Primary carpet backings for tufted carpets comprise, in one embodiment, fabric woven from warp tapes comprising polypropylene and weft yarns in a plain, closed weave with an average warp count of about 18 to 32 tapes per inch and a lower average weft count, wherein the warp tapes have deniers of about 250 to about 800 and the weft yarns comprise polypropylene tapes that are thicker and of greater denier than the warp tapes. In another embodiment carpets comprising a primary backing as described above tufted with carpet face yarn to provide a pile surface comprising a plurality of face yarn tufts on one side of the backing and a plurality of stitches of the face yarn on an opposite, stitched side of the tufted backing and, optionally having a secondary backing laminated to the stitched side of the backing, have good tuft holding properties for a wide range of carpet face yarn deniers, carpet pile surfaces and styles.
TUFTABLE CARPET BACKINGS AND CARPETS WITH ENHANCED TUFT HOLDING PROPERTIES

[0001] This invention relates to tuftable and tufted fabrics and, more particularly, to primary carpet backings with good tuftability and tuft holding capabilities and tufted backings and carpets with improved tuft hold.

BACKGROUND OF THE INVENTION

[0002] Primary backings for tufted carpets in the form of flat fabrics woven from tapes of synthetic polymeric noils, also commonly referred to as ribbons, ribbon yarns, slit film yarns and flat yarns, are well known and described in U.S. Pat. No. 3,110,905. A wide range of yarn compositions and configurations and their use in various backing fabric designs have been described in the literature. In actual practice, woven polypropylene tape fabrics are and have been long preferred primary backings for commercial manufacture of carpets due to important features such as strength, mold and mildew resistance, cost, tuftability and compatibility with other aspects of carpet manufacturing operations.

[0003] Primary backings conventionally used in commercial manufacture of common carpet styles are woven from polypropylene warp tapes with deniers of about 250 to about 600 g/9000 meters and weft tapes with deniers of about 750-1050 g/9000 meters. Thicknesses of the tapes range from 1.4 to about 2.2 mils and widths generally range from 40 to about 150 mils depending on fabric design features such as average warp and weft counts and coverages. The tapes are easily and economically prepared by conventional film extrusion and slitting or tape extrusion processes. Strengths, elongations and other characteristics of the tapes are such as to withstand the rigors of weaving, even on the wide looms—often as great as 9-15 feet—used for weaving backings for broadloom carpets, without so much breakage, twisting or folding to impair fabric performance and appearance. Suitably designed fabrics with such warp and weft tapes are tuftable, with strength and other properties suited to use to make carpets and performance of finished goods.

[0004] Primary backings made from such tapes are commonly fabrics woven in a plain, closed weave fabric. Fabric designs generally having about 10-42 tapes per inch in the warp and about 10-20 tapes per inch in the weft have commonly been reported in the literature, as seen from U.S. Pat. Nos. 4,123,577 and 6,740,385. In actual practice, primary backings commonly available for or used in a wide range of current commercially available carpets are plain weave fabrics designed with average warp counts of 24 or 28 tapes per inch and average weft counts of 11 to 18, with counts of 11 and 13 weft tapes per inch most commonly found in carpets for residential applications, such as in single family houses and apartments, and counts of 15, 16.5 and 18 common for carpets for commercial uses, such as in offices, hotels, stores, airports and the like. More specific tailoring of other backing designs to particular carpet styles is complicated, and empirical in many respects due to numerous manufacturing, performance and design features of both backings and carpets that must be accounted for and their complex, sometimes conflicting or unpredictable interrelationships.

[0005] Weaving efficiency is an important practical consideration relevant to tailoring backing fabric designs to carpet styles. Designing multiple backing fabrics with a common warp count can avoid separate beaming and loom set up otherwise needed for different counts, thereby promoting efficiency. Weft count variations have less effect on such weaving considerations, although cost factors favor fabric designs with essentially full or greater coverage at minimum counts consistent with tufting and carpet performance requirements.

[0006] With regard to carpet manufacturing performance, ease with which tufting needles and face yarn penetrate a backing is important for tuftability, generally improving with thinner, less tightly woven backings; however, thicker and more tightly woven fabrics have better tuft hold and strength, other things being equal. Smooth pile surfaces with uniform pile heights and patterned carpets with high pattern definition and regularity tend to call for primary backings with smooth surfaces and high weftline straightness, both of which can be enhanced in primary backing fabrics woven from conventionally configured tapes by tightness of the weave and relatively high weft counts, such as 15 per inch or greater. Both of those backing design aspects, however, can impact tuftability of a fabric.

[0007] Enhancement of one or both of tuftability and pile surface appearance is generally considered to result from use of backing fabrics designed so that needles used for tufting carpet face yarn preferentially penetrate the backings at intersections of warp and weft tapes, as opposed to piercing the tapes at their crossovers. A common rule of thumb for tufting involves correlating weft counts of backing fabrics with tufting stitch rates—that is, stitches per unit length in the direction of advancement of a backing through tufting—such that the former exceeds the latter by a significant proportion, such as 30-60%. While application of this rule of thumb can, or is often considered to provide improved tuftability, it also has limitations and exceptions. For example, with regard to tufted pile surface appearance, extensive studies of different commercial and experimental primary backing fabrics tufted in the same or similar low weight, cut pile construction, such as commonly found in carpets for commercial applications, indicates that backings with identical weft counts yielded tufted carpets with ratings for watermarking and pitting, which are well recognized indicators of carpet surface appearance, ranging from poor to very good. Backing fabrics woven from tapes in one direction and, in the other direction, fibrillated tapes or other yarns with a multi-filament or multi-sectioned configuration, as in U.S. Pat. Nos. 3,359,934 and 4,145,467, can be used to reduce piercing of tapes during tufting due to the more easily penetrated, open yarn configuration, but tuft holding properties of the fabrics are inferior to those of fabrics woven from tapes in both directions, and the fibrillated or multi-sectioned yarns add cost to backing fabrics and carpets.

[0008] With continuing emphasis on innovation and style in the carpet industry and demanded by carpet customers, primary backing fabrics are subject to new and increasing demands. Conventional backings often are inadequate in one or more respects and attempts to tailor backings to new carpet styles, weights and other characteristics require challenging and expensive modifications and significant investigation and trial and error with new backing designs. As an example, Berber-style carpets, which have become popular in recent years for commercial and residential uses, generally are characterized by large, heavy face yarn bundles with
deniers as high as 20000 g/9000 meters tufted at relatively low stitch rates on wide gauge tufters to provide a highly textured carpet face surface. These carpets contrast significantly with smoother, more uniform pile surfaces such as in conventional Saxony carpets with lighter face yarn, generally on the order of 800 to 4000 denier, tufted at higher stitch rates and gauge. With conventional primary backing fabrics of the type commonly used in Saxony and other smoother, more uniform pile surface carpet styles, even at the high end of conventional weft tape deniers in the range of 1000-1100. Berber carpets and their heavy face yarns approach performance limits of the backings because high average weft counts such as 15-18 tapes per inch are generally needed for reasonable surface appearance and tuft hold, though the high counts and thickness of the weft tapes are not conducive to tuftability. Another example is beck-dyed carpets, in which face yarn tufts can suffer significant pullout from tufted backings due to rigors of the dyeing technique and the equipment used to remove excess dye. Stitch pullout in beck-dyed loop pile carpets is a particular difficulty because loop pile tufts running in the machine direction of the tufted backing are formed from a continuous length of face yarn, such that tuft pullout can easily propagate over a significant portion of the tufted backing, ultimately producing off-quality carpets. In conventional backings, even weft counts as high as 15-18 tapes per inch can be deficient in tuft hold, yet higher counts can impair tuftability.

