A hydrophilized fiber, comprising a fiber having a hydrophobic surface and a phosphinate compound according to formula (I):

\[
\begin{align*}
\text{A} & \quad \text{OH} \\
\text{O} & \quad \text{OH} \\
\text{O} & \quad \text{OH} \\
\text{O} & \quad \text{OH}
\end{align*}
\]

wherein A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):

\[
\begin{align*}
\text{R}^1 & \quad \text{R}^2 \\
\text{N} & \quad \text{R}^3 \\
\text{R}^4 & \quad \text{N} \\
\text{R}^5 & \quad \text{R}^6
\end{align*}
\]

\[A'\]

A' is an organic group according to formula (III):

\[
\begin{align*}
\text{R}^7 & \quad \text{R}^8 \\
\text{N} & \quad \text{C} \\
\text{R}^9 & \quad \text{R}^{10} \\
\text{R}^{11} & \quad \text{R}^{12}
\end{align*}
\]

B, R⁴, and R^{10} are each independently methylene or poly-(methylene), which may optionally be substituted on one or more of such methylene units, and which may optionally be interrupted at one or more positions by an oxygen atom, R¹, R², R³, R⁵, R⁶, R⁷, R⁸, R⁹, R^{10}, R^{11}, R^{12}, and R^{13} are each independently H, alkyl, alkoxy, cycloalkyl, alkynyl, aryl, aralkyl, alkaryl or heteroarylcly, m, n, and n' are each independently 0 or an integer of from 1 to about 100, provided that m cannot be 0 if n' is 0, q and s are each independently 0 or an integer of from 1 to about 50, and p, r, and r' are each independently an integer of from 1 to about 20, or a salt thereof, disposed on at least a portion of such hydrophobic surface in an amount effective to increase the hydrophilicity of such portion of such hydrophobic surface is useful as a component of a hydrophilized fabric and a disposable absorbent article.
HYDROPHILIZED FIBER SUBSTRATE AND METHOD FOR HYDROPHILIZING A HYDROPHOBIC SURFACE OF A FIBER SUBSTRATE

FIELD OF THE INVENTION

[0001] This invention relates to a hydrophilized fiber substrate and a method for hydrophilizing a hydrophobic surface of a fiber substrate.

BACKGROUND OF THE INVENTION

[0002] Materials that have a low surface energy, such as, for example, polyolefin polymers, have hydrophobic surfaces. The hydrophobic properties of such materials are not desirable in some applications and methods for hydrophilizing low surface energy substrates, including treatment with surfactants and/or high energy treatment, are known. Each of these methods has significant limitations. Surfentant treatments tend to wash off when a treated substrate is exposed to water and the charges imparted to the surface of a treated substrate by high energy treatment tend, particularly in the case of a thermoplastic polymer substrate, to dissipate. The hydrophilic properties of such surfactant treated substrates and high energy treated substrates thus tend to exhibit limited durability. Furthermore, the surfactants that are rinsed off of a treated substrate by exposure to water alter the properties of the water, such as lowering the surface tension, which may also be undesirable.

[0003] Hydrophilized polyolefin fabrics are used in some products, including disposable absorbent articles, such as diapers, adult incontinence products, wipes, and feminine hygiene products, wherein a hydrophilic surface is desirable, but the durability of the hydrophilic properties of such surface is limited, due to the limitations of available hydrophilization techniques.

[0004] Accordingly, there is a need for more durably hydrophilizing low surface energy substrates.

SUMMARY OF THE INVENTION

[0005] In a first aspect, the present invention is directed to a hydrophilized fiber, comprising a fiber having a hydrophobic surface and a phosphinate compound according to formula (I):

\[ A \equiv C \equiv N \equiv R^1 \equiv R^2 \equiv R^3 \equiv R^4 \equiv R^5 \equiv R^6. \]

wherein:

[0006] A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):

\[ R^1 \equiv R^2 \equiv R^3 \equiv R^4 \equiv R^5 \equiv R^6 \equiv R^7 \equiv R^8 \equiv R^9 \equiv R^{10} \equiv R^{11} \equiv R^{12} \equiv R^{13}. \]

[0007] A' is an organic group according to formula (III):

\[ \equiv C \equiv N \equiv R^{10} \equiv N \equiv R^{10} \equiv C \equiv R^{10}. \]

[0008] B, R^4, and R^{10} are each independently methylene or poly(methylene), which may optionally be substituted on one or more of such methylene units, and which may optionally be interrupted at one or more positions by an oxygen atom.

[0009] R^1, R^2, R^3, R^5, R^6, R^7, R^8, R^9, R^{11}, R^{12}, and R^{13} are each independently H, alkyl, alkoxy, cycloalkyl, alkene, aryloalkyl, alkaryl, or heterocyclic.

[0010] m, n, and n' are each independently 0 or an integer of from 1 to about 100, provided that m cannot be 0 if n' is 0,

[0011] q and s are each independently 0 or an integer of from 1 to about 50, and

[0012] p, r, and r' are each independently an integer of from 1 to about 20, or a salt thereof, disposed on at least a portion of such hydrophobic surface in an amount effective to increase the hydrophilicity of such portion of such hydrophobic surface.

[0013] In a second aspect, the present invention is directed to a hydrophilized fabric comprising one or more hydrophilized fibers according the present invention, as described above.

[0014] In a third aspect, the present invention is directed to an absorbent article, comprising a hydrophilized fabric according to the present invention, as described above.

[0015] In a fourth aspect, the present invention is directed to a method for hydrophilizing a fiber having a hydrophobic surface, comprising treating such at least a portion of such hydrophobic surface with a phosphinate compound according to formula (I) or a salt thereof, as described above, to deposit a quantity of such compound on such portion of such hydrophobic surface.

DETAILED DESCRIPTION OF INVENTION

[0016] As used herein, “hydrophobic surface” means a surface that exhibits a tendency to repel water and to thus resist being wetted by water, as evidenced by a contact angle with water of greater than or equal to 70°, more typically greater than or equal to 90°. “Hydrophilic surface” means a surface that exhibits an affinity for water and to thus be wettable by water, as evidenced by a contact angle with
water of less than 70°, more typically less than 60°, and “hydrophilizing” a hydrophobic surface means rendering the surface more hydrophilic and thus less hydrophobic, as indicated by a decreased contact angle with water, wherein in each case, the contact angle with water is measured by a conventional image analysis method, that is, by disposing a droplet of water on the surface, typically a substantially flat surface, at 25° C., photographing the droplet, and measuring the contact angle shown in the photographic image.

[0017] As used herein, the term “alkyl” means a monovalent saturated straight chain or branched hydrocarbon radical, typically a monovalent saturated (C₃-C₂₀) hydrocarbon radical, such as for example, methyl, ethyl, n-propyl, iso-propyl, n-butyl, sec-butyl, t-butyl, pentyl, or n-hexyl, which may optionally be substituted on one or more of the carbon atoms of the radical. In one embodiment, an alkyl radical is substituted on one or more carbon atoms of the radical with hydroxy, alkoxy, amino, halo, carboxy, or phosphono, such as, for example, hydroxymethyl hydroxyethyl, methoxymethyl, ethoxymethyl, isopropoxymethyl, aminomethyl, chloromethyl or trichloromethyl, carboxyethyl, or phosphonometethyl.

[0018] As used herein, the term “alkoxy” means an oxy radical that is substituted with an alkyl group, such as for example, methoxy, ethoxyl, propoxy, isopropoxy, or butoxy, which may optionally be further substituted on one or more of the carbon atoms of the radical.

[0019] As used herein, the term “cycloalkyl” means a saturated cyclic hydrocarbon radical, typically a (C₃-C₁₉) saturated cyclic hydrocarbon radical, such as, for example, cyclohexyl or cyclooctyl, which may optionally be substituted on one or more of the carbon atoms of the radical.

[0020] As used herein, the term “alkenyl” means an unsaturated straight chain, branched chain, or cyclic hydrocarbon radical that contains one or more carbon-carbon double bonds, such as, for example, ethenyl, 1-propenyl, or 2-propenyl, which may optionally be substituted on one or more of the carbon atoms of the radical.

[0021] As used herein, the term “aryl” means a monovalent unsaturated hydrocarbon radical containing one or more six-membered carbon rings in which the unsaturation may be represented by three conjugated double bonds, such as for example, phenyl, naphthyl, anthyl, phenanthryl, or biphenyl, which may optionally be substituted one or more of carbons of the ring. In one embodiment, an aryl radical is substituted on one or more carbon atoms of the radical with hydroxy, alkenyl, halo, halooalkyl, or amino, such as, for example, methylphenyl, dimethylphenyl, hydroxyphenyl, chlorophenyl, trichloromethylphenyl, or aminophenyl.

[0022] As used herein, the term “aralkyl” means an alkyl group substituted with one or more aryl groups, such as, for example, phenylmethyl, phenylethyl, or triphenylethyl, which may optionally be further substituted on one or more of the carbon atoms of the radical.

[0023] As used herein, the term “alkyl” means an aryl group substituted with one or more alkyl groups, such as, for example, methylphenyl, dimethylphenyl, or trimethylphenyl, which may optionally be further substituted on one or more of the carbon atoms of the radical.

[0024] As used herein, the term “heterocyclyl” means a saturated or unsaturated organic radical that comprises a ring or condensed ring system, typically comprising from 4 to 16 ring atoms per ring or ring system, wherein such ring atoms comprise carbon atoms and at least one heteroatom, such as for example, O, N, S, or P per ring or ring system, which may optionally be substituted on one or more of the ring atoms, such as, for example, thiophenyl, benzothiophenyl, thiophenyl, pyranyl, benzofuranyl, xanthyl, pyridyl, pyrrolidinyl, pyrrolidinyl, pyrimadinyl, indolyl, quinolinyl, carbazolyl, phenanthrolinyl, thiazolyl, oxazolyl, phenoxyazolyl, or phosphabenzyl.

