Abstract:
Remshartgasschen NIEDERSTADT, Inventor; MAN Applicant Filing International [DE].

Inventors; and

Dimeric and/or oligomeric silanes and their reaction products with organosiloxanes are described. The dimeric or oligomeric silanes or mixtures thereof can be prepared by reaction of silanes which contain 2 or 3 OR groups with water. The further reaction of these dimeric and/or oligomeric silanes with organosiloxanes leads to polysiloxanes with functional groups. The polysiloxanes that form are suitable inter alia for the coating of fabrics.
The invention relates to dimeric or oligomeric silanes or mixtures thereof and to the reaction products of these silanes with organosiloxanes. It further relates to the use of the polyorganosiloxanes obtained in this reaction for the coating of fabrics.

Polysiloxanes which contain acrylate groups are known, e.g. from DE-A 102 19 734, EP-A 564 253, US-A 4 528 081 and EP-A 373 659 and US 6 211 322 B1. Furthermore, it is evident from the abovementioned literature that it is known to cure silicon compounds which contain acrylate units by free-radical polymerization. This free-radical polymerization can take place, for example, by UV irradiation.

According to the prior art, polyorganosiloxanes with functional groups, e.g. acrylate groups, in side chains can be prepared by condensation or equilibration reactions. Here, polyorganosiloxanes are reacted with monomeric silanes carrying reactive groups, where, in the case of condensation reactions, polysiloxanes with terminal OH groups are used as starting compounds.

The polyorganosiloxanes with reactive groups in side chains known from the prior art contain the side chains in random distribution. The reactivity of such polysiloxanes, e.g. with regard to their rapid curability or with regard to the oil repellent effects that can be achieved therewith, is not satisfactory in all cases.

The object of the present invention was to provide silanes from which, following reaction with polyorganosiloxanes, polymers can be obtained which have increased reactivity, e.g. in curing processes, or which are suitable for improving certain effects, e.g. the oil repellent effect of fiber materials treated with these polymers.

The object was achieved by dimeric and/or oligomeric silanes preparable by reaction of a silane of the formula (I).
or of a mixture of such silanes, with water, or of a mixture of a silane of the formula (I) and a compound of the formula (Ia), with water,

\[ X(O\text{R}^{15})_4 \]  

(Ia)

where \( X \) is Si or Ti,

in which all of the radicals \( R^{15} \), independently of one another, are \( R \) or are

\[ \text{O} \quad \text{O} \]
\[ \text{P}-\text{O}-\text{P}-\text{O}-\text{R} \]
\[ \text{OH} \quad \text{O}-\text{R} \]

or preferably \(-\text{CH}(\text{CH}_3)_2\),

where 0.5 to 1.5 mol of water are used per mole of silane or silane mixture, to give a dimeric and/or oligomeric product which contains 2 to 200, in particular 2 to 50, particularly preferably 2 to 15, silicon atoms in the molecule or to give a mixture of such dimeric or oligomeric products, where optionally in a first step firstly two identical or different silanes of the formula (I) are reacted together to give a dimer or oligomer and then this dimer or oligomer is further reacted with water under the abovementioned conditions,

where all of the radicals \( R \) present, independently of one another, are the phenyl radical or a branched or unbranched alkyl radical having 1 to 18 Carbon atoms, preferably \( \text{CH}_3 \) or \( \text{C}_2\text{H}_5 \),

\( R^1 \) is \( R \) or \( \text{OR} \) or

\[ \text{CH}_2-\text{NH}-\text{C}_6\text{H}_5 \]

where \( R^2 \) is the vinyl radical or a linear or branched alkyl radical having 1 to 18 carbon atoms, which may be substituted by one or more, optionally quaternized, amino groups, amido groups, mercapto groups, epoxy groups, phosphono groups, hydroxy groups or fluorine atoms, or where

\( R^2 \) is a radical of the formula (II), of the formula (III) or of the formula (IV),

\[ \text{O}-\text{R}^5 \]

(Ii)

\[ \text{O}-\text{R}^5 \]

in which both radicals \( R^5 \) are

\[ \text{O} \quad \text{R}^3 \]

or one of the radicals \( R^5 \) is \( \text{H} \) and the other is
where \( p \) is 0, 1 or 2,

where \( R_3 \) is in each case H or CH₃,

or where \( R_2 \) is a radical of the formula (V)

\[
-R^4-O-C-C≡CH_2
\]