SUMMARY OF THE INVENTION

[0009] This invention provides primary carpet backings with improved features and that solve difficulties with conventional backings, including those described above, by providing good tuftability and improved tuft holding properties for carpet face yarns with a broad range of deniers and in carpets with textured pile surfaces as well as those with more uniform pile heights calling for high tuft hold.

[0010] In one embodiment, the invention provides a tuftable fabric with tuft holding capabilities comprising fabric woven in a plain, closed weave from warp tapes comprising polypropylene resin and weft yarns, with an average warp count of about 18 to about 32 tapes per inch and a lower average weft count of about 10 to about 22 yarns per inch, wherein the warp tapes have deniers of about 250 to about 800 and the weft yarns comprise tapes comprising polypropylene resin that are thicker than the warp tapes and have deniers of about 1200 to about 1600.

[0011] Another embodiment of the invention provides carpets comprising a primary backing as described above tufted with carpet face yarn to provide a pile surface comprising a plurality of face yarn tufts on one side of the backing and a plurality of stitches of the face yarn on an opposite, stitched side of the tufted backing and, optionally, having a secondary backing laminated to the stitched side of the backing. The carpets have good tuft holding properties for a wide range of carpet face yarn deniers, carpet styles and pile surfaces.

[0012] In another embodiment, primary carpet backings having good tuftability and improved tuft hold for carpet face yarn tufted with a textured pile surface comprise fabric woven from polypropylene warp tapes and weft yarns in a plain, closed weave with an average warp count of about 18 to about 32 tapes per inch and an average weft count of about 10 to about 15 yarns per inch, wherein the warp tapes are about 1.4 to 2.0 mils thick with deniers of about 250 to about 800 and the weft yarns comprise polypropylene tapes about 1.7 to about 2.5 mils thick and thicker than the warp tapes, with deniers of about 1200 to about 1600.

[0013] In another embodiment, the invention provides tufted carpets comprising such a primary carpet backing fabric tufted with face yarn to form a textured pile surface. In a particular embodiment, the textured pile surface comprises carpet face yarn with a denier of about 5000 or greater.

[0014] In other embodiments, the invention provides primary carpet backings having good tuftability and tuft hold in loop pile tufted backings suitable for beck-dyeing and other smooth pile carpet styles, comprising fabric woven from warp tapes and weft yarns comprising polypropylene resin in a plain, closed weave with an average warp count of about 18 to about 32 tapes per inch and a lower average weft count of about 15 to about 20 yarns per inch, wherein the warp tapes are about 1.4 to 2.0 mils thick with deniers of about 250 to about 800 and the weft yarns comprise tapes that are thicker than the warp tapes and about 1.7 to about 2.5 mils thick, with deniers of about 1200 to about 1600. Carpets comprising face yarn tufted into the backings, and especially loop pile carpets with about 800 to about 4000 denier face yarn, have good resistance to tuft pullout, even in severe finishing environments such as beck dyeing operations.

[0015] As used herein the term “tufts” is used for its common meaning as understood in the carpet backing industry and encompasses alternate expressions such as ribbon yarns, flat yarns and slit film yarns; it includes structures with flat or profiled cross-sections, such as serrated or striated tapes, but does not include fibrillated tapes and similar yarns and structures such as can be made from tapes by slitting, splitting, stretching, twisting and combinations thereof to produce net-like or fibril-containing filaments, yarns and yarn structures. The terms “warp” and “weft” are also used for their commonly accepted meanings in the carpet backing and tufted carpet arts; “warp” yarns, yarns or elements of a fabric refers to tapes, yarns and elements of the fabric with their lengths disposed in the machine direction while “weft” tapes, yarns or elements are tapes, yarns or elements longitudinally disposed in the cross direction. The terms “pick” and “fill” are sometimes used synonymously with each other and with “weft” or “warp yarn”.

[0016] The term “mils” means one-one thousandth (0.001) of an inch. The word “denier” in reference to yarns and filaments is used for its ordinary meaning in the textile industry; all deniers recited herein are to be understood as expressed in units of grams per 9,000 meters; thus by way
of example, a 300 denier yarn or yarn of 300 denier refers to a yarn with a denier of 300 g/9000 m. The term “osy” is an abbreviation for ounces per square yard.

[0017] The expression “tuft hold” as used herein refers to holding power or properties of a backing fabric for face yarn with which it is or will be tufted. For purposes hereof, a modified version of the procedure of ASTM D-1335 is used to measure tuft-holding properties, with the modifications designed to give more useful measurements for loop pile carpets. The modifications are described more fully in connection with the Examples appearing below and involve leaving face yarn tufts uncut so that tuft pullout can propagate along a row of stitches over a substantial length in the machine direction, plotting load versus deflection as the loops in a row formed from a single face yarn are pulled out over a 10-inch length of the tufted sample and recording both the maximum load for removal of a single loop, referred to as “Maximum Load”, and average peak load for removal of tuft loops over a ten inch length, referred to as “Average Peak Load.”

DETAILED DESCRIPTION OF THE INVENTION

[0018] The invention proceeds from the discovery that smooth surfaced backings traditionally preferred for carpets with relatively uniform, more finely defined pile surfaces are not only unnecessary, but in some cases may be disadvantageous, for highly textured carpet surfaces as in Berber carpets. Although woven fabrics with designs as in common, commercially available primary backings and made from tapes used therefor but with lower average weft counts were found to tuft easily and yield pile surfaces with good appearance with heavy, 5000 denier face yarn, tuft hold for the heavy yarn bundles was inadequate. From investigations of experimental fabrics designed and constructed with varying counts of differently dimensioned weft yarns and tufted with various yarn types, it was discovered that certain weft tapes with greater deniers than those conventionally used in common backings could be woven by standard weaving techniques with conventional, lighter warp tapes into plain weave fabrics with reduced weft counts to provide backing fabrics that were not only easily tufted with the heavy denier face yarns, but also held the yarns tightly after tufting. Further studies with the heavier weft tapes revealed they also could be woven at high weft counts expected to impair weaving and tuftability into primary backing fabrics that are tuftable with lower denier face yarns and provide exceptional tuft hold for the yarns. Beck-dyeing trials of the tufted fabrics with face yarn tufts left uncut to provide loop pile surfaces provided good results, including low stitch pullout. In some embodiments, the high weft count fabrics also showed improved resistance over conventional backings to weftline distortions such as bow and skew during and after tufting with carpet face yarn.