[0025] As used herein, the indication that a radical may be “optionally substituted” or “optionally further substituted” means, in general, that is unless further limited, either explicitly or by the context of such reference, that such radical may be substituted with one or more inorganic or organic substituent groups, such as, for example, alkyl, alkenyl, aryl, aralkyl, alkyl, a hetero atom, or heterocyclic, or with one or more functional groups that are capable of coordinating to metal ions, such as hydroxyl, carboxyl, carboxyl, amino, imino, amido, phosphonic acid, sulphonyl acid, or arsenate, or inorganic and organic esters thereof, such as, for example, sulphate or phosphate, or salts thereof.

[0026] As used herein, the terminology “(C₃-C₉)” in reference to an organic group, wherein x and y are each integers, indicates that the group may contain from x carbon atoms to y carbon atoms per group.

[0027] In one embodiment, the phosphinate compound of formula (I) is in the form of a salt that comprises an anion derived (for example, by deprotonation of a hydroxy or a hydroxalkyl substituent) from a compound according to formula (I) and one or more positively charged counterions derived from non-toxic base. Suitable positively charged counterions may be monovalent or polyvalent and include inorganic cations and organic cations, such as for example, alkali metal cations, such as sodium, potassium, or lithium cations, ammonium and organic substituted ammonium cations, including quaternary ammonium cations, such as triethylammonium or triethanolammonium cations, phosphonium cations, such as tetrakis-hydroxymethylphosphonium cations, and alkaline earth cations, such as calcium or magnesium cations.

[0028] As used herein, the term “fiber” means a generally elongated article having a characteristic longitudinal dimension, typically a “length”, and a characteristic transverse dimension, typically a “diameter” or a “width”, wherein the ratio of the characteristic longitudinal dimension to the characteristic transverse dimension is greater than or equal to about 50, more typically greater than or equal to about 100.

[0029] Suitable fibers are those that have a hydrophobic surface and are typically hydrophobic synthetic polymer fibers, such as polyacrylonitrile fibers, poly(ethylene terephthalate) fibers, and poly(olefin) fibers, such as, for example, poly(ethylene) fibers or poly(propylene) fibers.

[0030] In one embodiment, the hydrophilized fabric of the present invention is a woven fabric comprising fibers having hydrophilic surfaces.

[0031] In one embodiment, the hydrophilized fabric of the present invention is a non-woven fabric comprising fibers having hydrophilic surfaces.
In one embodiment, the fabric is a nonwoven fabric in a web format comprising fibers having hydrophobic surfaces. Nonwoven materials are well known, see, for example, Butler I., et al., *Nonwoven Fabric Handbook*, Assoc. of the Nonwoven Fabrics Industry (1999).

Nonwoven fiber webs are typically formed by direct extrusion processes, such as spunbonding, meltblowing, solvent spinning, or electrospinning, in which the fibers and web are formed simultaneously, or by preformed fiber processes, such as dry laying or wet laying, in which fibers are laid into webs at a time subsequent to fiber formation, or by combinations of such processes, such as by spunbond-meltblown-spunbond, spunbond-airlaid, and meltblown-airlaid processes.

Typically, at least a portion of the fibers of a nonwoven fabric web are typically oriented with some non-zero angle relative to other fibers of the web. Places were two or more fibers touch, in either an adjacent or overlapping manner, are typically called "junctions". The fibers of a nonwoven fabric web are typically joined to one or more of the other fibers of the web, by, for example, thermal bonding, pressure bonding, ultrasonic bonding, or solvent bonding, at least some of the junctions.

In one embodiment, two or more nonwoven fiber webs are stacked to form a nonwoven fiber web laminate material. In another embodiment, one or more nonwoven fiber webs are stacked with one or more other materials, such as non-porous polymeric films or sheets, to form composite laminate materials.

In one embodiment, the phosphinate compound according to formula (I) is a single compound according to formula (I). In another embodiment, the phosphinate compound is a mixture comprising two or more compounds according to formula (I).

In one embodiment, n and n' are each zero, and m is an integer of from 1 to about 100, more typically from 1 to about 50, and even more typically from 1 to about 30.

In one embodiment, n and n' are each zero, m is an integer of from 1 to about 100, more typically from 1 to about 50, and even more typically from 1 to about 30, and A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer.

In one embodiment, n and n' are each zero, m is an integer of from 1 to about 100, more typically from 1 to about 50, and even more typically from 1 to about 30, and A is an organic group according to formula (II), wherein R¹, R², R³, R⁴, and R⁵ are each described as above.

In one embodiment, n, n', and m are each independently an integer of from 1 to about 100, more typically from 1 to about 50, and even more typically from 1 to about 30.

In one embodiment, n, n', and m are each independently an integer of from 1 to about 100, more typically from 1 to about 50, and even more typically from 1 to about 30, and A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer.

In one embodiment, q and s are independently 0 or an integer of from 1 to about 30, more typically from 1 to about 20.

In one embodiment, p, r, and r' are independently 0 or an integer of from 1 to about 10, more typically from 1 to about 6.

In one embodiment, A is derived from an ethylenically unsaturated monomer. The monomer may be hydrophilic or hydrophobic. Suitable monomers include those ethylenically unsaturated compounds in which the ethylenic bond is chemically activated by at least one adjacent group such as a sulphamate, phosphonate or carboxylate group. Examples include acrylic acid, fumaric acid, maleic acid, vinylsulphonic acid, vinylidene diphosphonic acid, methyl acrylate, itaconic acid, aconitic acid, mesaconic acid, citraconic acid, crotonic acid, isocrotonic acid, angelic acid, tiglic acid, vinyl alcohol, vinyl chloride, vinyl phosphonic acid, styrene sulphonic acid, styrene-p-sulphonic acid, 2-acrylamido-2-methyl propane sulphonic acid, and derivatives thereof, and the water-soluble salts of the aforesaid acids. Alternatively, the monomer may be ethyl/methyl/butyl acrylate or methacrylate, vinyl acetate, styrene, vinyl versatate, vinyl stearate, a vinyl silane, a vinyl siloxane, an N-vinyl pyrrolidone, acrylamide and derivatives thereof, hydroxyl ethyl acrylate/methacrylate, acrylate esters, tertiary-butyl acrylate, 2-ethylhexyl acrylate or octadecyl acrylate and derivatives thereof.

In one embodiment, A is derived from an ethylenically unsaturated monomer and is an organic group according to the formula (IV):

```
\[ \text{H}_3 \text{C} \quad \text{H} \quad \text{R}^{20} \quad \text{H} \\
\text{C} = \text{O} \quad \text{D} \quad \text{R}^{21} \]
```
R²⁰ is H or methyl,
R²¹ is H, alkyl or hydroxyalkyl, and
t is an integer of from 1 to about 100.

In one embodiment, R²⁰ is H, D is O and R²¹ is H
or alkyl, and t is an integer of from 1 to about 50,
much typically from 1 to about 30.

In another embodiment, A is according to formula (II),
wherein R¹, R², R³, and R⁴ are each independently H or
(C₅₋C₂₅)alkyl, each R⁴ is independently methylene or a
(poly(methylene) radical comprising from 2 to about 50
methylene units, which may optionally be substituted on one
or more of the methylene units, R⁶ is H or alkyl, more
typically (C₁₋C₅₀)alkyl, p is an integer of from 1 to about 10,
more typically 1, and q is 0 or an integer of from 1 to about
20.

In one embodiment, A is according to formula (II),
wherein R¹, R², R³, and R⁴ are each H, p is an integer of from
1 to about 10, more typically 1, q is 0, and R⁶ is alkyl, more
typically (C₁₋C₅₀)alkyl, even more typically (C₁₋C₂₅)alkyl.

In one embodiment, A is according to formula (II),
wherein R¹, R², R³, R⁴, R⁶ are each H, p is q is 1, and each
R⁴ is independently a methylene or poly(methylene) radical
comprising from 1 to about 50, more typically from 1 to
about 30 methylene units, which may optionally be sub-
tituted on one or more of the methylene units, and which may
optionally be interrupted at one or more positions by an
oxygen atom.

In one embodiment, each R⁴ is independently a
non-substituted methylene or poly(methylene) radical com-
prising from 1 to about 50, more typically from 1 to about
30, methylene units.

In one embodiment, each R⁴ is independently a
methylen or poly(methylene) radical comprising from 1 to
about 50, more typically from 1 to about 30, methylene units
that is substituted on one or more of the methylene units,
such as for example, a group according to formula (V):

wherein R²² and each R²³ is independently H, alkyl,
hydroxyl, or carboxyl, provided that at least one R²² or R²³
of such radical is alkyl, hydroxyl, or carboxyl, and wherein
v is an integer of from 1 to about 49, more typically from 1
to about 29.

In one embodiment, each R⁴ is independently a
poly(oxyalkylene) radical (that is, a poly(methylene) radical
interrupted with at one or more positions with an oxygen
atom) comprising from 1 to about 50, more typically from 1
to about 30, oxyalkylene units, such as for example, a
group according to formula (VI):

wherein R²⁴ is H, or alkyl, more typically, methyl or ethyl,
and v is an integer of from 1 to about 49, more typically from
1 to about 29.

