

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
16 December 2004 (16.12.2004)

PCT

(10) International Publication Number
WO 2004/109008 A1

(51) International Patent Classification⁷: **D06N 3/14**,
3/12, D06M 15/564, 15/643

TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(21) International Application Number:
PCT/US2004/017277

(22) International Filing Date: 1 June 2004 (01.06.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/475,741 4 June 2003 (04.06.2003) US

(71) Applicant (for all designated States except US): **DOW CORNING CORPORATION** [US/US]; 2200 West Salzburg Road, Midland, MI 48686-0994 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LIN, Shaow** [US/US]; 2008 Candlestick Lane, Midland, MI 48642 (US). **SUZUKI, Toshio** [JP/US]; 1209 Sterling Court, Midland, MI 48640 (US). **TOTH, Simon** [HU/US]; 5007 Goldenwood Drive, Midland, MI 48640 (US).

(74) Common Representative: **DOW CORNING CORPORATION**; ZOMBECK, Alan, Patent Department - Mail CO1232, Dow Corning Corporation, 2200 West Salzburg Road, Midland, MI 48686-0994 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)
- of inventorship (Rule 4.17(iv)) for US only

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SILICONE/POLYURETHANE COATED FABRICS

(57) Abstract: Fabrics are disclosed having a coating comprising a reaction product of a silicone component derived from an aqueous silicone emulsion and a polyurethane component derived from an aqueous silicone dispersion. The fabrics are particularly useful in the preparation of airbags having improved air or gas retention properties.

WO 2004/109008 A1

SILICONE/POLYURETHANE COATED FABRICS

[0001] The present invention provides fabrics having a coating resulting from the reaction product of a silicone component and a polyurethane component. More particularly, the fabrics of the present invention are coated with a coating composition comprising a reaction product of a silicone component derived from an aqueous silicone emulsion and a polyurethane component derived from an aqueous polyurethane dispersion. The coated fabrics of the present invention are particularly useful in the construction of airbags for automotive applications.

[0002] Typically airbag fabrics are coated with a silicone composition to provide airbags with the necessary thermal barrier from high temperature burst associated with hot gas ignition on deployment and some air / gas retention for a very short duration afterward. With the advancement of safer cold air canister and hybrid air / gas sources, a high thermal barrier property of an airbag coating is no longer a requirement. Instead, next generation side airbags and inflatable curtains (i.e. side air bags) need to retain pressurized air / gas to meet the initial burst pressure of the bag and stay inflated long enough to provide rollover protection for greater than 5 seconds. As silicone coating is known to be highly permeable to air and gas, it is no longer an ideal coating material for next generation side airbags and inflatable curtains. There exists a need for a high air / gas retention coating that coats and adheres well to the airbag fabrics.

[0003] One technique that has been reported to decrease coating weights and maintain low permeability performance of coated fabrics for use in airbags has been to use a two layered coating system, as disclosed for example in U.S. 6,177,365. The '365 patent teaches the application of a first layer to the fabric of a non-silicone material followed by the application of a silicone containing topcoat. U.S. 6,177,366 also teaches a two layer coating system for airbag fabrics where the first layer contains up to 30% of a silicone resin and the topcoat contains a silicone material. U.S. 6,239,046 teaches airbags having a first coating layer of adhesive polyurethane and a second coating layer of an elastomeric polysiloxane.

[0004] Alternative coating compositions have been disclosed based on polyurethanes, such as in U.S. 5,110,666, or on polyurethane/polyacrylate dispersions as found in U.S. 6,169,043.

In co-pending U.S. patent applications, serial numbers 10/118870, 10/118746, and 10/321234, we disclose curable coating compositions from emulsions of elastomeric polymers and polyurethane dispersions and methods for coating fabrics, including air bags.

[0005] U.S. 6,077,611 discloses printable paper release compositions from the combination of an aqueous silicone emulsion with an aqueous polyurethane emulsion. However, the '611 patent does not teach the use on its compositions for coating air bag fabrics.

[0006] While the coating systems cited above represents advancements in airbag technology, a need still exists to provide improved compositions and techniques for coating fabrics for use in airbags. In particular, coating compositions that provide similar or improved permeability at lower coating weights and improved aging stability are desired. Such coated fabrics are also expected to have further utility in any application requiring a fabric with reduced gas permeability.

[0007] The present invention provides a coated fabric comprising a fabric having a coating composition on at least a portion of the surface of the fabric, wherein the coating composition comprises a reaction product of;

- A) 5 to 60 weight parts of a silicone component wherein the silicone component is derived from an aqueous silicone emulsion, and
- B) 40 to 95 weight parts of a polyurethane component wherein the polyurethane component is derived from an aqueous polyurethane dispersion.

The present invention further provides a method of coating a fabric comprising;

(I) applying a composition on one surface of the fabric, the composition comprising;

- A) 5 to 60 weight parts of a silicone component wherein the silicone component is derived from an aqueous silicone emulsion, and

- B) 40 to 95 weight parts of a polyurethane component wherein the polyurethane component is derived from an aqueous polyurethane dispersion, and

(II) exposing the layer to air for sufficient time to form a cured coating. The present invention also relates to the fabrics prepared by this method.

[0008] The coated fabrics of the present invention are suitable for the construction of automotive airbag articles with improved air/gas retention properties.

[0009] The silicone component suitable as component A) in the present invention is derived from an aqueous silicone emulsion. Typically, the aqueous silicone emulsion is a water continuous emulsion of an organopolysiloxane. Aqueous silicone emulsions are well known in the art and are commonly produced by dispersing an organopolysiloxane in water with various emulsifying agents. The various emulsifying agents that can be used to create the silicone emulsions include anionic, nonionic, cationic, and zwitterionic surfactants, as well as polyvinyl alcohols. The aqueous silicone emulsion can be either a curable silicone emulsion, or an emulsion of pre-cured silicone.

[0010] In the curable silicone emulsion embodiment, the curable silicone emulsion comprises;

- a) a curable organopolysiloxane,
- b) an optional crosslinking agent,
- c) a cure agent in an amount sufficient to cure the organopolysiloxane.

[0011] The curable organopolysiloxane a) is defined herein as any organopolysiloxane having at least two curable groups present in its molecule. As used herein, a curable group is defined as any hydrocarbon group that is capable of reacting with itself, or alternatively with a crosslinker to crosslink the organopolysiloxane. This crosslinking results in a cured organopolysiloxane. Representative of the types of curable organopolysiloxanes that can be used as components in the silicone emulsions of the present invention are those known in the art to produce silicone rubbers or elastomers upon curing. Typically, these organopolysiloxanes can be cured via a number of crosslinking mechanisms employing a variety of cure groups on the organopolysiloxane, cure agents, and optional crosslinking agent. Two of the more common crosslinking mechanisms used in the art to prepare cured silicone films from silicone emulsions are addition cure and condensation cure. Thus, components (a), (b), and (c) can be selected according to the choice of cure or crosslinking mechanisms for the organopolysiloxane.