[0019] The invented fabrics are woven from warp and weft tapes comprising polypropylene resin. Homopolymer polypropylenes and propylene-dominated copolymers with one or more other monomers, such as ethylene, butene-1, hexene-1 and other copolymerizable monomers, and including metallocene-catalyzed propylene homopolymers and copolymers, are suitable polypropylene resins, as are polypropylene-dominated blends thereof and their blends with one or more other thermoplastic resins, such as polyethylene, polyesters and nylons. The polypropylene resins can contain pigments, stabilizers, process aids, anti-microbial agents, fillers and other suitable additives. Such additives and their use are well known in the art. Homopolymer polypropylene resins are easily formed into tapes with properties well suited to the invented backings and are generally preferred over more complex or costly resin compositions. Common, commercial tape-grade homopolymer resins with melt flow rates of about 1 to about 20 grams per 10 minutes, determined according to ASTM D-1238 at 230° C. and under load of 2.16 kg, are well suited to the tapes and manufacture thereof.

[0020] The tapes from which the backings are woven are essentially flat structures, with significantly greater average width than average thickness. As noted above, tapes, ribbons, flat yarns, slit film yarns and the like are embraced by the term “tapest” as are structures with profiled or contoured surfaces. Generally the ratio of average tape width to average thickness is at least about 10:1 and preferably from about 20:1 to about 200:1. Cross-sections of the warp and weft tapes can be essentially rectangular or contoured, for example, with striations or with grooves, ridges, serrations or other profiles. Combinations of uncontoured and profiled tapes, in the warp, weft or warp and weft can be used. Weft tapes with contoured surfaces can provide benefits in the invented backing fabrics because they tend to be more easily penetrated by tufting needles and with less heat generation than flat tapes, thereby enhancing tuftability of the fabrics even with their heavier, thicker weft tapes as compared to those in conventional primary backings. Preferred contoured tapes have thinner and thicker areas alternating across their widths and extending along their lengths. A preferred contoured tape is a serrated tape as described in commonly assigned U.S. Pat. No. 5,924,434, which is incorporated herein by reference.

[0021] Warp tapes of the invented backings have deniers of about 250 to about 800 g/9000 meters. Tapes with deniers above about 800 g impart undesirable stiffness and weight, while fabrics with lower denier tapes are flimsy with poor strength for tufting and poor tuft hold for tufted face yarn. Warp tape widths vary with average counts and generally are such as to provide approximately full or greater coverage in the warp. In one embodiment, warp coverage is about 90 to about 140% for ease of weaving, good coverage and tufting performance. In another embodiment, coverage of about 95 to about 130% is beneficial. Warp tapes preferably are about 1.4 to about 2.0 mils thick.

[0022] For good weaving performance, warp tapes of the invented primary backings preferably have tenacities of about 3.5 to about 5.5 g/denier and elongations of about 20 to about 45%, both as determined according to ASTM D-2256. Warp tape shrinkages at 270°F. preferably are about 1.8 to about 3.8%, determined from the difference in length, measured at room temperature, between an initial 100 cm long sample of tape and the same sample after being suspended in a forced air oven heated at 270°F. for twenty minutes and then removed and allowed to cool to ambient.

[0023] Weft yarns of the invented backings comprise tapes that comprise polypropylene and are heavier and thicker than the warp tapes, and also thicker than weft tapes in conventional backings used in commercial manufacture of common carpet styles. The weft tapes have deniers of about
1200 to about 1600 g/9000 meters. In one embodiment of the invention, all of the weft yarns of the invented backings are such heavier, thicker tapes. Benefits according to the invention can also be realized in backings in which the weft yarns comprise at least substantial proportions of weft tapes with deniers of about 1200 to about 1600 and thicknesses greater than the warp tapes and lesser proportions of weft tapes configured as in conventional backings. In a more particular embodiment, weft yarns of the backings comprise at least about 60% weft tapes with deniers of 1200 to about 1600 and thicknesses exceeding those of the warp tapes, and up to about 40% weft tapes having deniers of about 750 to about 1100 as in conventional primary backings and thicknesses that are the same as or different from those of the warp tapes and ranging generally from about 1.4 to about 2.2 mils.

[0024] Deniers of the heavier, thicker weft tapes of which the invented backings are comprised are about 1200 to about 1600 because, other things being equal, weft tapes with lower deniers yield fabrics with reduced tuft hold, while higher denier weft tapes can adversely affect fabric tuftability, both by increasing needle deflection and by promoting undesirable excess heat generation from friction between the backing and the tufting needles and face yarn as they are stitched back and forth through the backing. Thickness of the weft tapes exceeds that of the warp tapes and generally ranges from about 1.7 to about 2.5 mils. Weft tape thickness may influence reduced surface smoothness of the backings in lower weft count constructions, such as for Berber and other carpet styles with large tuft bundles or textured pile surfaces. Greater thickness of the weft tapes contributes to improved tuft hold in higher and lower weft count fabric designs. Surprisingly, the thinner warp tapes and thicker weft tapes in the invented backings provide better tuft hold and, in some embodiments, better tuft hold and pattern definition, than fabrics constructed in like manner but with thicker warps and thinner wefts.

[0025] Widths of the heavier, thicker weft tapes are selected in conjunction with average weft counts to provide essentially full or greater coverage. Lower coverage adversely impacts tuft hold, while coverage that is too high can impair tuftability. In one embodiment, coverage by the weft tapes is about 95 to about 220%, providing a good combination of tuft hold and tuftability. Widths of the weft tapes generally are selected within the range of about 80 to about 200 mils. In another embodiment, weft coverage is about 120 to about 210%, providing improvements in tuft hold and especially for heavy denier yarns in low weft count backings. Weft tape widths of about 100 to about 150 mils are preferred in some embodiments of the invention.

[0026] Other features of the heavier, thicker weft tapes that may be pertinent to weaving performance include tenacities of about 3.2 to 5.0 denier and elongations of about 20 to about 45%, both according to ASTM D-2256 and shrinkages at 270° F, determined as described above, of about 1 to about 2.5%. In one embodiment of the invention, weft tapes with deniers of about 1250 to about 1500 have tenacities of 3.5 to about 4.5 denier, elongations of 25 to 40% and shrinkages of 1.2 to 2.0%.