In one embodiment, A' is according to formula (III),
wherein each r and t' is an integer of from 1 to about
10, more typically 1, s is 0, R²⁷, R²⁸, R²⁹, R³⁰, R³¹, and R³² are
each independently H, alkyl, cycloalkyl, hydroxyalkyl, alkoxy-
alkyl, alkenyl, aryl, alralkyl, or alkaryl.

In one embodiment, A' is according to formula (III),
wherein each r and t' is an integer of from 1 to about
10, more typically 1, R²⁷, R²⁸, R²⁹, R³¹, R³₂, and R³³ are each
independently H, alkyl, cycloalkyl, hydroxyalkyl, alkoxy-
alkyl, alkenyl, aryl, alralkyl, or alkaryl, and R³⁰ is methylene
or poly(methylene), which may optionally be substituted on
one or more of such methylene units, and which may
optionally be interrupted at one or more positions by an
oxygen atom.

In one embodiment, each R³⁰ is independently a
non-substituted methylene or poly(methylene) radical com-
prising from 1 to about 50 methylene units, more typically
from 1 to about 30 methylene units.

In one embodiment, each R³⁰ is independently a
methylen or poly(methylene) radical of from 1 to about 50,
much typically from 1 to about 30, methylene units that is
substituted on one or more of the methylene units, such as
for example, a group according to formula (VI), wherein R²²,
R²³ and u are each as first described above.

In one embodiment each R³⁰ is independently a
poly(oxyalkylene) radical comprising from 1 to about 50,
more typically from 1 to about 30, oxyalkylene units, such
as for example, a group according to according to formula
(VI), wherein R²⁴ and v are each as first described above.

In one embodiment, each B is independently a
methylen or poly(methylene) radical of from 1 to about 50,
much typically from 1 to about 30, methylene units, which
may be optionally substituted on one or more of the meth-
ylene units with hydroxyl, alkyl, or carboxyl, and which may
be interrupted at one or more positions by an oxygen atom.

In one embodiment, each B is independently a
non-substituted methylene or poly(methylene) radical com-
prising from 1 to about 50, more typically from 1 to about
30, methylene units.

In one embodiment, each B is independently a
methylen or poly(methylene) radical of from 1 to about 50,
much typically from 1 to about 30, methylene units that is
substituted on one or more of the methylene units, such as
for example, a group according to formula (VI), wherein R²²,
R²³ and u are each as first described above.

In one embodiment, each B is independently a
poly(oxyalkylene) radical, such as for example, a group
according to according to formula (VI), wherein R²⁴ and v
are each as first described above.
In one embodiment:

m is 0,

n' is an integer of from 1 to about 30, more typically from 1 to about 10,

A is a group according to formula (II), wherein R¹, R², R³, and R⁴ are each H, R⁵ is methylene or (C₂₋C₆)poly(methylene), and p is an integer of from 1 to about 20, more typically from 1 to about 10, and q is an integer of from 1 to about 30, more typically from 1 to about 10, and

B is a group according to formula (V), wherein R²² is hydroxy(C₁₋C₆)alkyl, R²³ is H, and u is an integer of from 1 to about 10.

In one embodiment:

m is 0,

n' is an integer of from 1 to about 30, more typically from 1 to about 10,

A is a group according to formula (II), wherein R¹, R², and R³ are each H, R⁴ is (C₂₋C₁₀)alkyl, p is an integer of from 1 to about 20, more typically from 1 to about 10, and q is an integer of from 1 to about 30, more typically from 1 to about 10, and

B is a group according to formula (V), wherein R²² is hydroxy(C₁₋C₆)alkyl, R²³ is H, and u is an integer of from 1 to about 10.

In one embodiment:

m is an integer of from 1 to about 30, more typically from 1 to about 10,

n and n' are each 0,

A is a group according to formula (II), wherein R¹, R², R³, and R⁴ are each H, R⁵ is methylene or (C₂₋C₆)poly(methylene), p is an integer of from 1 to about 20, more typically from 1 to about 10, and q is an integer of from 1 to about 30, more typically from 1 to about 10, and

A' is a group according to formula (III), wherein R⁷, R⁸, R¹², and R¹³ are each H, R⁹ is hydroxy(C₁₋C₆)alkyl, r and r' are each independently integers of from 1 to about 20, more typically from 1 to about 10, and s is 0.

In one embodiment:

m is an integer of from 1 to about 30, more typically from 1 to about 10,

n and n' are each 0,

A is a group according to formula (II), wherein R¹, R², and R³ are each H, R⁴ is (C₂₋C₁₀)alkyl, p is an integer of from 1 to about 20, more typically from 1 to about 10, and q is 0, and

A' is a group according to formula (III), wherein R⁷, R⁸, R¹², and R¹³ are each H, R⁹ is hydroxy(C₁₋C₆)alkyl, r and r' are each independently integers of from 1 to about 20, more typically from 1 to about 10, and s is 0.

In one embodiment:

m is an integer of from 1 to about 30, more typically from 1 to about 10,

n and n' are each 0,

A is a group according to formula (II), wherein R¹, R², and R³ are each H, R⁴ is (C₂₋C₁₀)alkyl, p is an integer of from 1 to about 20, more typically from 1 to about 10, and q is 0, and

A' is a group according to formula (III), wherein R⁷, R⁸, R¹², and R¹³ are each H, R⁹ is hydroxy(C₁₋C₆)alkyl, r and r' are each independently integers of from 1 to about 20, more typically from 1 to about 10, and s is 0.

In one embodiment:

m is an integer of from 1 to about 30, more typically from 1 to about 10,

n and n' are each 0,

A is a group according to formula (IV), wherein R⁷ is H or methyl, R²¹ is H or (C₁₋C₆)alkyl, and t is an integer of from 1 to about 20, and

A' is a group according to formula (III), wherein R⁷, R⁸, R¹¹, R¹², and R¹³ are each H, R¹⁰ is methylene or (C₂₋C₁₀)poly(methylene), r and r' are each independently integers of from 1 to about 20, more typically from 1 to about 10, and s is an integer of from 1 to about 20.

In one embodiment, the phosphinate compound according to formula (I) exhibits a weight average molecular weight of from about 300 to about 500,000 grams per mole, more typically form about 300 to about 100,000 grams per mole, as determined by gel permeation chromatography and refractive index detection and comparison to polyacrylic acid standards.

In one embodiment, the phosphinate compound according to formula (I) is made by a process comprising the steps of:

(A) preparing a compound according to formula (VII), (VIII), or (IX):

wherein A, B, m, n, and n' each have the same meaning as first described above in regard to the phosphinate compound according to formula (I) and, subsequently,

(b) forming a reaction mixture by adding an appropriate amine compound to the compound of formula (VII), (VIII), or (IX); and

(ii) heating the reaction mixture for 15 to 180 minutes in the presence of a carbonyl compound, or

(C) reacting the compound according to formula (VII), (VIII), or (IX) with an ethylenically unsaturated monomer under appropriate reaction conditions.

The phosphinate compound according to formula (VII), (VIII) or (IX) may be in the form of free acids or in the form of at least partly neutralized salts thereof. Typically, the salts or partial salts are at least partially water soluble, more typically having a solubility in water at 20° C. of at least 10 g/l especially at least 100 g/l.

Phosphinate compounds according to formula (VIII) or (IX) may be formed by allowing hypophosphorous acid to react with an amine in the presence of a carbonyl compound, which is either a ketone or an aldehyde or a mixture thereof, and an inorganic acid. The ratio of the
The molar amount of hypophosphorous acid to molar amount amine is typically from 4:1 to 1:1, more typically 2:1. The hypophosphorous acid may be added to the reaction as the acid or as a salt thereof, e.g., sodium hypophosphite. The reaction is accompanied by the evolution of water.

Phosphinate compounds according to formula (VIII) or (IX) may be synthesized by the reaction of one or more than one primary amine, RNH₂, such as glycine, aspartic acid, glutamic acid, 4-amino butyric acid, 6-amino caproic acid, lysine, 1-amino sorbitol or tartrine, or one or more than one secondary amine, such as N,N’-dimethyl ethylenediamine or N,N’-dimethyl-ethylenetriamine or a mixture of at least two of the aforesaid amines, such that a phosphinate compound is formed in which not every unit is identical. Phosphinate compounds of varying molecular weights may be synthesized from a mixture of a primary amine and a secondary amine. The amine from which the phosphinate polymer of step (a) is synthesized is preferably a diamine, for example ethylene diamine, 1,8-diaminooctane or 1,12-diaminododecane.

Phosphinate compounds according to formula (VIII) or (IX) may be synthesized from one or more than one carbonyl compound.

Phosphinate compounds according to formula (VIII) or (IX) may be synthesized in any liquid phase in which the reactants and preferably the products are at least sparingly soluble, but preferably the reaction is performed in acidic aqueous solution at 40-120 °C. within a pH range of 0-2, such as, for example, 0.5-1.5. The amount of the carbonyl compound is normally 1-4 times the amount of the hypophosphorous acid; preferably the carbonyl compound is added slowly to a mixture of the other ingredients. The reaction is normally terminated after 0.5-5 hours. The product may be isolated by filtration to give the free polymere phosphinic acid, or, more preferably with base to form a solution of the phosphinate compound. The solution may be stripped of water to yield a solid salt of the polymeric phosphinate.

Typically, the reaction mixture of step (B) is adjusted to be acidic.

Typically, the reaction mixture of step (B) is heated under reflux.

Typically, the pH of the solution of step (B) is adjusted to have a pH of from about 0.5 to about 4, more typically, from about 0.5 to about 3, most typically about 1. The pH of the solution is typically adjusted by the addition of an acid, for example hydrochloric acid. The acid is typically added before the solution is heated under reflux.