[0012] In one embodiment of the present invention, the curable silicone emulsion comprises an organopolysiloxane that is addition curable. In this embodiment, the silicone emulsion comprises a curable organopolysiloxane containing at least two alkenyl groups, an organohydrido silicon compound is used as a crosslinking agent, and a hydrosilylation catalyst is used as the cure agent. Thus, in the addition curable emulsion embodiment, the silicone emulsion comprises;

- (a') a curable organopolysiloxane containing at least two alkenyl groups,

(b') an organohydrido silicon compound,

(c') a hydrosilylation catalyst.

Component (a') is selected from a curable organopolysiloxane which contains at least 2 alkenyl groups having 2 to 20 carbon atoms in its molecule. The alkenyl group on the curable

5 organopolysiloxane is specifically exemplified by vinyl, allyl, butenyl, pentenyl, hexenyl and decenyl, preferably vinyl or hexenyl. The position of the alkenyl functionality is not critical and it may be bonded at the molecular chain terminals, in non-terminal positions on the molecular chain or at both positions. The remaining (i.e., non-alkenyl) silicon-bonded organic groups of the curable organopolysiloxane are independently selected from hydrocarbon or halogenated
10 hydrocarbon groups which contain no aliphatic unsaturation. These may be specifically exemplified by alkyl groups having 1 to 20 carbon atoms, such as methyl, ethyl, propyl, butyl, pentyl and hexyl; cycloalkyl groups, such as cyclohexyl and cycloheptyl; aryl groups having 6 to 12 carbon atoms, such as phenyl, tolyl and xylyl; aralkyl groups having 7 to 20 carbon atoms, such as benzyl and phenylethyl; and halogenated alkyl groups having 1 to 20 carbon atoms, such
15 as 3,3,3-trifluoropropyl and chloromethyl. Typically, the non-alkenyl silicon-bonded organic groups in the curable organopolysiloxane makes up at least 85, or alternatively at least 90 mole percent, of the organic groups in the curable organopolysiloxane.

[0013] Thus, curable organopolysiloxane (a') can be a homopolymer, a copolymer or a terpolymer containing such organic groups. Examples include copolymers comprising
20 dimethylsiloxo units and phenylmethylsiloxo units, copolymers comprising dimethylsiloxo units and 3,3,3-trifluoropropylmethylsiloxo units, copolymers of dimethylsiloxo units and diphenylsiloxo units and interpolymers of dimethylsiloxo units, diphenylsiloxo units and phenylmethylsiloxo units, among others. The molecular structure is also not critical and is exemplified by straight-chain and partially branched straight-chain structures, the linear systems
25 being the most typical.

[0014] In the addition cure embodiment of the present invention, compound (b') is added and is an organohydrido silicon compound (b'), that crosslinks with the curable organopolysiloxane (a'). The organohydrido silicon compound is an organopolysiloxane which contains at least 2 silicon-bonded hydrogen atoms in each molecule which are reacted with the
30 alkenyl functionality of (a') during the curing of the composition. Those skilled in the art will, of course, appreciate that component (b') must have a functionality greater than 2 to cure the

curable organopolysiloxane. The position of the silicon-bonded hydrogen in component (b') is not critical, and it may be bonded at the molecular chain terminals, in non-terminal positions along the molecular chain or at both positions. The silicon-bonded organic groups of component (b') are independently selected from any of the saturated hydrocarbon or halogenated

5 hydrocarbon groups described above in connection with curable organopolysiloxane (a'), including preferred embodiments thereof. The molecular structure of component (b') is also not critical and is exemplified by straight-chain, partially branched straight-chain, branched, cyclic and network structures, linear polymers or copolymers being typical.

[0015] Typical organohydrido silicon compounds are polymers or copolymers comprising
10 $\text{RHSiO}_{2/2}$ units terminated with either $\text{R}_3\text{SiO}_{1/2}$ or $\text{HR}_2\text{SiO}_{1/2}$ units wherein R is independently selected from alkyl groups having 1 to 20 carbon atoms, phenyl or trifluoropropyl, typically methyl. Also, typically the viscosity of component (b') is 0.5 to 1,000 mPa·s at 25°C, alternatively 2 to 500 mPa·s. Component (b') typically has 0.5 to 1.7 weight percent hydrogen bonded to silicon. Alternatively, component (b') is selected from a polymer
15 consisting essentially of methylhydridosiloxane units or a copolymer consisting essentially of dimethylsiloxane units and methylhydridosiloxane units, having 0.5 to 1.7 weight percent hydrogen bonded to silicon and having a viscosity of 2 to 500 mPa·s at 25°C. Such a typical system has terminal groups selected from trimethylsiloxy or dimethylhydridosiloxy groups. Component (b') may also be a combination of two or more of the above described systems.

20 [0016] The organohydrido silicon compound (b') is used at a level sufficient to cure organopolysiloxane (a') in the presence of component (c'), described infra. Typically, its content is adjusted such that the molar ratio of SiH therein to Si-alkenyl in (a') is greater than 1. Typically, this SiH/alkenyl ratio is below 50, alternatively 1 to 20 or alternatively 1 to 12. These SiH-functional materials are well known in the art and many are commercially available.

25 [0017] In the addition cure embodiment of the present invention, component (c') is a hydrosilylation catalyst that accelerates the cure of the organopolysiloxane (a') and organohydrido silicon compound (b'). It is exemplified by platinum catalysts, such as platinum black, platinum supported on silica, platinum supported on carbon, chloroplatinic acid, alcohol solutions of chloroplatinic acid, platinum/olefin complexes,
30 platinum/alkenylsiloxane complexes, platinum/beta-diketone complexes, platinum/phosphine complexes and the like; rhodium catalysts, such as rhodium chloride and rhodium

chloride/di(n-butyl)sulfide complex and the like; and palladium catalysts, such as palladium on carbon, palladium chloride and the like. Component (c') is typically a platinum-based catalyst such as chloroplatinic acid; platinum dichloride; platinum tetrachloride; a platinum complex catalyst produced by reacting chloroplatinic acid and divinyltetramethyldisiloxane which is diluted with dimethylvinylsiloxyl endblocked polydimethylsiloxane, prepared according to U.S. Patent No. 3,419,593 to Willing; and a neutralized complex of platinous chloride and divinyltetramethyldisiloxane, prepared according to U.S. Patent No. 5,175,325 to Brown et al.. Alternatively, catalyst (c') is a neutralized complex of platinous chloride and divinyltetramethyldisiloxane.