[0027] Warp and weft tapes of the invented backings can be prepared by any suitable method. Commonly, a thermoplastic resin composition comprising polypropylene, such as described above, is extruded into tapes using suitably configured dies, or extruded as a molten film that is cooled and slit into tapes. In both extrusion and slit film methods, tape thickness is commonly controlled by adjusting width of the gap in the tape or film die. Tapes with contoured surfaces are conveniently made using extrusion dies with appropriate profiles. In tape extrusion, tape widths are typically controlled with inserts placed into the die gap. In slit film processes, spacing of cutting means used to slit the film can be adjusted to provide desired widths. In both processes, tapes usually are drawn to increase tenacity. In tape extrusion, tapes are typically drawn or stretched after extrusion and quenching. A result of stretching is that drawn tapes are somewhat narrower and thinner than their undrawn precursors; such changes can be accounted for by selecting extrusion die dimensions to compensate for changes from further processing. Similar considerations also apply in slit film processes, although spacing of cutting means to account for changes in dimensions due to drawing may vary depending on whether drawing precedes or follows slitting. These effects and adjustments to account for changes in dimensions are known to those skilled in the art.

[0028] The invented primary backings are woven from the warp tapes and wefts comprising tapes thicker than the warps tapes and with deniers of about 1200 to about 1600 in a plain, closed weave. Plain weave constructions are characterized by each weft crossing over and then under one warp, as is well known. The fabrics are woven in closed weave, with warp and weft yarns providing essentially full or greater coverage as noted above, because looser or more open fabrics are prone to undesirable shifting during tufting and have inadequate surface for good tuft hold. The fabrics can be woven using looms or other suitable weaving equipment. Projectile, pneumatic, liquid jet and rapier looms are commonly used, although the heavier weft tapes of the invented backings as compared to conventional backings can require increased fluid velocities or additional fluid sources in the cross direction in pneumatic and water jet weaving to ensure effective transport of the tapes across the full width of the loom. A tufting lubricant often is applied to the warp tapes, weft yarns or both to facilitate tufting; lubricants and their use are well known. After weaving, fabrics are usually taken up, for example on a roll, or they can be advanced directly to tufting or other processing without intermediate take-up in integrated operations in which looms are associated directly with tufting or other processing operations.

[0029] The invented backings are constructed with an average warp count of about 18 to about 32 tapes per inch and an average weft count that is less than the average warp count and ranges from about 10 to about 22 weft tapes per inch. Lower counts of the thicker weft tapes in conjunction with higher counts of the thinner warp tapes contribute to tuftability and tuft hold.

[0030] As noted above, lower weft counts within the range of about 10 to about 22 per inch contribute to improved surface and tuft hold in textured carpets', such as Berber carpets and other styles in which face yarn of about 5000 denier or more is present or with uneven pile heights or
surfaces. In one embodiment, backings for textured pile carpet styles are constructed with average warp counts of about 18 to about 32 tapes per inch and average weft counts of about 10 to about 16 tapes per inch. Tuft hold of such backings for heavy denier face yarns is surprisingly high as indicated by Maximum Load of about 2.4 pounds or greater, Average Peak Load of about 1.3 pounds or more, or both, for 5000 denier, two-ply BCF carpet face yarn tufted at 1/2 gauge and 7.5 stitches per inch. In another embodiment, fabrics constructed with an average of about 20 to about 28 warp tapes per inch and an average of 12 to about 15 weft tapes per inch provide exceptional tuft hold and tuftability for textured carpets, and especially Berber style carpets tufted with face yarn having deniers of 8000 to about 18000.

[0031] Backing fabrics with average weft counts of about 16 to about 22 tapes per inch provide surprising improvements in tuft hold in carpets tufted with lighter face yarns, and particularly about 800 to about 4000 denier face yarn for conventional, smooth pile surface styles. Tuft hold of these backings for lower denier face yarns is indicated by Maximum Loads of about 1.8 pounds or greater, Average Peak Loads of about 0.9 or more, or both, for 3300 denier two-ply BCF carpet face yarn tufted at 1/2 gauge and 8 stitches per inch.

[0032] For both lower and higher average weft counts constructions of the invented backing fabrics, average warp counts of about 24 and about 28 tapes per inch provide excellent tuftability and tuft hold and can also contribute to weaving efficiencies because conventional primary backing fabrics are commonly designed with those average warp counts, such that warp tapes can be beamed in common and the same looms can be shifted between use for the invented backings and conventional backings without substantial downtime for switching between styles. In some embodiments, average warp counts of about 30 to about 32 tapes per inch can provide similar benefits with regard to conventional backing styles with comparably high warp counts.

[0033] In a more specific embodiment, a primary backing fabric for tufting face yarn comprising large yarn bundles and other textured pile carpet surfaces has average warp count of about 20 to 32, average weft count of about 12, with 350 to 550 denier warp tapes about 1.4 to about 2.0 mils thick and 1200 to 1600 denier weft tapes that are thicker than the warp tapes and about 1.8 to about 2.5 mils thick. Despite its low weft count, tuft hold properties of such a primary backing for 5000 denier nylon carpet yarn tufted at 1/2 gauge 7.5 stitches per inch are as good as or better than those of current, commercial 24 and 28 warp by 15 or 16.5 pick primary backings made from conventional 250-600 denier polypropylene warp tapes and 750-1050 denier polypropylene weft tapes, as indicated by Maximum Load of at least about 2 lbs and Average Peak Load of at least about 1.2 pounds.

[0034] According to another embodiment of the invention, a primary backing for tufting with face yarn of up to about 4000 denier in smooth pile carpet styles has average warp count of about 20 to 32, average weft count of about 16 to about 20 and weft coverage of about 95% to about 145%, with 350 to about 550 denier warp tapes about 1.4 to about 2.0 mils thick and about 1250 to about 1500 denier weft tapes that are thicker than the warp tapes and about 1.8 to about 2.5 mils thick. Tuft hold properties of such a primary backing for such carpet face yarns is suited, in particular, to back dyeing as indicated by Maximum Load of about 1.8 pounds and Average Peak Load of about 0.9 pounds for 3300 denier nylon carpet yarn tufted at 1/2 gauge and 8 stitches per inch, and exceeds that of conventional 24x18 and 24x20 primary backings woven from conventional 250-600 denier polypropylene warp tapes and 750-1050 denier polypropylene weft tapes.

[0035] Weights of the woven primary backing fabrics according to the invention vary with average warp and weft counts and tape or yarn dimensions and, in general, are great enough to provide strength, tear resistance and integrity for handling, tufting and subsequent performance as part of a finished carpet structure, though not so great as to impede handling, needling or tufting. Fabric weights are commonly about 2.5 to about 3.5 oz. Preferred weights are about 3 to about 5 oz. The fabrics can be provided with any desired selvage treatment, such as tubed, alternating tubed and untubed, and latched cord selvages. They also can be provided with modified surfaces on one or both faces, such as needled, thermally or adhesively bonded staple or continuous filaments or webs to improve compatibility with dyes used in carpet finishing, increase dimensional stability or impart other affects.

