialty Tape Manufacturers and comprised about 0.0089 cm ~~3.5 mil~~ silicone adhesive on one side of an about 0.010 cm ~~4 mil~~ PET film. The tape was supplied as a 7.6 cm ~~3 in.~~ wide roll with perforations about every 9.8 cm ~~3.875 in.~~ The tape pieces were applied to the corners of adjacent tiles with the adhesive facing up. 61 cm x 61 cm ~~24 in. x 24 in.~~ square tiles were used. The installation was observed for about three months with no visible movement of tiles or loss of tape adhesion.

EXAMPLE 13

Tape was used to secure Tandus Flooring, Inc. Ethos® PVB-backed tile on a concrete floor under varying and unpredictable adverse conditions (about 1.0 kg/24 hr/93 sq. m ~~2.3 lb/24 hr/1000 sq. ft.~~ MVER, about 8.5-9 pH, and about 79.3% RH). The tape was SR336R release coated polyester silicone tape (0.0064 cm ~~2.5 mil~~ silicone-based adhesive on 0.0076 cm ~~3 mil~~ release coated polyester film) (commercially available from Specialty Tapes Manufacturing, Franksville, WI). The tape was supplied as a 7.6 cm ~~3 in.~~ wide roll with perforations about every 9.8 cm ~~3.875 in~~. The tape pieces were applied to the corners of adjacent tiles with the adhesive

side facing up. 61 cm x 61 cm ~~24 in. x 24 in.~~ square tiles were used. The installation was observed for about 3 months with no visible movement of the tiles or loss of tape adhesion. The installation area was in a semi-covered outdoor exposed area subject to rain and drastic swings in humidity typical of the climate in Dalton, GA, USA.

EXAMPLE 14

Tape was used to secure Tandus Flooring, Inc. Ethos® PVB-backed tile on a concrete floor under varying and unpredictable adverse conditions (about 1.1 kg/24 hr/93 sq. m ~~2.4 lb/24 hr/1000 sq. ft.~~ MVER, about 9.5-10 pH, and about 86.5% RH). The tape was 50600 Tesa release coated polyester silicone tape (commercially available from Tesa SE Tape). The tape was supplied as a 5 cm ~~2 in~~ wide roll. Strips were cut every 10 cm ~~4 in.~~ and were applied to the corners of adjacent tiles with the adhesive side facing up. 91 cm x 91 cm ~~36 in. x 36 in.~~ square tiles were used. The installation was observed for about 11 months with no visible movement of the tiles or loss of tape adhesion. The installation area was subjected to heavy foot traffic during the evaluation time.

It will be readily understood by those persons skilled in the art that the present invention is susceptible of broad utility and application. It will also be recognized by those skilled in the art that various elements discussed with reference to the various embodiments may be interchanged to create entirely new embodiments coming within the scope of the present invention. While the present invention is described herein in detail in relation to specific aspects and embodiments, it is to be understood that this detailed description is only illustrative and exemplary of the present invention and is made merely for purposes of providing a full and enabling disclosure of the present invention and to set forth the best mode of practicing the invention known to the inventors at the time the invention was made. The detailed description set forth herein is illustrative only and is not intended, nor is to be construed, to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications, and equivalent arrangements of the present invention. All directional references (e.g., upper, lower, upward, downward, left, right, leftward, rightward, top, bottom, above, below, vertical, horizontal, clockwise, and counterclockwise) are used only for identification purposes to aid the reader's understanding of the various embodiments of the present invention, and do not create limitations, particularly as to the position, orientation, or use of the invention unless specifically set forth in the claims. Joinder references (e.g., joined, attached, coupled, connected, and the like) are to be construed broadly and may include intermediate members between a connection of elements and relative movement between elements. As such, joinder references do not necessarily imply that two elements are connected directly and in fixed relation to each other. Further, various elements discussed with

reference to the various embodiments may be interchanged to create entirely new embodiments coming within the scope of the present invention. Many adaptations of the present invention other than those herein described, as well as many variations, modifications, and equivalent arrangements will be apparent from or reasonably suggested by the present invention and the above detailed description without departing from the substance or scope of the present invention. Accordingly, the detailed description set forth herein is not intended nor is to be construed to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications, and equivalent arrangements of the present invention.