[0018] Component (c') is added to the present composition in a catalytic quantity sufficient to promote the reaction between curable organopolysiloxane (a') and component (b') so as to cure the organopolysiloxane. Typically, the hydrosilylation catalyst is added so as to provide 0.1 to 500 parts per million (ppm) of metal atoms based on the total weight of the silicone component, alternatively 0.25 to 50 ppm.

[0019] In another embodiment, components (a), (b), and (c) are selected to provide a condensation cure of the organopolysiloxane. For condensation cure, an organopolysiloxane having at least 2 silicon bonded hydroxy groups (i.e. silanol, considered as the curable groups) would be selected as component (a), a organohydrido silicon compound would be selected as the optional crosslinking agent (b), and a condensation cure catalyst known in the art, such as a tin catalyst, would be selected as component (c). The organopolysiloxane useful as a condensation curable organopolysiloxane is any organopolysiloxane which contains at least 2 hydroxy groups (or silanol groups) in its molecule. Typically, any of the organopolysiloxanes described supra as component (a'), can be used as the organopolysiloxane in the condensation cure embodiment, although the alkenyl group would not be necessary in this embodiment. The organohydrido silicon compound useful as the optional crosslinking agent is the same as described infra for component (b'). The condensation catalyst useful as the curing agent in this embodiment is any compound which will promote the condensation reaction between the SiOH groups of organopolysiloxane (a') and the SiH groups of organohydrido silicon compound (b') so as to cure the former by the formation of -Si-O-Si- bonds.

Examples of suitable catalysts include metal carboxylates, such as dibutyltin diacetate, dibutyltin dilaurate, tin tripropyl acetate, stannous octoate, stannous oxalate, stannous

naphthanate; amines, such as triethyl amine, ethylenetriamine; and quaternary ammonium compounds, such as benzyltrimethylammoniumhydroxide, beta-hydroxyethyltrimethylammonium-2-ethylhexoate and beta-hydroxyethylbenzyltrimethyldimethylammoniumbutoxide (see, e.g., U.S. 3,024,210).

5 [0020] Component (A) can also be a pre-cured silicone emulsion. In this embodiment, the silicone component is cured prior to being emulsified to form the aqueous silicone emulsion. Aqueous emulsions of pre-cured silicones are well known in the art and are expected to be suitable as component (A) in the present invention. Typically, such emulsions are formed by emulsifying organopolysiloxanes, which have been cured by the either addition or
10 condensation techniques, as described supra, and subsequently emulsified using suitable emulsifying agents. Representative, non-limiting examples of pre-cured silicone emulsions useful as component (A) in the present invention are described in U.S. Patents 5,674,937 and 5,994,459.

[0021] Component (A) can also be a pre-cured silicone emulsion that is derived from a
15 process that the curing of silicone composition occurs after the emulsion is formed. In this case, the silicone composition within the emulsion may be a silicone compound containing self-curable functional groups or a mixture of silicone compounds containing hydrosilylation reactive groups.

[0022] Component (B) of the compositions of the present invention is a polyurethane
20 dispersion. "Polyurethane dispersion" as used herein describes mixtures of polyurethane polymers in water. Methods of preparing polyurethane dispersions are well known in the art and many polyurethane dispersions are commercially available. Polyurethane polymers are generally characterized by their monomer content and most commonly involve the reaction of a diisocyanate with a polyol and chain extender. While the present inventors believe the
25 polyurethane dispersion can be an aqueous mixture of any known polyurethane, typically the polyurethanes suitable for the use in the aqueous polyurethane dispersions are the reaction products (a) an isocyanate compound having at least two isocyanate (-NCO) functionalities per molecule; (b) a polyol having at least two hydroxy functionalities per molecule and a molecular weight ranging from 250 to 10,000 g/mol. The polyol may be selected from those
30 commonly found in polyurethane manufacturing such as hydroxy-containing or terminated polyethers, polyesters, polycarbonates, polycaprolactones, polythioethers, polyetheresters, polyolefins, and polydienes. Suitable polyether polyols for the preparation of polyether

polyurethanes and their dispersions include the polymerization products of cyclic oxides such as ethylene oxide, propylene oxide, tetrahydrofuran, or mixtures thereof. Polyether polyols commonly found include polyoxyethylene (PEO) polyols, polyoxypropylene (PPO) polyols, polyoxytetramethylene (PTMO) polyols, and polyols derived from the mixture of cyclic
5 oxides such as poly(oxyethylene-co-polypropylene) polyols. Typical molecular weights of polyether polyols can range from 250 to 10,000 g/mol. Suitable polyester polyols for the preparation of polyester polyurethanes and their aqueous dispersions include; hydroxy-terminated or containing reaction products of ethylene glycol, propylene glycol, diethylene glycol, neopentyl glycol, 1-4, butanediol, furan dimethanol, polyether diols, or mixtures
10 thereof, with dicarboxylic acids or their ester-forming derivatives.

[0023] Modified polyether polyurethanes such as polyetherester polyurethanes and polyethercarbonate polyurethanes may also be suitable polyurethanes for the preparation of aqueous polyurethane dispersions. These modified polyether polyurethanes can be derived by incorporating additional polyester polyols or polycarbonate polyols into polyether polyols
15 during the polyurethane manufacturing.

[0024] Typically the polyurethane polymer useful to prepare the polyurethane dispersion as component (B) in the compositions of the present invention is selected from polyether polyurethanes, polyester polyurethanes, polycarbonate polyurethanes, polyetherester polyurethanes, polyethercarbonate polyurethanes, polycaprolactone polyurethanes,
20 hydrocarbon polyurethanes, aliphatic polyurethanes, aromatic polyurethanes, and combinations thereof.

[0025] "Polyurethane dispersion" as used herein encompasses both conventional emulsions of polyurethane polymers, for example where a preformed polyurethane polymer is emulsified into an aqueous medium with the addition of surfactants and application of shear,
25 and also includes stable mixtures of self-dispersing polyurethane polymers. Polyurethane dispersions of self-dispersing polyurethane polymers are well known in the art and many are commercially available. These polyurethane dispersions are generally free of external surfactants because chemical moieties having surfactant like characteristics have been incorporated into the polyurethane polymer and therefore are "self emulsifying" or "self
30 dispersing". Representative examples of internal emulsifier moieties that can be incorporated into the polyurethane dispersions useful in the present invention include; ionic groups such as sulfonates, carboxylates, and quaternary amines; as well as nonionic emulsifier groups such

as polyethers. Such polyurethane dispersions are well known in the art, and are typically prepared by either a one stage or two-stage process. Typically, an isocyanate-terminated polyurethane prepolymer is made from isocyanates, polyols, optional chain extender, and at least one monomer containing a hydrophilic group to render the pre-polymer water

5 dispersible. The polyurethane dispersion can then be prepared by dispersing the isocyanate-terminated polyurethane pre-polymer in water with other polyisocyanates. Further chain extension can be effected by the addition of chain extenders to the aqueous dispersion.