[0036] In another embodiment, the invention provides tufted products, and particularly tufted carpets, with improvements in one or both of pile surface appearance and tuft lock. As compared to tufted products prepared from common commercial primary backings, and methods for making such products. The tufted products comprise a backing tufted with face yarn such that it penetrates the backing to form a plurality of tufts on a pile side and a plurality of stitches on the opposite, stitched side. The backing for such tufted goods comprises fabric woven from warp tapes comprising polypropylene resin in a plain, closed weave with an average warp count of about 18 to about 32 tapes per inch and a lower average weft count of about 10 to about 22 tapes per inch, wherein the warp tapes have deniers of about 250 to about 800 and the weft yarns comprise tapes comprising polypropylene resin that are thicker than the warp tapes and have deniers of about 1200 to about 1600.

[0037] Face yarns suitable for the tufted carpets are well known and can be composed of any suitable material. Natural fiber yarns, such as those with wool or cotton fibers, are suitable and highly regarded for premium and luxury applications, although synthetic yarns, which typically are composed of a plurality of filaments of thermoplastic polymeric resin, are more common due to lower cost, durability and other advantages. Synthetic carpet yarns with filaments comprising at least one thermoplastic resin, such as nylon, polyester, polypropylene and acrylic resins, are most common. Continuous filament yarns and spun yarns comprising staple fiber are both useful.

[0038] Continuous filament yarns used in carpets are usually bulked to provide texture. Bulking is introduced by various techniques such as crimping, texturing with fluid jets, twisting and detwisting and the like. Twisting, cabling, plying, heatsetting and combinations of such techniques are often used to impart or preserve bulk. Bulked continuous filament yarns are commonly known as “BCF” yarns. Nylon BCF yarns, composed of either nylon 66 or nylon 6, and
polypropylene BCF yarns are most commonly used in carpets although nylon spun yarns and polyester yarns also are used. Pigmented, or solution-dyed, yarns prepared by incorporating pigments into resins from which filaments are spun are suitable as are natural color yarns that can be dyed after tufting, for example in a finishing step. Generally, BCF carpet face yarns have deniers of at least about 1200. Deniers up to about 6000 are common in conventional carpet styles although in some styles deniers as high as 20,000 and even greater are known. Face yarns for Berber carpets typically have deniers of about 6000 or greater, with about 8000 to about 18000 being common. Filament counts of typical face yarns range from about 70 to about 1200, with filament deniers typically ranging from about 8 to about 30 in continuous filament yarns.

[0039] The face yarn is tufted into the backing such that a plurality of face yarn tufts project from one side of the primary backing and a plurality of stitches joining pairs of tufts is disposed on an opposite, stitched side of the primary backing. Generally, tufting involves advancing the backing through a tufting device equipped with a plurality of reciprocating tufting needles. Face yarn is stitched into the backing by the reciprocating action of the needles. Yarn tufts can be cut to provide a cut pile surface or can remain uncut to provide a looped pile surface.

[0040] Tufted backings and carpets can be provided in styles, weights, tuft densities and pile heights as desired. Examples of carpets with textured surfaces include loop pile Berber, cut pile Berber and other styles with uneven pile surfaces such as obtained by tufting with different face yarn weights, or in different pile heights. Examples of styles with smooth pile surfaces include Saxony, cut-and-loop, cut pile, and loop pile styles. Cut pile styles are common for residential applications while loop piles are more common in commercial, hospitality and carpet tile end uses. Pile heights of about ½ to about ¾ inch are common in residential carpets while about ¾ to about ½ inch are common for commercial carpets. Tuft densities typically range from about 30 to about 200 tufts per square inch for both types of carpets. While such features are common for a wide range of commercially available carpets, those skilled in the art will recognize that heavier and lighter weights, longer or shorter piles and greater or lesser tuft densities may be suited in other applications and are contemplated by the invention.

[0041] Tufted backings according to this aspect of the invention show good tufting performance, especially in terms of ease of needle penetration, lack of needle breakage, and low heat build-up due to friction between face yarns and backings during needle penetration. Depending on backing design, tuft hold of the tufted backings can be tailored to face yarn types and carpet styles. Low pick backings with 10 to 15 wefts per inch show surprising tuft hold for carpets tufted with textured pile surfaces, as do higher pick backings with about 16 to about 20 weft tapes per inch for 800 to 4000 denier yarns tufted in fine gauge, at high stitch rates and with other smooth pile surfaces. In embodiments of these higher weft count backings designed with significant overlap of weft yarns, for example at weft coverages of about 110 to about 145%, smooth pile surfaces tufted in patterns often show better regularity than conventional woven tape backings tufted in like manner.

[0042] Tufted carpets according to the invention preferably also include a secondary backing adhered to the stitched side of the tufted backing. Secondary backings provide improved dimensional stability to carpets and generally comprise a film, woven, knitted or nonwoven fabrics, woven or nonwoven scrims, nonwoven structures, or composites or combinations thereof. Preferred secondary backings are materials constructed of thermoplastic resins, and particularly polypropylene tapes or yarns, although for some applications natural fiber backings, such as those woven from jute, hemp and sisal are useful, as are woven paper. Particularly preferred secondary backings for carpets according to this invention are conventional polypropylene secondary backings, which are typically open weave fabrics woven from warp and weft tapes comprising polypropylene resin, or from tapes in one direction and polypropylene filament or spun yarns in the other. Plain weave and leno constructions are preferred. Most preferred secondary backings are fabrics comprising polypropylene tapes, and especially with tapes in the warp and polypropylene spun or multifilament weft yarns, in a plain or leno weave construction with about 10 to about 24 warp tapes per inch and about 4 to about 14 weft tapes or yarns per inch. Such secondary backings having a light weight layer of staple fibers or nonwoven web needleled or otherwise joined to a surface of the fabric also can be useful. In one embodiment, such a layer weighs about 1 to about 3 oz and comprises polypropylene fiber of about 2 to about 4 inches average length. Examples of woven secondary backings are ActionBac® Fabrics available from Amoco.

[0043] Carpets according to the invention are finished by application to the tufted primary backings according to the invention of steps comprising one or more of dyeing, application of binder to secure face yarn stitches to the tufted backing, and lamination of a secondary backing, if used. Finishing steps and binders for use to secure tuft stitches to the primary backing and, when used, laminate a secondary backing to the primary backing, are well known.

[0044] Dyeing can be conducted by any suitable means and normally precedes application of binders and lamination of secondary backings. Vat dyeing, beck dyeing and continuous dyeing are commonly used for carpets and their techniques, equipment and dye formulations are well known. Beck dyed carpets made from the invented backings preferably have nylon or polyester face yarns.