The carbonyl compound is typically added to the solution of step (B) during heating under reflux. The carbonyl compound is typically added dropwise and preferably over a period of about 20 to about 40 minutes, most typically about 30 minutes. The carbonyl compound is typically an aldehyde, most typically formaldehyde.

The solution of step (B) is typically heated under reflux for about 15 to about 180 minutes after addition of the carbonyl compound, more typically about 30 to about 120 minutes.

Alternatively, the reaction mixture of step (B) may be concentrated by evaporation or diluted by the addition of more liquid; the product may then be used as such or at least partly neutralized with a base, such as, for example, sodium hydroxide, or, alternatively, the reaction product may be heated with a base before use. If desired, the reaction products may be separated into pure components for example by column chromatography such as, for example, by ion exchange column chromatography.

In step (C) of the above process for making the phosphinate compound according to formula (I), the monomeric groups can be added at any pH. In one embodiment, the monomeric groups are added at a pH of 3-5, most preferably at a pH of 4.

Step (C) can take place in the presence of any suitable aqueous or organic solvent, preferably the solvent is aqueous when the monomeric group is hydrophilic and the solvent is organic when the monomeric group is hydrophobic. The most preferred aqueous solvent is water. The organic solvent may be toluene, xylene or ethyl acetate.

In step (C), the reaction can take place in the presence of any suitable initiator. The initiator is preferably a free radical source. The free radical source may be a peroxy salt such as an alkali metal (e.g., sodium) perarsenate or peracetate, hydrogen peroxide, a hydperoxide, chloride dioxide, sodium chlorate, sodium hypochlorite, organotin hydrides, azo compounds such as 4,4’-azobisobenzoylvaleric acid or azo-bis-isobutyronitrile, electrolysis, ultra violet or other ionizing radiation or ultrasound, or any combination of the foregoing.

Typically, the reaction components of step (C) are present in the solvent in an amount of from 15 to 60% weight by weight where the solvent is aqueous and 40 to 60% weight by weight where the solvent is organic.

In one embodiment, in an intermediate step (C) before step (C), the phosphinate compound of step (A) is dissolved in a suitable solvent. The solvent may be an aqueous solvent, most preferably water, or alternatively an organic solvent, such as toluene, xylene or ethyl acetate. In one embodiment the solvent is water and the pH of the solution is adjusted to pH 2-6, preferably 3-5, most preferably 4. The pH is preferably adjusted by the addition of a base, for example sodium hydroxide.

In one embodiment, in an intermediate step (C) before step (C), the monomeric group is preferably dissolved in a suitable solvent. The solvent may be an aqueous solvent, most preferably water, or alternatively an organic solvent, such as toluene, xylene or ethyl acetate. In one embodiment the solvent is water and the pH of the solution is preferably adjusted to pH 2-6, preferably 3-5, most preferably 4. The pH is preferably adjusted by the addition of a base, for example sodium hydroxide.

Typically, in step (C) part of the solution of phosphinate compound of step (C.1) is mixed with part of the solution of the monomeric group of step (C.2) and this mixture is added to the remainder of the solution of the phosphinate compound of step (C.1). Subsequently, the remainder of the solution of the monomeric group of step (C.2) is added. The additions of the mixture of part of the solution of phosphinate compound and part of the solution of monomeric group, and the addition of the remainder of the solution of monomeric group, to the part of the polymer solution preferably take place in the presence of a suitable
The reaction of step (C) may be carried out batchwise, semi-continuously or continuously, e.g. in a pipe reactor. The initiator may be added initially or, preferably, in a plurality of additions, or continuously or semi-continuously throughout the reaction. To maximize the yield of phosphonated product it is sometimes necessary to add the monomeric group, continuously or intermittently, during the reaction period to an aqueous solution of the phosphinate.

In one embodiment, the phosphinate compound according to formula (I) may be cross-linked, typically after deposition on the fiber, for example via the amino group by contacting the compound a conventional cross-linking agent, for example, a diepoxide, under appropriate reaction conditions. In one embodiment, the hydrophilized fiber comprises a fiber having a hydrophobic surface and a phosphinate layer, said phosphinate layer comprising the crosslinked reaction product of a reaction between a phosphinate compound according to formula (I) and a crosslinking agent for the phosphinate compound, disposed on at least a portion of such hydrophobic surface in an amount effective to increase the hydrophilicity of such portion of such hydrophobic surface. The phosphinate layer may, optionally, further comprise non-crosslinked phosphinate compound according to formula (I).

The phosphinate compound according to formula (I) may be in the form of a mixture with at least one of hydrochloric, sulphuric, phosphorous or phosphoric acids, or salts thereof, especially with hydrochloric acid e.g. in amount of 0.1-10 g/l hydrochloric acid but preferably 0.1-1 g/l. Also the phosphinate compounds may be used as a mixture with each other, or with their precursors such as formaldehyde, amines, ketones, and aldehydes, or with by-products such as N-methylated amines or oligomers or polymers with a repeating unit of the block amino phosphinate polymer of the present invention and one or more terminal units.

In one embodiment, the phosphinate compound according to formula (I) is deposited on at least a portion of the hydrophobic surface of a fiber by contacting the surface with a solution, emulsion or dispersion of phosphinate compound in a carrier, such as water, and then removing the carrier.

In one embodiment, the phosphinate compound according to formula (I) is deposited on at least a portion of the hydrophobic surface of a fiber by contacting such surface with a solution, emulsion or dispersion of phosphinate compound in a volatile carrier and removing the carrier by allowing the carrier to evaporate.

The hydrophobic surface of fiber may be contacted with the phosphinate solution, emulsion or dispersion by any convenient method such as, for example, by immersing the fiber substrate in such solution, emulsion or dispersion by applying such solution, emulsion or dispersion to the surface of the fiber substrate by brushing or spraying.

In one embodiment, the phosphinate compound is deposited on the hydrophobic surfaces of fibers by treating discrete fibers and the treated fibers are subsequently included as a component of a fabric. In another, more typical embodiment, a fabric comprising fibers having hydrophobic surfaces is made and phosphinate compound is deposited on the hydrophobic surfaces of the fibers of the fabric by treating the fabric.

In one embodiment, the phosphinate compound is deposited on at least a portion of the surfaces of a fiber or of the fibers of a fabric by immersing the fiber or the fabric in an aqueous treatment solution comprising the phosphinate compound and then removing the aqueous carrier by evaporation to leave an amount of phosphinate compound disposed on at least a portion of the surfaces of the fiber or the fibers of the fabric.

The aqueous treatment solution may, optionally further comprise other components. In one embodiment, the aqueous treatment solution further comprises one or more additional components selected from salts, water miscible organic solvents, sugars, and rheology modifiers. Suitable salts include, for example, NaCl and CaCl₂. Suitable water miscible organic solvents include saturated or unsaturated monohydrate alkanol and polyhydric alkanols, such as, for example, methanol, ethanol, isopropanol, ethyl alcohol, benzyl alcohol, oleyl alcohol, 2-butoxyethanol, and ethylene glycol, as well as alkyl ether diols, such as, for example, ethylene glycol monoethyl ether, propylene glycol monoethyl ether and diethylene glycol monomethyl ether. Suitable sugars include monosaccharides and polysaccharides, such as, for example, glucose or guar gum. Suitable rheology modifiers include, for example, alkali swellable polymers, such as acrylic acid polymers, hydrogen bridging rheology modifiers, such as carboxymethylcellulose or hydroxyethylcellulose, and hydrophobic associative thickeners, such as hydrophobically modified cellulose derivatives and hydrophobically modified alkoxyethyl urethane polymers.

In one embodiment, the aqueous treatment solution comprises, based on 100 parts by weight ("pbw") of such solution, from about 0.001 to about 30, more typically from about 1 to about 15, parts by weight ("pbw") of one or more phosphinate compounds according to formula (I), up to about 10 pbw of one or more components selected from salts, water miscible organic solvents, sugars, and rheology modifiers, and from about 60 to about 99.999, more typically from about 85 to about 99 pbw water.

In one embodiment, the pH of the aqueous solution of the phosphinate compound of formula (I) is adjusted to value within a predetermined range. In one embodiment, the pH of the treatment solution is adjusted to a selected value within the range of from about 1 to about 14 more typically from about 7 to about 12, and even more typically from about 9 to about 12.

In one embodiment, the hydrophilized fiber of the present invention comprises from about 0.001 to about 0.2, more typically from about 0.02 to about 0.1 grams of phosphinate compound per gram of fabric.

In one embodiment, the hydrophilized fiber of the present invention comprises from about 0.001 to about 10, more typically from about 0.1, to about 3, grams of phosphinate compound according to formula (I) per square meter of fabric.

In one embodiment, the hydrophilized substrate of the present invention is a woven or nonwoven fabric comprising fibers having hydrophobic surfaces, such as, for example, hydrophobic synthetic polymeric fibers, such as
poly(olefin) fibers, and a phosphinate compound according to formula (I) disposed on at least a portion of the surfaces of such fibers in an amount effective to render the fabric sufficiently hydrophilic to allow the fabric to absorb water.

[0132] In one embodiment, the fabric substrate consists essentially of, and more typically consists of, fibers that each have a hydrophobic surface, such as for example, a fabric comprising 100% poly(olefin) fibers.

[0133] In an alternate embodiment, the fabric substrate comprises a blend of fibers that each have a hydrophobic surface and other fibers, such as, for example cellulosic fibers. Typically, such blends comprise greater than or equal to 50% fibers having hydrophobic surfaces and less than or equal to 50% other fibers, such as for example a blend of 50% poly(olefin) fibers and 50% cotton fibers.