(V)

in which \( R^4 \) is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms,

or where \( R_2 \) is a radical of the formula (VI) or of the formula (VII) or of the formula (X)

\[
-R^4-\text{NH-CH2CH2}-\text{COOR}^8
\]

(VH)

in which \( R^8 \) is H or CH₃ or C₂H₅ or -CH₂CH₂OH and \( R^8 \) is H or -COOR^8

\[
-R^2-\text{NH-CH₂CH₂-CH2NH-CH₂COOR}^8
\]

(X)

or in which \( R^2 \) is a radical of one of the formulae (XI), (Xla) or (XII) to (XX) or of the formula

(XVIIIa) or formula (XXa) or formula (XXb) or formula (XXc),

\[
-R-R-R-\text{Si-OR}
\]

(XI)

\[
-R^4\left(\text{NH-CH₂CH₂}\right)_p-\text{NH-CH-CH-C-}\text{NR₂}
\]

(Xla)
in which $p$ is 0, 1 or 2.

$R^4$ is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms,

$R^3$ is in each case H or CH$_3$,

$R^{14}$ is H or a linear or branched alkyl radical having 1 to 18 carbon atoms or is a radical of the formula (XIX),

in which the individual units -(CH$_2$O)$_f$- and -(CHR$_3$O)$_f$- may be distributed arbitrarily over the chain, in which $k$ and $l$ are in each case a number in the range from 1 to 22 and the sum $k+l$ is in the range from 3 to 25,

in which $f$ is 0 or 1,

all of the radicals $R'^6$, independently of one another, are H or
in which A is a direct bond or a divalent radical of the formula

\[
\begin{align*}
\text{CH}_2\text{O}-\left(\text{CH}-\text{CH}-\text{O}\right)_s\text{R}^{17} \\
\text{CH}_2\text{C}-\text{CH}_2\text{O}- \\
\text{R}^{12}
\end{align*}
\]

where the values of \(u, v\) and \(s\) are chosen such that the equivalent weight of this radical \(R^2\) is in the range from 100 to 5000, where one or two of \(u, v\) and \(s\) can also assume the value 0 and where the individual units \(-\text{CH}_2\text{CH}_2\text{O}-\) and \(-\text{CH}-\text{CH}-\text{O}-\)

can be distributed arbitrarily over the chain,

where \(R^{12}\) is H or \(\text{C}_2\text{H}_5\) and
where \(R^{17}\) is \(\text{R}\) or \(-\text{R}^1\text{-NH}_2\) or

\[
\begin{align*}
\text{-CH-CH-NH-CH-CH-CH}_2\text{O-}\text{R-Si(OR)}_2\text{R}^{11} \\
\text{CH}_3\text{OH}
\end{align*}
\]

\[
\text{R}^{13}
\]

\[
\text{N}\left(\text{CH}_2\right)_3\text{M}
\]

\[
\text{OH}
\]

\[
\text{OH}
\]

where \(M\) is selected from

\[
\text{-OR}, \text{NR}_2, \text{N} \quad \text{and} \quad \text{Si[OSi(CH}_3)_3]_2
\]

\[
\text{CH}_2
\]

\[
\text{OH}
\]

where \(M\) is selected from

\[
\text{-OR}, \text{NR}_2, \text{N} \quad \text{and} \quad \text{Si[OSi(CH}_3)_3]_2
\]

\[
\text{CH}_2
\]

\[
\text{OH}
\]

\[
\text{OH}
\]

\[
\text{XVIII}
\]

\[
\text{XVIIIa}
\]

\[
\text{XIX}
\]
\[
- R^4\left(\text{NH-CH}_2\text{-CH}_2\right)_{p}\text{-NH-CH}_2\text{-CH-CH}_2\text{-RF} \quad (XX)
\]

\[
- R^4\text{INH-CH}_2\text{CH}_2\text{J-NH-CH-RF} \quad (XXa)
\]

\[
- R^4\left(\text{NH-CH}_2\text{-CH}_2\right)_{p}\text{-NH-CH}_2\text{-CH-CH}_2\text{-O-}\text{C-}\text{C=CH}_2 \quad (XXb)
\]

\[
- R^4\text{INH-CH}_2\text{CH}_2\text{V-NH-CH-CH}_2\text{-NR}_2 \quad (XXc)
\]