[0045] Binders for anchoring tuft stitches to primary backings and, when used, adhering secondary backings to the stitched side of a primary backing, typically comprise aqueous latex compositions that can be applied in liquid form to the stitched surface of the tufted backing and then heated to remove liquid contents and cure the binder. Latex formulations used in carpet manufacture are commonly particulate-filled, aqueous latexes of organic polymer compositions that cure on heating. Crosslinkable styrene-butadiene copolymers are most commonly used as the organic polymer of the backcoat formulations. Calcium carbonate is common particulate filler and typically is present in latexes in significant amounts (e.g., 60-85 wt %) to impart viscosities facilitating backcoat application with simple liquid coating equipment.

[0046] Alternatively, thermoplastic binders are used to bind the stitches or stitches and secondary backing by melting a thermoplastic resin with lower softening or melting point than other carpet components in contact with the tufted backing or tufted backing in contact with a secondary
backing and then cooling to solidify the resin. Thermoplastic resins also can be applied to tufted backings in melted form and then cooled in contact therewith, and with a secondary backing if used, to solidify the resin and bind the carpet structure.

[0047] In use, binder is applied to the stitched surface of the backing or otherwise contacted with the stitched surface in amounts effective to anchor tuft stitches to the primary backing and, if used, to also adhere a secondary backing to the stitched surface. Liquid binders such as aqueous latex formulations are commonly applied by liquid application methods such as passage through dip baths with doctor blade or other distribution aids, or through an applicator roll assembly. Heating to drive off liquid components of latex formulations is commonly conducted in drying ovens operated at speeds for efficient manufacture and temperatures effective to drive off the liquid components but not so high as to damage the carpet structure or its components. Thermoplastic binders can be extruded into contact with the stitched surface or, if already present in solid form in a tufted or secondary backing, can be heated to melt the resin. Subsequent cooling solidifies the binder and bonds the carpet structure.

[0048] The following examples illustrate the invention but are not to be considered to limit its scope. In the examples, Maximum Load and Average Peak Load of tufted primary backing samples were determined by testing a 6-inch by 8-inch section of tufted primary backing fabric. Samples were mounted in a tensile tester in the fixture used to measure tuft bind according to ASTM D-1335. To measure tuft hold, testing was conducted with backing samples tufted in stitch patterns free of step-overs capable of constraining removal of face yarns. Two changes from the standard test method were made: (1) the yarns making up the loops to be tested were not cut at adjacent loops, and (2) a load deflection curve was recorded as the loops in a row formed from a single face yarn were pulled out over a 10-inch length of the tufted sample. Stitch holding properties were measured as the Maximum Load to remove a single loop and the Average Peak Load from 1” and 10” to remove a row of tuft loops. Results are reported as an average of ten replications for a given sample.

EXAMPLE 1

[0049] Tapes were prepared from a common, commercially available polypropylene homopolymer resin having a melt flow rate of about 5.5 g/10 min., determined according to ASTM D-1238 at 230° C. and under 2.16 kg load, by extruding a film of melted resin, cooling the melted film in a cold water quench bath, passing the film over a series of cutting blades to slit it along its length into a plurality of narrow lengths, drawing the slit film over a series of rotating heated roll pairs operating at successively higher rotation rates to provide an overall draw ratio of 6:1 and then passing the resulting drawn tapes over a series of annealing rolls. Dimensions and properties of the warp and weft tapes were as shown in the following table.

<table>
<thead>
<tr>
<th>Property</th>
<th>Warp Tapes</th>
<th>Weft Tapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denier (g/9000 m)</td>
<td>475</td>
<td>1400</td>
</tr>
<tr>
<td>Thickness (mils)</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Width (mils)</td>
<td>50</td>
<td>115</td>
</tr>
<tr>
<td>Tenacity (g/denier)</td>
<td>4.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Warp Tapes</th>
<th>Weft Tapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elongation (%)</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>Shrinkage (% at 270°F)</td>
<td>2.5</td>
<td>1.8</td>
</tr>
</tbody>
</table>

[0050] The warp and weft tapes were woven in plain, 1/1 weave on a wide width projectile loom with an average warp count of 24 tapes per inch and average weft count of 18 tapes per inch. Warp coverage was 120% and weft coverage was 207%. The resulting fabric weighed 4.8 oz/yd.

[0051] The fabric was tufted with a two-ply, 3300 denier nylon face yarn at ¼ gauge and 8 stitches per inch. Yarn tufts were left uncut, forming a smooth, loop pile surface with ½ inch pile height, as in carpets common for commercial applications. Visual observation showed a smooth, even pile surface.

[0052] The tufted fabric was tested for tuft hold resulting in a Maximum Load measurement of 2.0 lbs and Average Peak Load measurement of 1.1 lbs.

Control A

[0053] A sample of a commercially available primary carpet backing fabric, identified as PolyBac Fabric 2218 and having polypropylene warp tapes 1.8 mils thick by 50 mils wide with deniers of 475 at 24 tapes per inch and warp coverage of 120% as in Example 1, and polypropylene weft tapes 2.1 mils thick by 95 mils wide with a longitudinally serrated surface profile and denier of 1050 at 18 tapes per inch and weft coverage of 170%, was tufted with the same yarn and in the same manner as in Example 1. The pile surface of the tufted backing had a uniform appearance but both Maximum Load and the Average Peak Load, tested as in Example 1 and reported below in TABLE 1, were less than in Example 1.

Control B

[0054] In this control, a second, commercially available primary carpet backing, identified as PolyBac Fabric style 2224, was used. The primary backing was woven from polypropylene tapes with 24 warp tapes per inch and 20 weft tapes per inch. As in Example 1, the warp tapes were 1.8 mils thick by 50 mils wide with deniers of 475, providing warp coverage of 120%, while the weft tapes were 2.1 mils thick by 95 mils wide with deniers of 1050 providing weft coverage of 195%. The weft tapes had longitudinal serrations providing a plurality of alternating grooves and ridges along their lengths. The primary backing fabric was tufted with the face yarn and in the same manner as in Example 1 and tested for tuft hold. Results are reported in TABLE 1.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Maximum Load (lbs)</th>
<th>Average Peak Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>2.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Control A</td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Control B</td>
<td>1.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

[0055] As seen from TABLE 1, Example 1 and Controls A and B, the 1400 denier, 18 weft tape per inch fabric of Example 1 had the highest Maximum tuft pullout load (2.0 lbs.) and highest Average Peak Load (1.1 lbs.).
In beck-dyeing of tufted primary backing fabrics, the tufted backing according to Example 1 suffered fewer yarn pullouts than that of Control A.

EXAMPLES 2-3 AND COMPARATIVE EXAMPLES C-D

Additional primary backing fabrics with average counts of 24 warp tapes per inch by 18 weft tapes per inch were made following the general procedure of Example 1. The warp tapes in all examples were composed of a polypropylene homopolymer resin and were 1.5 mils thick by 50 mils wide with deniers of 475. Weft tapes were composed of polypropylene homopolymer resin and had varying dimensions and deniers, as reported in TABLE 2. Fabric weights were 4.4 osy in each of Examples 2 and 3.