[0134] In one embodiment, hydrophilized fabric of the present invention comprises a porous nonwoven fabric that consists of fibers having hydrophobic surfaces, more typically, a porous nonwoven fabric of poly(olefin) fibers, even more typically a porous nonwoven fabric of poly(propylene) fibers, and a phosphinate compound according to formula (I) disposed on at least a portion of the surfaces of the fibers of such porous nonwoven fabric.

[0135] One indication of increased hydrophilicity of a treated hydrophobic surface is a decreased contact angle of water droplets with a treated surface compared to the contact angle of water droplets with an untreated surface. Water droplet contact angle is awkward to determine with respect to a typical fiber due to the fiber surface configuration, that is due to the lack of a substantially flat surface. A water droplet contact angle measurement that is representative of the fiber surface can conveniently be made using a flat sheet or sample coupon of same material as the fiber of interest. Typically, the treated surface exhibits a water droplet contact angle of less than 70°, more typically less than 60°.

[0136] In one embodiment, the hydrophilized fiber substrate is durable, in the sense that at least a portion of the phosphinate compound remains on the surfaces of the one or more fibers of the fiber substrate when the hydrophilized fiber substrate is contacted with water. One aspect of the durability of the hydrophilic properties of hydrophilized fiber substrate of the present invention can be evaluated by rinsing the hydrophilized fiber substrate in water and measuring the surface tension of rinse water. In one embodiment of the hydrophilized fiber substrate, the rinse water exhibits a surface tension of from about 20 to about 70 millinewtons per meter (mN/m), more preferably from about 25 to about 70 mN/m, as determined according to American Society for Testing and Materials test no. ASTM 1331 using a Wilthemy plate (Kruss Instruments). In a preferred embodiment, the fabric is rinsed according to the following procedure:

[0137] (A) place a 20x18 cm sample of hydrophilized fabric in 40 milliliters of a 0.909 wt % NaCl aqueous solution,
[0138] (B) then stir the fabric in the solution for 10 seconds,
[0139] (C) then allow the fabric to sit without any agitation for 5 minutes,
[0140] (D) then stir the fabric in the solution for 10 seconds,
[0141] (E) then remove the fabric from the solution, and
[0142] (F) then allow the solution to rest for 10 minutes prior to making the surface tension measurement.

[0143] One aspect of the increased hydrophilicity of the hydrophilized fiber substrate of the present invention can be evaluated by a “strikethrough” test. In one embodiment, the hydrophilized fabric, exhibits a strikethrough time, as determined according to European Disposable and Nonwovens Association test no. EDANA 150.3-96 of from less than about 10 seconds, more preferably from about 2 to about 5 seconds, and still more preferably from about 2 to about 4 seconds, and even more preferably from about 2 to about 3 seconds. In a preferred embodiment, the strikethrough time is measured according to the following procedure:

[0144] (A) place a 12x12 cm sample of the hydrophilized fiber on top of a stack of 10 filter papers (ERT-FF3) and under a 50 mL separating funnel,
[0145] (B) then place a conductivity electrode on top of the stack of filter papers and under the treated fabric,
[0146] (C) deliver a 5 mL aliquot of an aqueous 0.909 wt% NaCl solution from a burette to the funnel (a “gush”) and measuring the time (the “strikethrough time”) from the moment the liquid touches the fabric until all liquid disappears into the stack of filter papers,
[0147] (D) optionally, repeating step (C) multiple times using the same fabric sample and stack of filter papers and recording the strikethrough time for each gush.

[0148] In one embodiment, the disposable absorbent article of the present invention has a composite laminate structure and comprises one or more layers of a hydrophilized porous nonwoven fabric according to the present invention and one or more layers of a nonporous polymer film, such as a nonporous poly(olefin) film.

[0149] In one embodiment, the disposable absorbent article according to the present invention is an article, such as a diaper, an adult incontinence product, or a feminine hygiene product, for absorbing aqueous physiological fluids, such as urine. In one embodiment, such disposable absorbent article has a composite laminate structure and comprises at least one layer of a porous hydrophilized fabric, typically a porous hydrophilized nonwoven fabric, at least one layer of a nonporous water impermeable film, such as a poly(ethylene) film, and at least one layer of an absorbent material, typically a superabsorbent material, disposed between the layer of porous hydrophilized fabric and the layer of nonporous water impermeable film.

[0150] As used herein, the term “super-absorbent material” refers to a water-swellable, water-insoluble organic or inorganic material capable, under favorable conditions, of absorbing at least several times, preferably at least 10 times and most preferably at least 30 times, its weight in an aqueous solution containing about 0.9 weight percent of sodium chloride. Suitable superabsorbent materials are generally known. Organic materials suitable for use as a super-absorbent material of the present invention can include natural materials such as agar, pectin, guar gum, and modified natural materials such as the sodium salt of carboxymethylcellulose, as well as synthetic materials such as syn-
thetic hydrogel polymers. Such hydrogel polymers include, for example, alkali metal salts of polyacrylic acids, partially-neutralized polyacrylamides, ethylene maleic anhydride copolymers, and polymers and copolymers of vinyl sulfonic acid, polyacrylates, polyacrylamides, and polyvinyl pyridines. Other suitable polymers include hydrolyzed acrylonitrile graft starch, acrylic acid graft starch, and isobutylene maleic anhydride copolymers and mixtures thereof. Examples of polymer materials suitable for use include those comprising monomeric units derived from polymerizable, unsaturated, acid-containing monomers, such as ethylenically unsaturated carboxylic acids, such as acrylic acid or methacrylic acid, acid anhydrides, such as maleic anhydride, ethylenically unsaturated sulfonic acids, and mixtures thereof and optionally further comprising monomeric units derived from non-acid-containing monomers, such as ethylenically unsaturated carboxylic acid ester monomers or ethylenically unsaturated sulfonic acid ester monomers. Other polymer materials for use in the present invention possess a carboxyl group. These polymers include hydrolyzed starch-acrylonitrile graft copolymer, partially neutralized starch-acrylonitrile graft copolymer, starch-acrylic acid graft copolymer, partially neutralized starch-acrylic acid graft copolymer, saponified vinyl acetate-acrylic ester copolymers, hydrolyzed acrylonitrile or acrylamide copolymers, lightly crosslinked products of any of the foregoing copolymers, partially neutralized polyacrylic acid, and slantly network crosslinked products of partially neutralized polyacrylic acid. These polymers may be used either independently or in the form of mixtures with other polymers.

The superabsorbent material is typically present in the form of composite material comprising a granular superabsorbent particulate, typically sized between 100 microns and 1000 microns dispersed in a permeable meshwork that spaces the super-absorbent particles from each other, provides cushioning, provides open voids to permeate and transfer liquid through the composite material, and provides strength to the composite material as a whole. The permeable meshwork may comprise a natural material or a synthetic polymer and typically comprises cellulose fluff. Cellulose fluff is made of cellulose fibers obtained from wood-pulping processes and is commonly used in absorption applications where strands of the fibers are loosely intertwined to provide a meshwork having a greater volumetric percentage of open void than of intertwined strands.

In use, the layer of hydrophilized fabric of the disposable absorbent article is oriented toward the user, typically the wearer, of the disposable absorbent article. Aqueous physiological fluid that may be produced by the user flows toward to flow through the porous hydrophilized fabric layer into the absorbent layer. The nonporous water impermeable film provides a barrier against leakage from the absorbent layer.

In one embodiment, the disposable absorbent article is a wipe that comprises one or more layers, each independently comprising a hydrophilized woven fabric or a hydrophilized nonwoven fabric.

EXAMPLE 1

A phosphinate compound according to formula (E1):

\[ \text{H}_2\text{N} \rightarrow \text{(CH)}_{12} \rightarrow \text{NH}_2 \]

was made as follows.

An oligomer was prepared as follows ("Oligomer Method 1"). To a 1.5 L reactor fitted with a reflux condenser, temperature probe and N\textsubscript{2} gas line was added 214 g sodium hypophosphate (85 percent by weight ("wt %")) and water (550 ml). Sodium persulphate (14.9 g), an initiator, was dissolved in water (50 ml). Propargyl alcohol (110.8 g) was dissolved in water (195 g). The reaction mixture was heated to reflux (approximately 105\textdegree C.) under an inert atmosphere. At reflux the initiator solution was added at steady rate over 4.5 hours and the propargyl alcohol solution was steadily added through a peristaltic pump over 210 minutes. Upon completion of the feeds the reaction was maintained at reflux for 1 hour before cooling to room temperature.

An aqueous solution of 1,12-Diaminododecane (66 g in 447 ml of water) was mixed with 490 g (23 wt %) of an oligomer made according to Oligomer Method 1. The solution was adjusted to pH 1 with hydrochloric acid (92 g, 36 wt %). This solution was then heated to reflux and formaldehyde (46.8 g 37 wt %) was added drop wise over a period of 30 minutes. The reaction mixture was refluxed for a further 30 minutes and then cooled to room temperature; the reaction yield was 1158 g of product.

The product exhibited a weight average molecular weight of 840 grams per mole (as determined using gel permeation chromatography and polyacrylic acid standards). A sample of the product was adjusted to pH 14 with NaOH to facilitate analysis by \textsuperscript{31}P NMR, the spectrum of which showed a polymeric product with 86% aminophosphin groups.

EXAMPLE 2

A phosphinate compound according to formula (E2) was made as follows.