Depending on the choice of the hydrophilic group used to render the polyurethane polymer water dispersible, an additional reaction step may be needed to convert the hydrophilic group to an ionic species, for example converting a carboxyl group to an ionic salt or an amine to an amine salt or cationic quaternary group.

[0026] Representative, non-limiting examples of polyurethane dispersions that are suitable for use as component (B) in the compositions of the present invention, as well as general descriptions of techniques useful to prepare polyurethane dispersions can be found in U.S.

15 Patent Nos. 4,829,122, 4,921,842, 5,025,064, 5,055,516, 5,308,914, 5,334,690, 5,342,915, 5,717,024, 5,733,967, 6,017,998, 6,077,611, 6,147,155, and 6,239,213.

[0027] Representative, non-limiting examples of commercially available polyurethane dispersions that are suitable for use as component (B) in the compositions of the present invention include: *WITCOBOND* W 290H, W 296, and W 213 (Uniroyal Chemical Division, 20 Crompton Corporation, Middlebury, CT); *DISPERCOLL* U42, *BAYHYDROL* 121, and Bayhydrol 123 polycarbonate polyurethane dispersions (100 Bayer Road, Pittsburgh, PA 15025); *SANCURE* 2710 and 2715 aliphatic polyether polyurethane dispersions (Noveon, Inc. Cleveland, OH); *NEOREZ* R-966, R-967, R-9603 aliphatic polyurethane dispersions (NeoResins Division, Avecia, Wilmington, MA).

25 [0028] Optionally, an adhesion promoter, component (C), can be added to the reaction product of (A) and (B) to form the coating compositions of the present invention. Generally, the adhesion promoter can be selected from organofunctional silanes known in the art to enhance the adhesion of polymeric films to various surfaces. Often, these organofunctional silanes are referred to as silane coupling agents in the art. Typical of the organofunctional silanes that can be added to the curable compositions of this invention are those described in 30 U.S. 6,042,943. Typically, the organofunctional silane is selected from 3-(trimethoxysilyl)propyl acrylate, methacryloxypropyltrimethoxysilane, tetraethoxysilane,

allyltrimethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, octyltriethoxysilane, methyltriethoxysilane, methyltrimethoxysilane, vinylmethyldimethoxysilane, β - (3,4-epoxycyclohexyl)ethyltrimethoxysilane, and γ - glycidylpropyltrimethoxysilane.

Alternatively, the organofunctional silane is γ - glycidylpropyltrimethoxysilane such as
5 Z-6040 (Dow Corning Corporation, Midland, MI).

[0029] The amount of adhesion promoter added to the composition can vary, but generally is 0.05 to 10.0 weight percent of the total coating composition. Alternatively, the adhesion promoter is 0.1 to 5 weight percent of the total coating composition.

[0030] Alternatively, the airbag fabric can be treated with an adhesion promoter, as defined
10 infra, prior to coating with the compositions of the present invention. When used in this manner, a coat weight of less than 10 g/m² is typically sufficient to ensure adhesion of the cured coatings to the airbag fabric.

[0031] Other additives can be optionally incorporated into the coating composition of this invention, as component (D), to derive additional specific features. Such additives include,
15 but not limited to; reinforcing or extending fillers such as colloidal silica, fumed silica; colorants and pigments; stabilizers as thermal, UV, and weathering stabilizers; flame retardants, thickeners, biocides, and preservatives.

[0032] The curable coating compositions can be prepared by mixing components (A), (B), and optionally (C) and (D) by any of the techniques known in the art such as milling,
20 blending, and stirring, either in a batch or continuous process. The viscosity of the components and final curable coating composition typically determines the technique and particular device selected. Representative examples of batch reactors that can be used to prepare the curable coating compositions include batch mixers readily available from the following suppliers; Ross, Myers, Turello, Premier, Hockmeyer, and Spangenberg.

25 [0033] The present invention also provides a method of coating a fabric comprising;
(I) applying a composition on one surface of the fabric, the composition comprising;

A) 5 to 60 weight parts of a silicone component wherein the silicone component is derived from an aqueous silicone emulsion, and

B) 40 to 95 weight parts of a polyurethane component wherein the polyurethane
30 component is derived from an aqueous polyurethane dispersion,

and

(II) exposing the layer to air for sufficient time to form a cured coating.

[0034] The components A) and B) in this method, are the same as described above and techniques for applying these components to fabrics are further described below.

[0035] Step (II) of the method of the present invention is exposing the layer of the composition on the fabric to air for sufficient time to form a cured coating. Step (II) can be accelerated by increasing the temperature at which this step is performed, for example, from about room temperature to about 180°C, alternatively from room temperature to about 150°C, or alternatively from about room temperature to about 130°C, and allowing the coating to cure for a suitable length of time.

[0036] The coating compositions may be applied to fabric substrates according to known techniques. The compositions can be applied a various coat weights, but typical coat weights are 30 – 35 g/m². Coating techniques include, but not limited to, knife coating, roll coating, dip coating, flow coating, squeeze coating, and spray coating. Knife coating includes knife-over-air, knife-over-roll, knife-over-foam, and knife-over-gap table methods. Roll coating includes single-roll, double-roll, multi-roll, reverse roll, gravure roll, transfer-roll coating methods.

[0037] The coating composition can be cured by exposing the composition to air for sufficient time to allow the coating to cure. The cure step can be accelerated by increasing the temperature, for example, from about room temperature to about 180°C, alternatively from room temperature to about 150°C, or alternatively from about room temperature to about 130°C, and allowing the coating to cure for a suitable length of time. For example, the coating composition typically cures in less than about 3 min at 150°C.

[0038] The coating compositions of the present invention have excellent film forming properties and adhere well to a variety of substrates such as fabrics, fibers, yarns, and textiles. Thus, the coatings of the present invention can be applied to a variety of fabrics, fibers, yarns, and textiles.