Comparative fabrics C and D, corresponding to the fabric of Example 2 but with the variations described below, were also prepared following the general procedure of Example 1. Comparator C was woven from 1050 denier weft yarns in the form of fibrillated tapes at an average count of 18 wefts per inch; it weighed 4 osy. Comparator D was a 6.3 osy composite of a woven fabric according to Comparator C and 2 osy of 6 denier nylon staple fiber that was made by needle punching the fiber to the fabric.

The fabrics from Examples 2-4 and Comparators C and D were tufted with two-ply, 3300 denier nylon BCF carpet face yarn. The primary backing was tufted on a ½ gauge loop pile tufting machine. Face weight of the tufted yarn was 18 osy. The tufted backings were tested for tuft hold. Results appear in TABLE 2.

<table>
<thead>
<tr>
<th>Example or Comparator</th>
<th>Dimensions (mils, type)</th>
<th>Average Weft Count (tapes/ia)</th>
<th>Maximum Load (lbs)</th>
<th>Ave. Peak Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1200 denier</td>
<td>18</td>
<td>1.5</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>2.1 x 115 sersed tape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1200 denier</td>
<td>18</td>
<td>1.7</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>2.1 x 115 tape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp. C</td>
<td>1050 denier fibrillated</td>
<td>18</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Comp. D</td>
<td>1050 denier fibrillated</td>
<td>18</td>
<td>1.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

As seen from these examples and TABLE 2, the fabrics from Examples 2 and 3 showed higher Maximum Loads than the comparative fabrics, including Comparator D with its needle punched fiber layer. The fabrics of Examples 2 and 3 were easily woven and performed well in tufting, with excellent pattern definition in tufted fabrics. Average Peak Loads for the tufted fabrics of Examples 2 and 3 were at least as high as for the comparative tufted backings.

EXAMPLE 4

The primary backing fabric of Example 2 was tufted with a 2-ply nylon carpet face yarn on a ½ gauge pattern loop tufting machine. Carpet face weight was about 48 osy. The tufted primary backing was then beck dyed. Tuft bind was measured on the dyed, tufted primary backing according to the procedure of ASTM D-1335. The average of 15 tests was 1.5 lbs.

A woven fabric according to Control B was tufted in the same manner and beck dyed. Tuft bind of the dyed, tufted primary backing, measured according to ASTM D-1335 as an average of 15 tests, was 1.2 pounds.

Both dyed tufted backings had excellent pattern definition. The increased tuft bind results with the primary backing fabric of Example 2 indicates a reduced tendency for loops to be pulled out in the dyeing process.

EXAMPLE 5

A woven primary backing fabric made as in Example 1 was tufted with a two-ply, 5000 denier nylon BCF carpet face yarn. The primary backing was tufted on a ½ gauge loop pile tufting machine at a stitch rate of 7.5 in per inch. Face weight was 27 osy. The tufted primary backing had excellent pattern definition. It was tested for tuft hold, with the results that a Maximum Load of 2.8 lbs. and an Average Peak Load of 1.8 lbs. were measured.

EXAMPLE 6

A primary backing fabric was woven on a projectile loom from polypropylene warp tapes in a count of 24 tapes per inch and polypropylene weft tapes in a count of 12 tapes per inch. The warp tapes had deniers of 475 with rectangular cross-sections 50 mils wide by 1.8 mils thick. Weft tapes were 1400 denier rectangular cross-sectioned tapes 115 mils wide by 2.3 mils thick. Warp coverage was 120% and weft coverage was 138%.

A Berber style tufted backing was prepared by tufting the primary backing fabric with a two-ply, 5000 denier nylon face yarn at ½ gauge and 7.5 stitches per inch in an alternating high/low pattern. Total weight of the face yarn was 27 osy. Despite the large bundles and weight of the face yarn and thickness of the backing fabric, tufting proceeded smoothly even at high speed and the tufted backing exhibited not only good pattern definition but also good healing—that is, recovery from needle penetrations and closing of the backing around face yarn tufts to hold them in place—after tufting. The tufted fabric was tested for tuft hold, yielding a Maximum Load measurement of 2.6 lbs and an Average Peak Load measurement of 1.4 lbs.

Control E

A commercial 28x16.5 polypropylene primary backing, identified as SI Patternlok 2.0, having warp tapes and fibrillated weft yarns was tufted in the same manner as the primary backing in Example 7. Warp tapes of the backing had deniers of 400 and dimensions of 1.8 mils thick by 40 mils wide; warp coverage was 112%. Weft yarns had deniers of 1040 and dimensions of 2.2 mils thick by 86 mils wide. Weft coverage calculated for the fibrillated wefts was 124%. Testing for tuft hold yielded Maximum Load and Average Peak Load measurements less than in Example 6, as seen in TABLE 3 below.
TABLE 3

<table>
<thead>
<tr>
<th>Example or Control</th>
<th>Weft Count (tapes/inch)</th>
<th>Maximum Load (lbs)</th>
<th>Average Peak Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>16.5</td>
<td>2.3</td>
<td>1.3</td>
</tr>
<tr>
<td>F</td>
<td>12</td>
<td>2.6</td>
<td>1.4</td>
</tr>
</tbody>
</table>

EXAMPLE 7

A 3.4 osy, closed, plain weave fabric was woven from 475 denier polypropylene warp tapes 1.8 miles thick by 50 miles wide and 1260 denier polypropylene weft tapes 2.1 miles thick by 115 miles wide, at 24 warps per inch by 12 wefts per inch. The fabric was tufted with 2-ply, 3300 denier nylon BCF yarn at 3/4 gauge and 8 stitches per inch, providing a face weight of 18 osy.

Testing of the tufted fabric for tuft hold yielded an Average Peak Load measurement of 0.5 pound and a Maximum Load measurement of 1 pound.

EXAMPLES 8, 9 AND CONTROLS F-L

Following procedures as in Example 1, primary backing fabrics woven from polypropylene tapes and tufted backings according to the invention with different face yarns, face weights and tufting patterns were prepared.

The fabric of Example 8 was a plain, closed weave fabric woven with average counts of 24 warp tapes per inch and 12 weft tapes per inch. Warp tapes were 1.8 miles thick by 50 miles wide with deniers of 475. Weft tapes were 2.3 miles thick by 115 miles wide with denier of 1400. Weight of the fabric was 3.7 osy. The fabric was tufted with different face yarns in varying gauges, stitch rates, patterns and pile heights, and tuft hold properties were tested.

For comparison, commercially available closed, plain weave primary carpet backing fabrics designated Controls F-H, were tufted in the same manner and tested. Control F weighed 3.8 osy and had 400 denier warp tapes 1.8 miles thick by 40 miles wide at 28 tapes per inch and 1040 denier fibrillated polypropylene wefts 2.2 miles thick by 86 miles wide at 16.5 wefts per inch. Control G weighed 3.4 osy and had 400 denier warp tapes and 1040 denier weft tapes at 28 warp tapes per inch and 14 weft tapes per inch. Control H weighed 3.6 osy and was woven from 475 denier warp tapes and 1050 denier serrated weft tapes at 24 warp tapes per inch and 15 weft tapes per inch.