An aqueous solution of aminododecane (14.8 g in 50 ml of water) was mixed with 100 g (23 wt %) of an
oligomer made according to Oligomer Method 1. The solution was adjusted to pH 1 with hydrochloric acid (20 g, 36 wt %). This solution was then heated to reflux and formaldehyde (6.7 g, 37 wt %) was added dropwise over a period of 30 minutes. The reaction mixture was refluxed for a further 30 minutes and then cooled to room temperature. Upon cooling the product separated into 2 layers, 50 ml of ethanol was added to give a homogeneous yellow solution. Yield was 245 g.

A sample of the product was adjusted to pH 14 with NaOH to facilitate analysis by 31P NMR, the spectrum of which showed a complex polymeric product, a proton coupled 31P-NMR showed that 12% of which contained terminal PH bonds.

EXAMPLE 3

A phosphinate compound according to formula (E3):

\[
\text{HO} \rightleftharpoons \text{N} \rightleftharpoons \text{CO} \rightleftharpoons \text{O} \rightleftharpoons \text{P} \rightleftharpoons \text{Na}^+ \quad \text{Na}^+ \\
\text{H}_2 \text{N} \rightleftharpoons \text{(H}_2\text{C}_6\text{)} \rightleftharpoons \text{N} \rightleftharpoons \text{H} \rightleftharpoons \text{O} \rightleftharpoons \text{Na}^+ \quad \text{Na}^+ \\
\]

was made as follows.

An aqueous solution of 1,6-Diaminohexane (9.3 g in 75 ml of water) was mixed with 100 g (23 wt %) of an oligomer made according to Oligomer Method 1. The solution was adjusted to pH 1 with hydrochloric acid (16 g, 36 wt %). This solution was then heated to reflux and formaldehyde (6.7, 37 wt %) was added dropwise over a period of 30 minutes. The reaction mixture was refluxed for a further 30 minutes and then cooled to room temperature; the reaction yield was 188 g of product.

The product exhibited a weight average molecular weight of 792 grams per mole (as determined using gel permeation chromatography and polyacrylic acid standards).

EXAMPLE 4

A compound according to formula ((E4))

\[
\text{HO} \rightleftharpoons \text{N} \rightleftharpoons \text{CO} \rightleftharpoons \text{O} \rightleftharpoons \text{P} \rightleftharpoons \text{C}_12\text{H}_{25} \\
\text{H}_2 \text{N} \rightleftharpoons \text{(H}_2\text{C}_6\text{)} \rightleftharpoons \text{N} \rightleftharpoons \text{H} \rightleftharpoons \text{O} \rightleftharpoons \text{C}_12\text{H}_{25} \\
\]

was made as follows.

An oligomer was prepared as follows (Oligomer Method 2*). To a 1-L oil jacketed reactor fitted with overhead stirrer, temperature probe and condenser was added dodecyl amine (37 g, 0.2 mol), hydrochloric acid (20 g, 36 wt %, 0.2 mol) and 200 ml deionized water. The mixture was heated to 50 °C and stirred for 1 hour, after which the amine had all dissolved. An oligomer made according to Oligomer Method 2 (424 g, 0.1 mol) was added with a further 200 ml of deionized water. The reaction mixture was measured as pH 1 and was milky in color and viscous.

\[
p=\text{f}_{\text{internal}}(36-43 \text{ ppm})/0.5 \quad \text{(f-external, 23-25 ppm)}
\]

EXAMPLE 5

A phosphinate compound according to the formula (E5):

\[
\text{O} \rightleftharpoons \text{C}_12\text{H}_{25} \\
\text{OH} \rightleftharpoons \text{N} \rightleftharpoons \text{P} \rightleftharpoons \text{N} \rightleftharpoons \text{C}_12\text{H}_{25} \\
\text{OH}
\]

was made as follows.

To a 1-L oil jacketed reactor fitted with overhead stirrer, temperature probe and condenser was added dodecyl amine (37 g, 0.2 mol), hydrochloric acid (101.6 g, 36 wt %, 1.0 mol) was added slowly followed by hypophosphorous acid (158.4 g, 50 wt %, 1.2 mol). The solution was heated to 100 °C under nitrogen. Formaldehyde (166 g, 36 wt %, 2.0 mol) was added via a dosing pump over 2.5 hours. After the addition the reaction mixture was aged for 1 hour and then cooled to room temperature. The reaction yield was 850 g, the molecular weight was determined to be 711 (using Polyacrylic acid standards). A small sample was adjusted to pH 14 for analysis by 31P NMR. The degree of oligomerisation was calculated as p=6.6 from the 31P NMR spectra using the following equation (1):

\[
p=\text{f}_{\text{internal}}(36-43 \text{ ppm})/0.5 \quad \text{(f-external, 23-25 ppm)}
\]

To a 500 ml flask was added 1,12-diaminododecane (11.4 g), hydrochloric acid (6 g, 36 wt %), deionized water (50 ml) and an oligomer made according to Oligomer Method 2 (120 g). The mixture was heated to 50 °C and stirred for 1 hour, after which the amine had all dissolved. The reaction mixture was measured as pH 1 and was milky in color and viscous.

The reaction was heated to 100 °C under nitrogen and then formaldehyde (4.8 g 36 wt %) was added over 30 minutes using a dosing pump. After ageing for 1 hour, the reaction was cooled to room temperature.

The reaction yielded 190 g of a light colored product. A small sample was adjusted to pH 14 for analysis by 31P NMR and the presence of 80% oligomeric product was calculated. The molecular weight was determined, using gel permeation chromatography and polyacrylic acid standards, to be 429.
[0171] The reaction was heated to 100° C. under nitrogen and then formaldehyde (24.8 g 36 wt %, 0.296 mol) was added over 30 minutes using a dosing pump. After ageing for 1 hour, the reaction was cooled to room temperature. At this point, a small sample was adjusted to pH 14 for analysis by 31P NMR and the presence of 89.6% oligomeric product was calculated.

[0172] The reaction mixture was then re-heated to 100° C. and a further portion of formaldehyde (2.48 g) was added. After a further 1 hour the reaction mixture was cooled to room temperature. Upon standing the mixture separated into 2 layers but became homogeneous as sodium hydroxide (75 g, 46.48 wt %) was added. The reaction yielded 961 g of a brown colored product.

[0173] The solids content of the product was measured as 17.5 wt %; A small sample was adjusted to pH 14 for analysis by 31P NMR and showed 94% broad polymeric peaks (35-40 ppm). The product exhibited a weight average molecular weight of 725 grams per mole (as determined using gel permeation chromatography and polyacrylic acid standards).

EXAMPLE 6

[0174] A phosphinate compound according to formula (E6):

\[
\begin{align*}
\text{H}_2\text{N} & \text{(CH}_3\text{)}_6\text{N} \text{H} \text{CO}_2\text{H} \\
& \text{O} \\
\text{OH} & \text{OH} \\
\text{H}_2\text{O} & \\
\text{N} & \text{(CH}_2\text{)}_6\text{N} \\
& \text{OH} \\
\text{OH} & \text{OH}
\end{align*}
\]

was made as follows:

[0175] To a 500 ml flask was added 1,6-diaminohexane (5.8 g, 0.05 mol), hydrochloric acid (5 g, 36 wt %, 0.05 mol) and 100 ml deionized water. The mixture was heated to 50° C. and stirred for 1 hour, after which the amine had all dissolved. An oligomer made according to Oligomer Method 2 (106 g, 0.025 mol) was added. The reaction mixture was measured as pH 1 and was milky in color and viscous.

[0176] The reaction was heated to 100° C. under nitrogen and then formaldehyde (4.2 g 36 wt %, 0.05 mol) was added over 30 minutes using a dosing pump. At this point, a small sample was adjusted to pH 14 for analysis by 31P NMR and the presence of a few % of the starting oligomer was calculated. A further portion of formaldehyde (2.0 g) was added. After a further 1 hour the reaction mixture was cooled to room temperature. The reaction yielded 220 g of a brown colored product.

[0177] A small sample was adjusted to pH 14 for analysis by 31P NMR, and showed 93% broad polymeric peaks (35-40 ppm). The product exhibited a weighty average molecular weight of 763 grams per mole (as determined using gel permeation chromatography and polyacrylic acid standards).

EXAMPLE 7

[0178] A phosphinate compound according to formula (E7):

\[
\begin{align*}
\text{H}_2\text{N} & \text{(CH}_3\text{)}_6\text{N} \text{H} \text{CO}_2\text{H} \\
& \text{O} \\
\text{OH} & \text{OH} \\
\text{H}_2\text{O} & \\
\text{N} & \text{(CH}_2\text{)}_6\text{N} \\
& \text{OH} \\
\text{OH} & \text{OH}
\end{align*}
\]

was made as follows.

[0179] An oligomer was made as follows (Oligomer Method 3'). An aqueous solution of 1,8-diaminoctane (147 g in 330 ml of water) was mixed with hypophosphorous acid (264 g of a 50% by weight aqueous solution) and hydrochloric acid (203 g of a 36% by weight aqueous solution) to give a solution of pH 1. This solution was then heated to reflux and formaldehyde (160 g of a 37.5% by weight aqueous solution) was added dropwise over a period of 30 minutes. The reaction mixture was refluxed in total for a period of 60 minutes. The resulting mixture was then allowed to cool to room temperature and then adjusted to pH 14 for analysis only, by the addition of sodium hydroxide (2 g of 47% by weight aqueous solution to 2 g of the reaction mixture). The reaction yield was 1104 g. Gel permutation chromatography gave molecular weight of 380 grams per mole with a polydispersity of 1.9. The product was characterized by 31P NMR, the spectrum showed an oligomeric product with 74% phosphinic acid groups which could be further reacted. An aqueous solution of the product (80 g in 43 ml of water) was adjusted to pH 4 by the addition of sodium hydroxide (5 g of 47% by weight aqueous solution) to form mixture 7A.