[0039] The coating composition can be applied on wet or dry air bag fabric. These water based emulsion airbag coatings can be applied directly onto any fabric that is useful to construct an airbag article such as woven fabrics for airbags, pre-sewn airbags roll substrates, or one-piece-woven (OPW) airbag fabrics. Fabrics and airbags prepared from other fibers can also be applied with Si/PU coatings that is disclosed in this invention to arrive at similar reduction in air permeation. Example fibers include, but not limited to, polyesters such as

polyethylene terephthalate (PET), polybutylene terephthalate (PBT), and derivatives containing them, polyamide fibers, polyetheresters, polyester amide copolymers, and polyether amide copolymers.

[0040] The coating compositions of the present invention can also be applied to wet fabrics, immediately following a scouring operation. The compositions provide good adhesion to the fabric surface, and dries to a uniform coating without imperfections.

[0041] The coating composition of the instant invention produces coatings that are useful as fabric coatings, and in particular for decreasing air permeability of the coated fabrics at relatively lower coating weights. Thus, the coating compositions of the present invention provide coated fabrics suitable for the construction of automotive airbag articles with improved air/gas retention properties.

EXAMPLES

[0042] The following examples are presented to further illustrate the compositions and methods of this invention, but are not to be construed as limiting the invention, which is delineated in the appended claims. All parts and percentages in the Examples are on a weight basis and all measurements were obtained at about 23°C, unless indicated to the contrary.

[0043] The particle size and profile of the formed emulsion coating compositions were evaluated using a *MALVERN MASTERSIZER S* (Malvern Instruments, Malvern, UK) equipped with 300RF mm range lens to detect particle size in the range 0.05 to 900 μm . The particle size profile indicates the stability and compatibility of mixture emulsion coatings. The particle size profile of an emulsion coating is reported using these three parameters: $D(v, 0.5)$, $D(v, 0.9)$ and span. $D(v, 0.5)$ is referred as the average particle size and is the size of particle at which 50% of the sample is smaller and 50% is larger than this size. This value is also known as the mass medium diameter. $D(v, 0.9)$ gives a size of particle for which 90% of the sample is below this size. Span is the measurement of the width of the particle size distribution and is the ratio of $[D(v, 0.9) - D(v, 0.1)]$ to $D(v, 0.5)$.

[0044] The effectiveness of the compositions representative of this invention as coatings for airbag applications were evaluated via an air deployment test using T-shaped airbags woven from Nylon 6,6 polyamide multi-filament yarns. The T-shaped airbags (or T-bag in short) were produced from woven fabrics using one-piece woven (OPW) technology with 470 dtex (or 235 g/m^2) woven specification and had a surface area of 0.0454 to 0.04796 m^2 per side. The coatings were applied onto the airbag fabrics using the knife-over-air method on a

Werner Mathis U.S.A. lab-coater (Concord, NC). The coated airbags were flash dried for 1 minute at 100°C, followed by curing for 3 minutes at 130°C. The coated T-bags were then evaluated for air deployment and retention using a lab testing unit. The deployment testing involved mounting the T-bag onto the testing device through the openings of the bags. A
 5 pressurized canister with a predetermined amount of air was then “bombed” (i.e. quickly released) into the T-bag such that the initial peak pressure reached 3.5 bar (350 kPa) inside the T-bag. The air pressure inside the T-bag was constantly monitored and graphed as a function of time. The time required to deflate down to 0.5 bar (50 kPa) of pressure was reported as the T-bag deployment hold-up time.

10 **Examples 1 - 3**

Comparative examples of silicone coated airbag performance

[0045] To illustrate the air retention property of the coatings of the present invention, a series of air bag coating compositions were prepared from representative commercial products presently used in the airbag coating industry. DC 3730 (Dow Corning Corporation,
 15 Midland, MI) liquid silicone rubber (LSR) was selected for this comparison. DC 3730 is supplied as two-part silicones (A and B parts) comprising of vinyl-functional silicone fluids, hydride-functional fluids, platinum catalyst, silica filler and others. The LSR thermally cured to form a cross-linked silicone coating matrix. The resulting mechanical properties are summarized in Table 1.

Table 1

Patent example	1	2	3
Coating type	DC 3730 LSR	DC 3730 LSR	DC 3730 LSR
Coat wt., g/m ²	35	70	130
T-bag deployment hold-up, initial (seconds)	0.65	4.23	24.5
T-bag deployment hold-up, after aged 400 hrs @ 107°C (seconds)	< 0.2	2.66	6.56

[0046] As shown in these examples, to achieve a T-bag deployment hold-up time of 5
 25 seconds or higher, a coat weight of over 100 g/m² over Nylon 6,6 airbag was required. Additionally, the LSR coated airbags have relatively poor thermal aging stability, as illustrated in Examples 1 to 3.

Examples 4 – 6*Reference examples; Preparation of curable LSR silicone emulsions*

[0047] Curable silicone emulsions were prepared for use as representative examples of the

silicone emulsions that can be used in the preparation of the coating compositions of the

present invention. The formulations for these silicone emulsions are shown in Table 2. The

silicone components used in these emulsions comprised: a) three different vinyl functional

organopolysiloxanes, designated as Vi Siloxane 1, 2, and 3; and b) a poly(dimethyl-co-

methylhydrogen)siloxane containing 0.76 % hydrogen and having a viscosity of 5 cSt

($0.05 \text{ cm}^2/\text{s}$), as the organohydro silicon compound. Vi Siloxane 1 was a dimethylvinyl

siloxyl terminated dimethylpolysiloxane having a viscosity of 55,000 cP (55,000 mPa·s),

designed as $M^{\text{Vi}}D_XM^{\text{Vi}}$ in Table 2. Vi Siloxane 2 was a dimethylvinyl siloxyl terminated,

dimethyl polysiloxane having a viscosity of 450 cP (450 mPa·s), designed as $M^{\text{Vi}}D_XM^{\text{Vi}}$ in

Table 2. Vi Siloxane 3 was a dimethylvinyl siloxyl terminated, dimethyl, methylvinyl

polysiloxane having a viscosity of 350 cP (350 mPa·s), designed as

$M^{\text{Vi}}D_XD^{\text{Vi}}_yM^{\text{Vi}}$ in Table 2. These silicone mixtures were emulsified using either selected

partially hydrolyzed polyvinylacetate or polyvinyl alcohol (PVA solution prepared from

Mowinol 30-92 of Clariant: a 92% hydrolyzed PVA with a viscosity of 30 cSt for a 4 wt.%

aqueous solution), or polyoxyethylene lauryl ether (Brij 30, Brij 35L). These emulsions were

prepared in a high shear Hauschild mixer by gradually incorporating deionized water to form

an emulsion of curable silicones. The particle size profile of these emulsions varied,

depending on the type of surfactants used, as summarized in Table 2.