In which RF is a perfluoroalkyl radical having 5 to 23 carbon atoms,
in which \( R^{10} \) is a divalent radical of one of the formulae (XXI) to (XXIVa),

\[
-0\text{-CH}_2\text{-CH-CH-N} \quad - R^{11} \quad \text{N-CH}_2\text{-CH-CH}_2\text{-O} \quad (XXI)
\]

In which \( R^{13} \) is H or \(-\text{CH(CH}_3)_2\) or \(-\text{CH}_2\text{-CH(CH}_3)_2\),

\[
\begin{array}{c}
\text{NH} \quad \text{OH} \\
\text{NH} \quad \text{OH}
\end{array}
\quad (XXII)
\]

\[
\left(\text{NH-CH}_2\text{-CH}_2\right)_{p}\text{-NH-CH-CH}_2\text{-OH} \quad - K \quad - \text{O-CH-CH-NH}\left(\text{CH}_2\text{-CH}_2\text{NH}\right)_p \quad (XXIII)
\]

In which \( K \) is a linear or branched alkylene radical having 2 to 18 carbon atoms,
in which \( f \) is 0 or 1

where each of the radicals \( R^i \) is

\[
-\text{CH}_2^d
\]

in which \( d \) is a number from 1 to 6,

or is a radical of one of the formulae (XXV) to (XXXI),

\[
-\text{CH}_2^f \text{NH} \text{CH}_2^f
\]

(XXV)

\[
-\text{CH}_2^3 \text{NH} \text{CH}_2^3 \text{NH} \text{CH}_2^3
\]

(XXVI)

\[
-\text{CH}_2^f \text{CH}_2^f
\]

(XXVII)

\[
-\text{CH}_2^f \text{CH}_2^f
\]

(XXVIII)

\[
-\text{CH}_2^f \text{CH}_2^f \text{CH}_3 \text{CH}_3
\]

(XXIX)

\[
-\text{CH}_2^f \text{NH} \text{R}^i \text{Si} \text{R}^j \text{O} \text{Si} \text{R}^k \text{NH} \text{CH}_2^f
\]

(XXX)
in which \( z \) is a number from 8 to 500, preferably from 8 to 20, where all or some of the nitrogen atoms which are present in the abovementioned formulae and which are not part of an amide group may be present in quaternized form.

The dimeric/oligomeric silanes according to the invention are suitable for the treatment of fabrics, such as, for example, wovens.

The reaction of the dimeric or oligomeric silanes according to the invention or of mixtures of these silanes with organosiloxanes of the formula (VIII) leads to novel polyorganosiloxanes in which the reactive groups originating from the silanes in side chains are present in block form, whereas products from the prior art have the reactive side chains in statistical distribution.

Surprisingly, it has been found that these novel polyorganosiloxanes can on the one hand have excellent reactivity, in particular in curing processes, and on the other hand can bring about improved effects of fiber materials treated therewith, such as, for example, increased oil repellent effect. Advantages result particularly when the functional groups \((R^2)\) present in the silanes contain acrylate radicals, see, for example, formulae (III), (IV), (V) and (XVI). These acrylate radicals are then also present in the products obtained following reaction with organosiloxanes and can cure and/or polymerize, e.g. through UV radiation. This makes the novel polysiloxanes highly suited for coating processes, e.g. coating fabrics. Glass-fiber fabric can also be treated with these novel polysiloxanes. In addition, glass-fiber fabric can also be treated with dimeric/oligomeric silanes according to the invention and then be cured, or condensed with the elimination of alcohol. The application of the dimeric/oligomeric silanes according to the invention or of the novel polysiloxanes according to the invention to the fabrics or to the glass-fiber fabric can take place by known methods, e.g. by coating or padding (bath impregnation).