[0180] An aqueous solution of acrylic acid (84 g in 336 ml of water) was adjusted to pH 4 by the addition of sodium hydroxide (30 g of 47% by weight aqueous solution) to form mixture 7B.

[0181] A 1 L vessel was charged with half of mixture 7A and heated to reflux. The remaining half of mixture 7A was dissolved with half of mixture 7B to give mixture 7C and added to the vessel over a period of 180 minutes. Simultaneously, an aqueous solution of sodium persulphate (8.3 g in 111 ml of water) was added dropwise over a period of 390 minutes. As mixture 8C was completed, the remaining half of mixture 7B was added dropwise over a period 150 minutes. The reaction mixture was refluxed for a total of 450 minutes after which it was allowed to cool to room temperature. The product exhibited a weight average molecular weight of 2473 grams per mole and a polydispersity of 2.9 (as determined using gel permeation chromatography and polyacrylic acid standards). The product was further characterized using 31P NMR giving a spectrum which accorded with the suggested product.
EXAMPLE 8

[0182] A phosphinate compound according to formula (E8):

\[
\begin{align*}
\text{CO}_2\text{H} & - \text{H} - \text{C} & \text{O} & - \text{H} \\
\text{O} & - \text{H} & \text{N} & - (\text{CH}_2)_{12} & \text{N} & - \text{H} & \text{CO}_2\text{H} \\
\text{H} & & & & \text{H} & & \\
\end{align*}
\]

was made as follows.

[0183] An oligomer was made as follows ("Oligomer Method 4"). An aqueous solution of 1,12-diaminododecane (204 g in 624 ml of water) was mixed with hypophosphorous acid (264 g of a 50% by weight aqueous solution) and hydrochloric acid (203 g of a 36% by weight aqueous solution) to give a solution of pH 1. This solution was then heated to reflux and formaldehyde (160 g of a 37.5% by weight aqueous solution) was added dropwise over a period of 30 minutes. The reaction mixture was refluxed in total for a period of 60 minutes. The resulting mixture was then allowed to cool to room temperature and then adjusted to pH 14 for analysis only, by the addition of sodium hydroxide (2 g of 47% by weight aqueous solution to 2 g of the reaction mixture). The reaction yield was 1455 g. Gel permeation chromatography gave a molecular weight of 325 with a polydispersity of 1.2. The product was characterized by $^31P$ NMR, the spectrum showed an aliphatic product with 60% phosphonic acid groups which could be further polymerized. An aqueous solution of the product (100 g) was adjusted to pH 4 by the addition of sodium hydroxide (7.5 g of 47% by weight aqueous solution) to form mixture 8A.

[0184] An aqueous solution of acrylic acid (50 g in 200 ml of water) was adjusted to pH 4 by the addition of sodium hydroxide (23.4 g of 47% weight aqueous solution) to form mixture 8B.

[0185] A 1.1 L vessel was charged with half of mixture 8A and heated to reflux. The remaining half of mixture 8A was dissolved with half of mixture 8B to give mixture 8C and added to the vessel over a period of 180 minutes. Simultaneously, an aqueous solution of sodium persulphate (4.9 g in 66 ml of water) was added dropwise over a period of 390 minutes. As mixture 8C was completed, the remaining half of mixture 8B was added dropwise over a period 150 minutes. The reaction mixture was refluxed for a total of 450 minutes after which it was allowed to cool to room temperature. The product exhibited a weight average molecular weight of 2373 g/mole and a polydispersity of 2.4 (as determined using gel permeation chromatography and polyacrylic acid standards). The product was further characterized using $^31P$ NMR giving a spectrum which accorded with the suggested product.

EXAMPLE 9

[0186] The treated fabric substrates of Examples 9-1 to 9-8 were made as follows.

[0187] Aqueous 1 wt % solutions of the phosphinate compounds of Examples 1-8 were prepared. The pH of the each of the solutions was adjusted to pH=1, pH=1.5, or pH=9, as noted in TABLES I and II below.

[0188] Samples of nonwoven poly(propylene) fabric (each 30 cm x 20 cm, having a weigh about 17 grams per square meter of fabric and an average thickness of about 0.12 millimeters ("mm")) were cut, marked to distinguish upper side to be treated, weighed, and placed against an aluminum foil. Gloves were worn during all handling of the fabric. The fabric samples were each treated with a respective one of the phosphinate solutions dipping the fabric sample into the solution, removing the fabric sample from the solution and then squeezing excess solution out of the fabric. The dampened fabrics samples were then dried by placing the samples in an oven at 60°C for about 30 minutes, and cooled to room temperature. Based on the difference between the weight of the fabric after treatment and the weight before treatment, the treated fabric typically contained from about 0.02 to 0.1 gram of phosphinate compound per gram of treated fabric.

[0189] The treated fabric samples were evaluated by rinsing in a dilute salt solution and measuring the surface tension of rinse solution according to ASTM 1331 (except as specifically noted below). In each case, A 20x18 cm sample (360 cm$^2$ total area) was cut from the treated fabric. The fabric sample was placed onto 40 milliliters ("mL") of a 0.90 wt % NaCl aqueous solution and the fabric was stirred in the solution for 10 seconds, the fabric was then allowed to sit without any agitation for 5 minutes, was then stirred for 10 seconds, and was then removed from the solution. The solution was allowed to rest for 10 minutes and the surface tension of the solution was then determined using a Wilhelmy plate (Kruß Instruments).

[0190] The surface tension results for the treated fabrics of Examples 9-1A to 9-8 are set forth in TABLE I below in milliNewtons per meter (mN/m) for each fabric, along with the identity of the phosphinate compound used to treat the fabric and the pH of the treatment solution.

<table>
<thead>
<tr>
<th>Fabric EX #</th>
<th>Phosphinate Compound EX #</th>
<th>pH</th>
<th>Surface Tension (mN/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-1A</td>
<td>1</td>
<td>1.5</td>
<td>37.78</td>
</tr>
<tr>
<td>9-1B</td>
<td>1</td>
<td>9.0</td>
<td>45.99</td>
</tr>
<tr>
<td>9-2A</td>
<td>2</td>
<td>1.5</td>
<td>28.78</td>
</tr>
<tr>
<td>9-2B</td>
<td>2</td>
<td>9.0</td>
<td>29.74</td>
</tr>
<tr>
<td>9-3A</td>
<td>3</td>
<td>1.5</td>
<td>32.58</td>
</tr>
<tr>
<td>9-3B</td>
<td>3</td>
<td>9.0</td>
<td>39.96</td>
</tr>
<tr>
<td>9-4A</td>
<td>4</td>
<td>1.5</td>
<td>27.51</td>
</tr>
<tr>
<td>9-4B</td>
<td>4</td>
<td>9.0</td>
<td>44.01</td>
</tr>
<tr>
<td>9-5A</td>
<td>5</td>
<td>1.5</td>
<td>27.16</td>
</tr>
<tr>
<td>9-5B</td>
<td>5</td>
<td>9.0</td>
<td>29.54</td>
</tr>
<tr>
<td>9-6A</td>
<td>6</td>
<td>1.5</td>
<td>36.75</td>
</tr>
<tr>
<td>9-6B</td>
<td>6</td>
<td>9.0</td>
<td>36.85</td>
</tr>
<tr>
<td>9-7A</td>
<td>7</td>
<td>4.5</td>
<td>50.6</td>
</tr>
<tr>
<td>9-7B</td>
<td>7</td>
<td>10</td>
<td>52.7</td>
</tr>
<tr>
<td>9-8</td>
<td>8</td>
<td>1.7</td>
<td>61.1</td>
</tr>
</tbody>
</table>

[0191] The surface tension of a control aqueous solution of 0.909 wt % NaCl was determined to be about 72 mN/m. A reduction of the surface tension of the solution used to rinse a treated fabric sample provides a rough indication of the amount of phosphinate compound washed off of the fabric sample by the rinse procedure. A rinse solution surface tension that is close to that of the control salt solution
indicates minimal rinse-off; and increasing magnitude of the difference between the rinse solution and the control salt solution indicating increasing amount of phosphate rinse-off.

[0192] The treated fabric samples were also evaluated by a “strikethrough” test according to EDANA test 150.3-96 (except as specifically noted below). A 12x12 cm sample of treated fabric was placed on top of a stack of 10 filter papers (ERT-FF3) and placed under a 50 mL separating funnel. A conductivity electrode made from stainless steel was placed on top of the stack of filter papers and under the treated fabric. A burette was filled with 0.9% wt % NaCl (saline solution) up to 50 mL. Making sure that the funnel stopcock was closed, a 5 mL aliquot of the saline solution was delivered from the burette to the funnel. The funnel stopcock was opened and the time from the moment the liquid touched the fabric until all liquid disappears into the stack of filter papers (the “strikethrough time”) was measured. After 60 seconds, a second 5 mL aliquot of the saline solution was introduced to the fabric sample. Three samples were tested for each treated fabric and five “gushes”, that is separate 5 mL aliquots of salt solution, were used for each sample. The average strikethrough time, in each case arithmetic average of the results for three samples of treated fabric, for the fabrics of Examples 9-7A, 9-7B, and 9-8 was greater than 50 seconds for each of five gushes. The results for treated fabrics of Examples 9-1A to 9-6B are set forth in TABLE II below in seconds (s) as the arithmetic average of the results for the three samples of each fabric, along with the identity of the phosphate compound used to treat the fabric and the pH of the treatment solution.