Table 2

Patent examples		4	5	6
Vi Siloxane 1	$M^{Vi}D_xM^{Vi}$	17.18	17.18	17.18
Vi Siloxane 2	$M^{Vi}D_xM^{Vi}$	3.23	3.23	3.23
Vi Siloxane 3	$M^{Vi}D_xD^{Vi}_yM^{Vi}$	2.62	2.62	2.62
SiH Siloxane	MD^H_xDyM	1.69	1.69	1.69
Surfynol 61	Inhibitor	0.26	0.26	0.26
PVA Sol 80 TAD	20% Mowinol 30-92 (Clariant)			2.4
4-98 PVA solution (20%)	10% Mowinol 4-98			
5-88 PVA solution (10%)	10% Mowinol 5-88			
Brij 35L	polyoxyethylene (23) lauryl ether	2	1.2	
Brij 30	polyoxyethylene (4) lauryl ether		0.5	
D.I. Water		10	6	9.7
Total parts		36.98	32.68	37.08
Wt.% solids		71.3	80.5	68.7
pH reading		4.1	4.5	5.4
Emulsion appearance		white creamy	white creamy	white creamy
Particle size * D(v, 0.5)		0.613	1.695	5.672
D(v, 0.9),		1.01	3.69	14.69
span		1.12	1.74	2.55

* Particle size reported in micrometers

Examples 7 – 9

- 5 *Coatings prepared from addition curable liquid silicone rubber emulsions*
- [0048] Waterborne coatings were prepared from the addition curable liquid silicone rubber (LSR) emulsions of reference examples 4 and 5 and several commercially available polyurethane dispersions, as summarized in Table 3. The polyurethane dispersions used were Sancure 2715 polyurethane dispersion (from Noveon Inc., Cleveland, OH), and Dispercoll
- 10 U42 polyurethane dispersion (Bayer, Pittsburgh, PA). Witcobond XW epoxy emulsion was also added as an adhesion promoter. Nalco 1050 colloidal silica was added as optional reinforcing filler. Syl-Off 7927 platinum emulsion catalyst was incorporated to cure the silicone polymers within the silicone emulsion upon heating and drying. Polacryl BR-300 was added as a thickener to control the viscosity of the coating and to improve the coating
- 15 application and quality.
- [0049] The Si/PU coatings were prepared by incorporating silicone emulsion components gradually into PU dispersion, followed by mechanical stirring to yield a homogeneous mixture is yield. This is done to ensure minimal pH shock to the PU dispersion(s), as many of the silicone emulsions are acidic in nature. In some case, the pH of the mixture is monitored
- 20 to ensure the pH of the Si/PU mixture stayed above 6.0. Optional curing agent, adhesion

promoter, and additives were added subsequently. If necessary, a buffer solution could be used to keep the final Si/PU emulsion mixture at a pH 6.0 or higher. The particle size profile is taken on the final Si/PU coating mixture. An average particle size, $D(v, 0.5)$, of sub-micron is a good indication of successful preparation of Si/PU coating mixtures.

- 5 **[0050]** The resulting Si / PU coatings were all homogeneous, and stable emulsions. To illustrate the excellent film-forming property and the mechanical property, cured films were made by casting onto a Teflon mode and dried. The resulted films were uniform with milky appearance and have characteristic strength of a tough elastomers; i.e. high tensile strength.

10

Table 3

Patent examples	7	8	9
<i>Si emulsion type</i>	Add. Cure	Add. Cure	Add. Cure
<i>Si/PU ratio</i>	40/60	40/60	40/60
Colloidal silica, wt. %			
Crosslinker, wt. % (total)			
Crosslinker, wt. % (PU)			
Sancure 2715 PUD	40	26.3	40
Dispercoll U42 PUD		10	
Witcobond XW	1	1	1
Nalco 1050	4.5	4.5	4.5
Silicone emulsion of example 4	16	16	
Silicone emulsion of example 5			16
Syl-Off 7927 Pt catalyst	1.8	1.8	1.8
Polacryl BR-300	0.4	0.4	0.4
Total parts	63.7	60	63.7
Malvern, particle size*			
D(v, 0.5)			
D(v, 0.9)	38.8	38.8	38.8
Span	8.829	8.829	8.829
Wt. % solids	44.6	44.6	44.6
T-bag deployment; hold-up time in seconds			
Coat wt. on T-bag			
Cured coatings tensile, psi (MPa)	1937 (13.3)	1532 (10.5)	2391 (16.5)
% Elongation	200	212	236
Modulus at 100%, psi (MPa)	1287 (8.9)	903 (6.2)	1385 (9.5)

* particle size reported in micrometers

Examples 10–12*Coatings based on addition-curable silicone emulsions*

[0051] Coating compositions were also prepared from commercially available addition-curable silicone emulsions, as summarized in Table 4. Examples 10–12 illustrate the

- 5 deployment hold-up times for airbags coated with these coatings. The waterborne Si / PU coatings were applied, using conventional knife-over-air technique, onto a one-piece-woven (OPW) Nylon6,6 airbag fabrics. The coated airbags were dried and cured at 130°C for 2 minutes to give a cured coating weight of about 30 g/m². The coated airbags were tested for their air hold-up property using a custom-built deployment test device. The coated T-shaped
- 10 airbags were mounted to a compressed air canistor with a prescribed amount of air. The compressed air was released into the coated airbag on depolyment to reach a burst pressure of about 3.5 bar (i.e. 350 kPa). The air hold-up time of the coated airbag is the time it elapsed when the air pressure inside the airbag reached 0.5 bar (i.e. 50 kPa). For uncoated airbag, the compressed air leaked through the airbag too fast to report a time. For a typical 3730 LSR
- 15 coated airbag at about 35 g/m², the time was less than 1 second.

[0052] The Si/PU aqueous coatings exhibited excellent film integrity and air-retention property, even at a low coat weight of about 30 g/m², as summarized in Table 4.