TABLE 4-continued

<table>
<thead>
<tr>
<th>Example or Control</th>
<th>Face Yarn</th>
<th>Tufting</th>
<th>Ave Peak Load (pounds)</th>
<th>Max. Load (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>as in 8A</td>
<td></td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>(28 x 16.5)</td>
<td>as in 8A</td>
<td></td>
<td>1.5</td>
<td>2.8</td>
</tr>
<tr>
<td>B</td>
<td>as in 8B</td>
<td>Diamond pattern loop pile as in 8B</td>
<td>1.5</td>
<td>2.7</td>
</tr>
<tr>
<td>G</td>
<td>High denier BCF</td>
<td>¾ gauge, 7 stitches/in.</td>
<td>1.1</td>
<td>2.0</td>
</tr>
<tr>
<td>(28 x 14)</td>
<td>2-ply 3300 denier nylon</td>
<td>¾ gauge, 8 stitches/in.</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>H</td>
<td>as in 8C</td>
<td>18 osy face wt.</td>
<td>0.7</td>
<td>1.2</td>
</tr>
</tbody>
</table>

The primary backing fabric of Example 9 was a plain, closed weave fabric woven with an average warp count of 24 tapes per inch and an average weft count of 12 tapes per inch. Warp tapes were 1.8 miles thick by 50 miles wide with deniers of 475. Weft tapes were 2.1 miles thick by 115 miles wide with deniers of 1260. Weight of the backing fabric was 3.4 osy. The fabric was tufted with different face yarns and tufting patterns as reported in TABLE 5 below, representing various carpet styles.

For comparison, commercially available closed, plain weave primary carpet backing fabrics designated I-L, and woven from polypropylene warp tapes and wefts, as described more fully below, were tufted in like manner. Control I weighed 3.5 osy and was woven from 435 denier warp tapes and 1088 denier weft tapes at 24 warps per inch and 15 wefts per inch. Control J weighed 3.4 osy and was woven from 400 denier warp tapes and 1040 denier weft tapes at 28 warps per inch and 14 wefts per inch. Control K weighed 3.5 osy and was woven from 435 denier warp tapes and 1088 denier weft tapes at 28 warps per inch and 13 wefts per inch. Control L weighed 3.4 osy and was woven from 435 denier warp tapes and 1088 denier weft tapes at 28 warps per inch and 13 wefts per inch.

TABLE 5

<table>
<thead>
<tr>
<th>Example or Control</th>
<th>Face Yarn</th>
<th>Tufting</th>
<th>Ave Peak Load (pounds)</th>
<th>Max. Load (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9A (24 x 12)</td>
<td>3-ply, 9400 denier nylon BCF</td>
<td>¾ gauge, alternating high/low pattern as in 9A</td>
<td>5.2</td>
<td>9.7</td>
</tr>
<tr>
<td>9B (24 x 12)</td>
<td>8140 denier nylon BCF</td>
<td>¾ gauge, 9.3 stitches/in. as in 9B</td>
<td>4.4</td>
<td>8.4</td>
</tr>
<tr>
<td>9C (28 x 14)</td>
<td>2-ply, 5000 denier nylon BCF</td>
<td>¾ gauge, 7.5 stitches/in. as in 9B</td>
<td>2.1</td>
<td>6.2</td>
</tr>
<tr>
<td>9D (28 x 14)</td>
<td>7.5 stitches/in.</td>
<td>27 osy face weight</td>
<td>2.1</td>
<td>5.8</td>
</tr>
</tbody>
</table>
We claim:

1. A primary backing fabric with tuftability and tuft hold for carpet face yarn with deniers as high as about 20000 g/900 m comprising fabric woven in a plain, closed weave from warp tapes comprising polypropylene resin and weft yarns, with an average warp count of about 18 to about 32 tapes per inch and a lower average weft count of about 10 to about 22 yarns per inch, wherein the warp tapes have deniers of about 250 to about 800 and the weft yarns comprise tapes comprising polypropylene resin that are thicker than the warp tapes and have deniers of about 1200 to about 1600.

2. The primary backing fabric of claim 1 wherein the weft tapes have thicknesses of about 1.7 to about 2.5 mils.

3. The primary backing fabric of claim 2 wherein the warp tapes have thicknesses of about 1.4 to about 2.0 mils.

4. The primary backing fabric of claim 2 having weft coverage of about 95 to about 220%.

5. The primary backing fabric of claim 1 having an average weft count of about 10 to about 16 weft tapes per inch and improved tuft hold for textured carpets as indicated by at least one of an Average Peak Load of at least about 1.1 pounds and a Maximum Load of at least about 2.2 pounds, for 5000 denier face yarn tufted at ¼ gauge and 7.5 stitches per inch in an alternating high/low pattern.

6. The primary backing fabric of claim 5 having an average warp count of about 24 tapes per inch.

7. The primary backing fabric of claim 5 having an average warp count of about 28 tapes per inch.

8. The primary backing fabric of claim 5 having an average warp count of about 30 to about 32 tapes per inch.

9. The primary backing fabric of claim 1 having an average weft count of about 16 to about 20 weft tapes per inch and improved tuft hold for carpets tufted with face yarn having deniers of about 800 to about 4000 to form a smooth pile surface, as indicated by an Average Peak Load of at least about 0.9 pounds and a Maximum Load of at least about 1.8 pounds, for 3300 denier face yarn tufted at ¼ gauge and 8 stitches per inch.

10. The primary backing fabric of claim 9 having an average warp count of about 24 tapes per inch.

11. The primary backing fabric of claim 9 having an average warp count of about 28 tapes per inch.

12. The primary backing fabric of claim 9 having an average warp count of about 30 to about 32 tapes per inch.

13. The primary backing fabric of claim 1 wherein at least 60% of the weft tapes have deniers of about 1200 to about 1600 and thicknesses of about 1.7 to about 2.5 mils.

14. Tufted carpet comprising a primary carpet backing according to claim 1 having a pile surface comprising a plurality of tufts of face yarn projecting from a side of the backing and a plurality of stitches of the face yarn disposed on an opposite, stitched side of the backing.

15. The tufted carpet of claim 14 wherein the primary backing fabric has an average weft count of about 10 to about 15 tapes per inch and the carpet is tufted with a textured pile surface.

16. Berber carpet comprising the tufted carpet of claim 15.

17. The tufted carpet of claim 14 wherein the primary backing fabric has an average weft count of about 16 to about 22 weft tapes per inch and the face yarn has a denier of about 800 to about 4000.

18. The tufted carpet of claim 18 wherein the face yarn provides a smooth pile surface.


20. The tufted carpet of claim 14 additionally comprising a secondary carpet backing adhered to the stitched side of the primary backing.

* * * * *