What is claimed is:

1. A modular carpet system, comprising:

a carpet tile comprising a face and a backing, wherein the backing comprises a polymer having at least 50% amorphous content, wherein the carpet tile is operative for remaining dimensionally stable under adverse conditions, wherein adverse conditions comprise at least one of

a moisture vapor emission rate of at least ~~about~~ 1.8 kg/24 hr/93 sq. m ~~4 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of at least ~~about~~ 80%, and

a surface moisture pH of at least ~~about~~ 8; and

an adhesive component comprising a silicone-based adhesive.

2. The system of claim 1, wherein the adverse conditions comprise at least one of

a moisture vapor emission rate of at least ~~about~~ 2.3 kg/24 hr/93 sq. m ~~5 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of at least ~~about~~ 90%, and

a surface moisture pH of at least ~~about~~ 10.

3. The system of claim 1, wherein the polymer comprises polyvinyl butyral.

4. The system of claim 1, wherein the polymer comprises modified polycarbonate, ultra high molecular weight polyethylene, atactic polypropylene, a silicone elastomer, a thermoplastic polyolefin, a thermoplastic elastomer, bitumen, or any combination thereof.

5. The system of claim 1, wherein the backing further comprises a filler.

6. The system of claim 5, wherein the backing comprises from ~~about~~ 25 to ~~about~~ 60 wt% polyvinyl butyral and from ~~about~~ 40 to ~~about~~ 75 wt% filler.

7. The system of claim 1, wherein the backing further comprises a plasticizer.

8. The system of claim 7, wherein

the adhesive is in contact with the backing, and

the adhesive resists being plasticized by the plasticizer after exposure to 60°C ~~140°F~~ for 30 days.

9. The system of claim 1, wherein remaining dimensionally stable under adverse conditions comprises having a change in length or width of less than ~~about~~ 0.15% after being immersed in water for at least ~~about~~ 2 hours.

10. The system of claim 1, wherein remaining dimensionally stable under adverse conditions comprises having a change in length or width of less than ~~about~~ 0.15% as measured using ISO 2551.

11. The system of claim 1, wherein remaining dimensionally stable under adverse conditions comprises having a planar deviation of less than ~~about~~ 0.20 cm ~~0.078 in.~~ after being immersed in water for ~~about~~ 2 hours.

12. The system of claim 1, wherein the adhesive has an adhesive tack of greater than 2.35 N/sq. cm ~~3.5 lb-f/sq. in.~~ prior to exposure to adverse conditions.

13. The system of claim 1, wherein the adhesive has an adhesive tack of ~~about~~ 5.16 N/sq. cm ~~7.6 lb-f/sq. in.~~ prior to exposure to adverse conditions.

14. The system of claim 1, wherein the adhesive has an adhesive tack of greater than 1.36 N/sq. cm ~~2.0 lb-f/sq. in.~~ after being immersed in water for ~~about~~ 1 day.

15. The system of claim 1, wherein the adhesive has an adhesive tack of greater than 1.57 N/sq. cm ~~2.7 lb-f/sq. in.~~ after being immersed in a pH 12 solution for ~~about~~ 1 day.

16. The system of claim 1, wherein the adhesive has shear strength of from ~~about~~ 14.9 N/sq. cm ~~21.7 lb-f/sq. in.~~ to ~~about~~ 23.0 N/sq. cm ~~33.3 lb-f/sq. in.~~ prior to exposure to adverse conditions.

17. The system of claim 1, wherein the adhesive component comprises an adhesive tape, an unsupported adhesive fastener, an adhesive coating, or any combination thereof.

18. The system of claim 1, wherein

the adhesive component comprises an adhesive tape, and

the adhesive tape exhibits substantially no delamination after exposure to adverse conditions.

19. The system of claim 1, wherein the adhesive component comprises an adhesive tape having a thickness of from ~~about~~ 0.00254 cm ~~1 mil~~ to ~~about~~ 0.0127 cm ~~5 mil~~.