Table 4

Patent examples	10	11	12
Si/PU ratio	40/60	40/60	30/70
Si emulsion type	Add. Cure	Add. Cure	Add. Cure
Sancure 2715 PUD	40	26.3	30.7
Dispercoll U42 PUD		10	
Syl-Off 7910	25	25	12.5
Syl-Off 7927	0.87	0.87	0.43
BR-300 thickener	0.8	0.8	0.8
Total parts	66.67	62.97	44.43
Wt. % solids	38.8	40.9	38.5
pH @ 25 °C	8.829	8.667	
Particle size*, D(v, 0.5)	0.466	0.318	0.463
D(v, 0.9)	1.27	0.86	1.43
Span	2.44	2.38	2.82
T-bag deployment; hold-up time in seconds	8.3	16.35	22.35
Coat wt. on T-bag, g/m²	29.8	29.8	31.4
Cured coating, tensile, psi (MPa)	2544 (17.5)	2161 (14.9)	2875 (19.8)
% Elongation	394	359	382
Modulus at 100%, psi (MPa)	1022 (7.0)	675 (4.6)	1040 (7.2)

* particle size reported in micrometers

5

Examples 13-14

Coatings derived from pre-cured silicone elastomer emulsion

- 10 [0053] Waterborne Si-PU coatings useful as fabric and airbag coatings were also prepared from emulsion latex of a pre-cured silicone elastomer. The silicone component used in the following example coatings was Dow Corning® 3-2345 silicone latex. The 3-2345 silicone latex is a 85 wt.% solids water-continuous emulsion of a silicone elastomer. The silicone elastomer in the oil phase is a reaction product of vinyl-functional silicone fluids and hydride-
- 15 functional silicone fluids which are cured via a platinum catalyzed addition reaction. The polyurethane component was SANCURE 2715 polyurethane dispersion (Noveon Inc.) and

DISPERCOLL U42 polyurethane dispersion (Bayer Corp.). The formulations and resulting physical properties are summarized in Table 5.

[0054] The Si-PU coatings based on these compositions displayed excellent air retention property at low coating weights, as summarized in Table 5.

5

Table 5

Patent examples	13	14
Si/PU ratio	30/70	40/60
Si emulsion type	Pre-cured	Pre-cured
Sancure 2715 PUD	30.7	26.3
Dispercoll U42 PUD		10
3-2345 silicone latex	11.2	11.2
BR-300 thickener	0.8	0.8
Total parts	42.7	48.3
Viscosity, cps		
Wt. % solids	49.4	53
pH @ 25 °C		9.63
Malvern particle size*, D(v, 0.5)	1.167	0.322
D(v, 0.9)	2.53	1.25
Span	1.74	3.56
T-bag deployment; hold-up time in seconds	8.5	13.2
Coat wt. on T-bag, g/m²	28.6	28.98
Cured coating, tensile, psi (MPa)	1800 (12.4)	-
% Elongation	395	-
Modulus at 100%, psi (MPa)	687 (4.7)	-

Examples 15 – 19

Curable Si / PU Coatings derived from selected polyurethane dispersions

- 10 [0055] The fabrics and airbags coated with Si / PU coatings in this invention also have very desirable surface property: low coefficient of friction, smooth silky feel of a silicone, and tack-free surface. Illustrated in the following examples are the selected Si / PU coatings prepared from addition curable silicone emulsion (Syl-Off 7910 emulsion silicone fluids and Syl-Off 7927 emulsion platinum catalyst). The polyurethane silicone components are selected
- 15 from Sancure 2715 (anionic polyurethane dispersion at 38 wt.% solids, from Noveon Inc.), UCX-021-005 (anionic polyurethane dispersion at 50.9% solids, from Uniroyal Chemical,

Crompton Corp.), and Dispercoll U42 (anionic polyurethane dispersion at 51% solids, Bayer Corp.).

[0056] To illustrate the desirable surface property of the Si / PU coatings, two separate sets of comparative examples were also included: a pure silicone coating (Example 17), and a polyurethane coating (Examples 18 and 19). These coatings were applied onto Nylon 6.6 woven fabric and cured to give coated fabrics. The coefficient of friction of the coated fabrics was measured. Table 6 summarizes the results for the Si / PU coated fabrics having a low coefficient of friction, smooth silky feel, and tack-free surface.

Table 6

Patent example	15	16	17	18	19
Si/PU ratio	40/60	40/60	100/0	0/100	0/100
Si cure chem.	7910	7910	7910	7910	7910
Crosslinker, wt.% (total)		0		0	
Sancure 2715 PUD	26.3				26.3
UCX-02-005 PUD		20		20	
Dispercoll U42 PUD	10	10		10	10
Syl-Off 7910	25	25	25		
Syl-Off 7927	0.87	0.87	0.87		
BR-300 thickener	0.5	0.5	0.5	0.5	0.5
Total parts	62.67	56.37	26.37	30.5	36.8
Viscosity, cps					
Wt. % solids	40.5	45.1	40	45.1	40.5
Particle size * D(v, 0.5)	0.299				
D(v, 0.9)	0.96				
Span	2.87				
T-bag deployment; hold-up time in seconds					
Coat wt. on T-bag					
Coat wt. on Flat fabric, g/m ²	26	26	23	26	30
CoF, static	0.188	0.236	0.166	0.428	0.352
CoF, kinetic	0.109	0.186	0.129	0.398	0.235
Cured film, tensile, psi (MPa)	1861(12.8)	2205(15.1)			
% Elongation	409	350			
Modulus at 100%, psi (MPa)	529 (3.6)	529 (3.6)			

Examples 20 – 24*Si / PU coating compositions with selected adhesion promoter / additives*

[0057] Various Si-PU coatings were prepared from Sancure 13057 polyurethane dispersion, commercially obtained from Noveon, Inc. (Cleveland, OH), NeoRez 967 polyurethane dispersion (NeoResins, a division of AVECIA, Wilmington, MA), 17545-129A curable silicone rubber emulsion (example 4 of this write-up), and Syl-Off 7927 platinum emulsion catalyst.

[0058] To this series of Si-PU coatings, the following adhesion promoters were respectively incorporated: Witcobond XW epoxy emulsion (from Uniroyal Chemical, Crompton Corp.), Z-6040 glycidoxypropyltrimethoxysilane (from Dow Corning Corp.), and Coat-O-Sil 1770 silane (Witco Corp., Crompton Corp.). These adhesion promoters were added at 2.2 wt. % of the total amount of the coating solids. Witcobond XW is an aqueous emulsion can be directly added to the coating; Z-6040 and CoatOsil 1770 silanes are added into the coating and become water dispersible after a short period of mixing and partial hydrolysis to form a water-soluble / compatible product. As shown in Table 7, coating quality was maintained, and the tensile strength and % elongation of the cured coatings were only moderately affected.