<table>
<thead>
<tr>
<th>Fabric EX #</th>
<th>Phosphinate Compound EX #</th>
<th>pH</th>
<th>Gush #</th>
<th>Average Strikethrough Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-1A 1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4.92</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>5.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>6.34</td>
<td></td>
</tr>
<tr>
<td>9-1B 1</td>
<td>2</td>
<td>3</td>
<td>2.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>3.34</td>
<td></td>
</tr>
<tr>
<td>9-2A 2</td>
<td>2</td>
<td>3</td>
<td>2.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>2.63</td>
<td></td>
</tr>
<tr>
<td>9-2B 2</td>
<td>2</td>
<td>3</td>
<td>1.84</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>4.11</td>
<td></td>
</tr>
<tr>
<td>9-3A 3</td>
<td>3</td>
<td>3</td>
<td>1.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>2.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>3.36</td>
<td></td>
</tr>
<tr>
<td>93-B 3</td>
<td>3</td>
<td>3</td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>3.33</td>
<td></td>
</tr>
</tbody>
</table>

1. A hydrophilized fiber, comprising a fiber having a hydrophobic surface and a phosphate compound according to formula (I):

![Diagram of A](image)

wherein:

A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):

![Diagram of A'](image)

wherein:

A' is an organic group according to formula (III):

![Diagram of A'](image)

B, R^4, and R^{10} are each independently methylene or poly(methylene), which may optionally be substituted on one or more of such methylene units, and which may optionally be interrupted at one or more positions by an oxygen atom,

R^{11}, R^{2}, R^{3}, R^{2}, R^{7}, R^{5}, R^{6}, R^{11}, R^{12}, and R^{13} are each independently H, alkyl, alkoxyl, cycloalkyl, alkenyl, aryl, aralkyl, alkaryl, or heterocyclyl,

m, n, and n' are each independently 0 or an integer of from 1 to about 100, provided that m cannot be 0 if n' is 0,
q and s are each independently 0 or an integer of from 1 to about 50, and

p, r, and r' are each independently an integer of from 1 to about 20, or a salt thereof,

disposed on at least a portion of such hydrophobic surface in an amount effective to increase the hydrophilicity of such portion of such hydrophobic surface.

2. The hydrophilized fiber of claim 1, wherein the fiber is a hydrophobic synthetic polymer fiber.

3. A hydrophilized fabric, comprising one or more hydrophilized fibers according to claim 1.

4. The hydrophilized fabric of claim 3, wherein the fabric is a nonwoven fabric.

5. The hydrophilized fiber of claim 1, wherein n and n' are each 0 and m is an integer of from 1 to about 100.

6. The hydrophilized fiber of claim 1, wherein m is 0 and n and n' are each independently an integer of from 1 to about 100.

7. The hydrophilized fiber of claim 1, wherein A is derived from an ethylenically unsaturated monomer and is an organic group according to the formula (IV):

\[
\begin{align*}
    R^{20} & \quad \text{is H or methyl,} \\
    D & \quad \text{is O or NH,} \\
    R^{21} & \quad \text{is H, alkyl or hydroxyalkyl, and} \\
    t & \quad \text{is an integer of from 1 to about 100.}
\end{align*}
\]

8. The hydrophilized fiber of claim 1, wherein A is derived from an ethylenically unsaturated monomer and is an organic group according to the formula (IV):

\[
\begin{align*}
    R^{22} & \quad \text{and each } R^{23} \text{ is independently H, alkyl, hydroxy, or carboxyl, provided that at least one } R^{22} \text{ or } R^{23} \\
    & \quad \text{of such radical is alkyl, hydroxy, or carboxyl, and wherein } v \text{ is an integer of from 1 to about 49.}
\end{align*}
\]

9. The hydrophilized fiber of claim 1, wherein:

\[
\begin{align*}
    m & = 0, \\
    n' & = \text{an integer of from 1 to about 30,}
\end{align*}
\]

A is a group according to formula (II), wherein R^1, R^2, R^3, R^4, and R^5 are each H, R^2 is methylene or (C_2-C_5), poly(methylene), p is an integer of from 1 to about 20, and q is an integer of from 1 to about 30, and

B is a group according to formula (V), wherein R^{22} is hydroxy(C_1-C_5) alkyl, R^{23} is H, and u is an integer of from 1 to about 10.

10. The hydrophilized fiber of claim 1, wherein:

\[
\begin{align*}
    m & = 0, \\
    n' & = \text{an integer of from 1 to about 30,}
\end{align*}
\]

A is a group according to formula (II), wherein R^1, R^2, R^3, and R^5 are each H, R^2 is methylene or (C_2-C_5), poly(methylene), p is an integer of from 1 to about 20, and q is 0, and

B is a group according to formula (V), wherein R^{22} is hydroxy(C_1-C_5) alkyl, R^{23} is H, and u is an integer of from 1 to about 10.

11. The hydrophilized fiber of claim 10, wherein each A^' is a group according to formula (III), wherein R^7, R^8, R^9, R^{13}, and R^{14} are each H, R^2 is hydroxy(C_1-C_5) alkyl, r and r' are each independently integers of from 1 to about 20, and s is 0.

12. The hydrophilized fiber of claim 1, wherein:

\[
\begin{align*}
    m & = \text{an integer of from 1 to about 30,} \\
    n' & = \text{an integer of from 1 to about 30,}
\end{align*}
\]

A is a group according to formula (II), wherein R^1, R^2, R^3, and R^5 are each H, R^2 is (C_2-C_5), poly(methylene), p is an integer of from 1 to about 20, and q is 0, and
A' is a group according to formula (III), wherein $R^7$, $R^8$, $R^{12}$, $R^{13}$ are each H, $R^9$ is hydroxy(C$_1$-C$_6$)alkyl, $r$ and $r'$ are each independently integers of from 1 to about 20, and $s$ is 0.

19. The hydrophilized fiber of claim 1, wherein:

- $m$ is an integer of from 1 to about 30,
- $n$ and $n'$ are each 0,
- $A$ is a group according to formula (IV), wherein $R^{20}$ is H or methyl, $R^{21}$ is H or (C$_1$-C$_6$)alkyl, and $t$ is an integer of from 1 to about 20, and
- $A'$ is a group according to formula (III), wherein $R^7$, $R^8$, $R^{10}$, $R^{11}$, and $R^{12}$ are each H, $R^{13}$ is methylene or (C$_2$-C$_6$)poly(methylene), $r$ and $r'$ are each independently integers of from 1 to about 20, and $s$ is an integer of from 1 to about 20.

20. The hydrophilized fiber of claim 1, wherein the phosphinate compound according to formula (I) exhibits a weight average molecular weight of from about 500 to about 500,000 grams per mole.

21. An absorbent article, comprising a hydrophilized fabric according to claim 3.

22. The absorbent article of claim 21, wherein the absorbent article has a composite laminate structure and comprises at least one layer of a porous hydrophilized fabric, at least one layer of a nonporous water impermeable film, and at least one layer of an absorbent material, disposed between the layer of porous hydrophilized fabric and the layer of nonporous water impermeable film.

23. The absorbent article of claim 22, wherein porous hydrophilized fabric is a porous hydrophilized nonwoven fabric.

24. The absorbent article of claim 22, wherein the absorbent material is a superabsorbent material.

25. A method for hydrophilizing a fiber having a hydrophobic surface, comprising treating such at least a portion of a hydrophobic surface with a phosphinate compound according to formula (I):

$$\begin{align*}
A' & \text{ is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
\end{align*}$$

wherein:

- $A$ is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):

$$\begin{align*}
A & = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
\end{align*}$$

wherein:

- $A'$ is an organic group according to formula (III):

$$\begin{align*}
A' & \text{ is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
\end{align*}$$

wherein:

- $A'$ is an organic group according to formula (III):

$$\begin{align*}
A' & \text{ is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
\end{align*}$$

wherein:

- $A$ is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):

$$\begin{align*}
A & = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
& = \text{A is an organic group comprising one or more monomeric units derived from an ethylenically unsaturated monomer or an organic group according to formula (II):} \\
\end{align*}$$

wherein:

- $A'$ is an organic group according to formula (III):

$$\begin{align*}
A' & \text{ is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
\end{align*}$$

wherein:

- $A'$ is an organic group according to formula (III):

$$\begin{align*}
A' & \text{ is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
& = \text{A' is an organic group according to formula (III):} \\
\end{align*}$$

wherein:
B, R', and R'' are each independently methylene or poly(methylene), which may optionally be substituted on one or more of such methylene units, and which may optionally be interrupted at one or more positions by an oxygen atom.

R¹, R², R³, R⁴, R⁷, R⁸, R⁹, R¹¹, R¹² and R¹³ are each independently H, alkyl, alkoxy, cycloalkyl, alkenyl, aryl, aralkyl, alkaryl, or heterocyclyl.

m, n, and n' are each independently 0 or an integer of from 1 to about 100, provided that m cannot be 0 if n' is 0, q and s are each independently 0 or an integer of from 1 to about 50, and

p, r, and r' are each independently an integer of from 1 to about 20, or a salt thereof.

dispensed on at least a portion of such hydrophobic surface in an amount effective to increase the hydrophilicity of such portion of such hydrophobic surface.

27. The hydrophilized fiber of claim 26, wherein the crosslinking agent is a diepoxide.

28. The hydrophilized fiber of claim 26, wherein the phosphinate layer further comprises a phosphinate compound according to formula (I) that is not crosslinked.

* * * * *