20. The system of claim 1, wherein the adhesive component comprises an adhesive tape having a tensile strength of from ~~about~~ 89 N ~~20 lb-f~~ to ~~about~~ 178 N 40 ~~lb-f~~.

21. The system of any of claims 1 to 20, used in an installation comprising the adhesive component and the carpet tile.

22. The system of claim 21, wherein

the carpet tile is a first carpet tile of a plurality of carpet tiles, the plurality of carpet tiles being positioned in a side by side configuration in the installation, and

the adhesive component maintains the plurality of carpet tiles in the side by side configuration within the installation.

23. The system of any of claims 1 to 20, used according to a method comprising securing the carpet tile in an installation with the adhesive component under adverse conditions, wherein the adverse conditions comprise at least one of

a moisture vapor emission rate of at least ~~about~~ 2.3 kg/24 hr/93 sq. m ~~5 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of at least ~~about~~ 90%, and

a surface moisture pH of at least ~~about~~ 10,

wherein the carpet tile resists deformation under the adverse conditions.

24. The system of any of claims 1 to 20, used according to a method comprising securing the carpet tile in an installation with the adhesive component under adverse conditions, wherein the adverse conditions comprise at least one of

a moisture vapor emission rate of at least ~~about~~ 2.3 kg/24 hr/93 sq. m ~~5 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of at least ~~about~~ 90%, and

a surface moisture pH of at least ~~about~~ 10,

wherein

the carpet tile resists deformation under the adverse conditions, and

the adhesive component maintains the carpet tile in the installation under the adverse conditions.

25. A modular carpet system, comprising:

a carpet tile comprising a face and a backing, wherein the backing comprises polyvinyl butyral, the polyvinyl butyral being at least 50% amorphous, wherein the carpet tile undergoes a change in length or width of less than ~~about~~ 0.15% after being immersed in water for at least ~~about~~ 2 hours; and

an adhesive component comprising a silicone-based adhesive, wherein

the adhesive has an initial adhesive tack of greater than 2.35 N/sq. cm ~~3.5 lb-f/sq. in.~~, and

the adhesive has an adhesive tack of greater than 1.36 N/sq. cm ~~2.0 lb-f/sq. in.~~ after being immersed in water for ~~about~~ 1 day.

26. The system of claim 25, wherein the adhesive has an adhesive tack of ~~about~~ 5.16 N/sq. cm ~~7.6 lb-f/sq. in.~~ prior to exposure to adverse conditions.

27. The system of claim 25 or 26, wherein the adhesive component comprises an adhesive tape, an unsupported adhesive fastener, an adhesive coating, or any combination thereof.

28. A modular carpet system, comprising:

a carpet tile comprising a face and a backing, wherein the backing comprises polyvinyl butyral, the polyvinyl butyral being at least 50% amorphous, wherein the carpet tile is operative for remaining dimensionally stable under adverse conditions, wherein adverse conditions comprise at least one of

a moisture vapor emission rate of at least ~~about~~ 1.8 kg/24 hr/93 sq. m ~~4 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of at least ~~about~~ 80%, and

a surface moisture pH of at least ~~about~~ 8; and

an adhesive tape comprising a silicone-based adhesive.

29. The system of claim 28, wherein the adverse conditions comprise at least one of

a moisture vapor emission rate of up to ~~about~~ 3.6 kg/24 hr/93 sq. m ~~8 lb/24 hr/1000 sq. ft.~~,

an in situ relative humidity of up to ~~about~~ 85%, and

a surface moisture pH of up to ~~about~~ 11.

30. A modular carpet system, comprising:

a carpet tile comprising a face and a backing, wherein the backing comprises polyvinyl butyral, the polyvinyl butyral being at least 50% amorphous, wherein the carpet tile exhibits a planar deviation of less than ~~about~~ 0.20 cm ~~0.078 in.~~ after being immersed in water for ~~about~~ 2 hours; and

an adhesive component comprising a silicone-based adhesive, wherein

the adhesive has an initial adhesive tack of greater than 2.35 N/sq. cm ~~3.5 lb-f/sq. in.~~, and

the adhesive has an adhesive tack of greater than 1.36 N/sq. cm ~~2.0 lb-f/sq. in.~~ after being immersed in water for ~~about~~ 1 day.