Table 7

Patent examples	20	21	22	23	24
Si/PU ratio	40/60	40/60	40/60	40/60	40/60
Adhesion promoter, wt. %	0	2.2	2.2	2.2	2.2
Sancure 13057 PUD	28.6	28.6	28.6	28.6	28.6
NeoRez 967 PUD	12.75	12.75	12.75	12.75	12.75
Silicone emulsion of example 4	16.7	16.7	16.7	16.7	16.7
Syl-Off 7927	0.87	0.87	0.87	0.87	0.87
BR-300 thickener	0.8	0.8	0.8	0.8	0.8
Witcobond XW		1			0.5
DC Z-6040 silane			0.55		
CoatOsil 1770 silane				0.55	0.3
Total parts	59.72	60.72	60.27	60.27	60.52
Wt. % solids	43	43.2	43.5	43.5	43.4
Coating quality	Good	Good	Good	Good	Good
Cured film, tensile, psi (MPa)	1949 (13.4)	2293 (15.8)	1686 (11.6)	2083 (14.3)	2377 (16.4)
% Elongation	428	395	269	362	412
Modulus at 100%, psi (MPa)	479 (3.3)	529 (3.6)	639 (4.4)	547 (3.7)	554 (3.8)

CLAIMS

1. A coated fabric comprising a fabric having a coating composition on at least a portion of the surface of the fabric, wherein the coating composition comprises a reaction product of;

5 A) 5 to 60 weight parts of a silicone component wherein the silicone component is derived from an aqueous silicone emulsion, and

 B) 40 to 95 weight parts of a polyurethane component wherein the polyurethane component is derived from an aqueous polyurethane dispersion.

10 2. The coated fabric of claim 1 wherein the aqueous silicone emulsion is a curable silicone emulsion.

3. The coated fabric of claim 2 wherein the curable silicone emulsion comprises;

15 a) a curable organopolysiloxane,
 b) an optional crosslinking agent,
 c) a cure agent in an amount sufficient to cure said organopolysiloxane.

20 4. The coated fabric of claim 3 wherein the curable silicone emulsion is an addition curable silicone emulsion comprising;

 (a') a curable organopolysiloxane containing at least two alkenyl groups,
 (b') an organohydrido silicon compound,
 (c') a hydrosilylation catalyst.

25 5. The coated fabric of claim 2 wherein the aqueous silicone emulsion comprises an condensation curable organopolysiloxane.

6. The coated fabric of claim 1 wherein the aqueous silicone emulsion is a pre-cured silicone emulsion.

7. The coated fabric of claim 1 wherein the polyurethane dispersion comprises a polyurethane selected from polyether polyurethanes, polyester polyurethanes, polycarbonate polyurethanes, polyetherester polyurethanes, polyethercarbonate polyurethanes, polycaprolactone polyurethanes, hydrocarbon polyurethanes, aliphatic polyurethanes, aromatic polyurethanes, and combinations thereof.
8. The coated fabric of claim 1 further comprising;
(C) an adhesion promoter
9. The coated fabric of claim 8 wherein the adhesion promoter is an organofunctional silane.
10. The coated fabric of claim 9 wherein the organofunctional silane is selected from 3-(trimethoxysilyl)propyl acrylate, methacryloxypropyltrimethoxysilane, tetraethoxysilane, allyltrimethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, octyltriethoxysilane, methyltriethoxysilane, methyltrimethoxysilane, vinylmethyldimethoxysilane, β - (3,4-epoxycyclohexyl)ethyltrimethoxysilane, and γ - glycidylpropyltrimethoxysilane.
11. The coated fabric of claim 1 further comprising;
(D) an additive selected from reinforcing fillers, extending fillers, colloidal silica, fumed silica, colorants, pigments, thermal stabilizers, UV stabilizers, weathering stabilizers, flame retardants, thickeners, biocides, and preservatives.
12. The coated fabric of claim 1 wherein the fabric is an airbag fabric.
13. The coated fabric of claim 1 wherein the fabric is a woven polyamide fabric.
14. An article of manufacture comprising the coated fabric of claim 1.

15. A method of coating a fabric comprising;

(I) applying a composition on one surface of the fabric, the composition comprising;

A) 5 to 60 weight parts of a silicone component wherein the silicone component is

5 derived from an aqueous silicone emulsion, and

B) 40 to 95 weight parts of a polyurethane component wherein the polyurethane

component is derived from an aqueous polyurethane dispersion,

and

(II) exposing the layer to air for sufficient time to form a cured coating.

10

16. A coated fabric prepared by the method of claim 15.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/017277

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D06N3/14 D06N3/12 D06M15/564 D06M15/643

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D06N D06M

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 198812 Derwent Publications Ltd., London, GB; Class A26, AN 1988-082040 XP002300131 & JP 63 035888 A (SANYO CHEM IND LTD) 16 February 1988 (1988-02-16) abstract	1-11,14
X	WO 00/78895 A (MILLIKEN & CO) 28 December 2000 (2000-12-28) cited in the application page 8, paragraph 2; claims 1-13,21,24; example 1 page 9, line 4 - line 6 page 9, line 14 - line 16 page 10, last paragraph ----- -/--	1,7-16

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

12 October 2004

Date of mailing of the international search report

27/10/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5618 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Pamies Ollé, S

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/017277

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/095123 A (CIBA SC HOLDING AG) 28 November 2002 (2002-11-28) page 4, paragraph 6; claims 1,3,8,10,15-17; examples page 7, paragraph 5 - page 8, line 11; examples -----	1,7-11, 13-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PC/US2004/017277

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 63035888	A	16-02-1988	NONE	
WO 0078895	A	28-12-2000	US 6177365 B1	23-01-2001
			US 6177366 B1	23-01-2001
			AU 5493200 A	09-01-2001
			AU 5617300 A	09-01-2001
			AU 5617400 A	09-01-2001
			BR 0006932 A	26-06-2001
			BR 0006933 A	26-06-2001
			BR 0006934 A	26-06-2001
			CA 2340903 A1	28-12-2000
			CA 2340939 A1	28-12-2000
			CA 2340940 A1	28-12-2000
			CN 1320089 T	31-10-2001
			CN 1320149 T	31-10-2001
			CN 1320090 T	31-10-2001
			EP 1121276 A1	08-08-2001
			EP 1115811 A1	18-07-2001
			EP 1119471 A1	01-08-2001
			JP 2003502522 T	21-01-2003
			JP 2003513841 T	15-04-2003
			JP 2003526557 T	09-09-2003
			WO 0078577 A1	28-12-2000
			WO 0078895 A1	28-12-2000
			WO 0078578 A1	28-12-2000
			US 2003040238 A1	27-02-2003
			US 6701971 B1	09-03-2004
			US 6698458 B1	02-03-2004
			US 2001005660 A1	28-06-2001
			US 2001009829 A1	26-07-2001
WO 02095123	A	28-11-2002	BR 0201913 A	22-04-2003
			WO 02095123 A1	28-11-2002
			EP 1390579 A1	25-02-2004
			US 2003072952 A1	17-04-2003