The starting substances used for the preparation of silanes according to the invention are silanes of the formula (I)

\[
\begin{align*}
\text{RO}-\text{Si}&-(R^2)\text{Si}-\text{R}^1 \\
\text{R} & \\
\text{O} & \\
\end{align*}
\]

\[(\text{I})\]

It is possible to use a single compound of the formula (I) or a mixture of such silanes. The silane or silane mixture is reacted with water in quantitative ratios such that 0.5 to 1.5 mol of water are used per mole of silane. If a mixture of silanes/formula (I) is used, then of course the number of
moles of the individual silanes present in the mixture are to be added together in order to calculate the required amount of water.

The described reaction of the silanes of the formula (I) with water leads to a dimeric or oligomeric product or a mixture of such products. This comprises on average 2 to 200, in particular 2 to 50 and particularly preferably 2 to 15, silicon atoms in the molecule. In the normal case, the product that forms is a mixture which contains dimeric and oligomeric silanes. These dimeric or oligomeric silanes are formed in the reaction of the silanes of the formula (I) with water by 2 OR groups of two different silane molecules reacting in the presence of water with the elimination of ROH to give compounds which have Si-O-Si bonds. The number of silicon atoms which the resulting mixture contains on average per molecule, and also the relative quantitative ratio of dimer to oligomer can be controlled in a manner known to the chemist through the reaction conditions, thus, for example, through the ratio of the amount of silanes used to the amount of water. The silanes of the formula (I) used are preferably compounds which are liquid at room temperature. If silanes of solid consistency are to be used, it is advisable to use a solvent which does not react with water under the conditions of the reaction of the silanes. Examples of solvents are low molecular weight dialkyl ketones.

The reaction of the silanes of the formula (I) with water takes place preferably at a temperature which is 5-10°C higher than the boiling point of the alcohols ROH resulting from the silanes, and during the reaction, the alcohol ROH resulting from silane and water is preferably distilled off directly, optionally under reduced pressure. It may be advantageous to add a catalyst for the reaction of silane with water. Suitable catalysts are described below.

The silanes of the formula (I) contain two or three OR groups bonded to an Si atom. If the radical R¹ in formula (I) is OR, 3 OR groups are present. From silanes with 2 or 3 OR groups, it is possible, following dimerization/oligomerization and subsequent further reaction with α, ω-dihydroxydialkylpolysiloxanes, which is described below, to obtain polysiloxanes which contain two or more adjacent reactive groups in block form. These reactive groups originate from the radicals R² of the silanes of the formula (I).

In a series of cases, it is advantageous not to react silanes of the formula (I) with water, but firstly to react two identical or different silanes of the formula (I) together to give a dimer or oligomer which still contains OR groups, and then in a second step to react the resulting dimer or oligomer with water. Here, the reaction with water takes place under the conditions already specified above. The process produces dimeric/oligomeric silanes according to the invention as can also be prepared by the described reaction of silanes of the formula (I) with water.

In formula (I), all of the radicals R present, independently of one another, are the unsubstituted phenyl radical or an alkyl radical having 1 to 18 carbon atoms. However, each radical R is
preferably the methyl radical or the ethyl radical.
The radical \( R^1 \) is either a radical of the specified meaning or is a radical

\[-OR\text{ or }-\text{CH}_2\text{-NH-}\]

For the radical \( R^2 \) in the silanes of the formula (I), the following various possibilities can be contemplated:

a) vinyl radical

b) linear or branched alkyl radical having 1 to 18 carbon atoms which can be substituted by one or more amino groups, amido groups, mercapto groups, epoxy groups or fluorine atoms. In the case of a substitution by amino groups, the latter may be present in free and/or quaternized form.

Suitable examples of substituted alkyl radicals of the specified type are

\[-\text{CH}_2^-\text{-NH-CO-} \quad \text{or} \quad \text{CH}_2^-3\text{-OH}\]

where \( t = 2-4 \)

\[\text{(-CH}_2\text{-)}_t\text{ N}^{\text{B}}(\text{CH}_3)(\text{CH}_3\text{Xn-C}_1\text{8H}_37)\text{ CF}^\text{p} \quad t = 2-4\]

\[-\text{CH}_3\text{O-C-CH-CH;} \quad \text{or} \quad \text{P (O CH}_2\text{)}_2\]

\[-\text{CH}_2\text{CH}_2\text{ P (OC}_2\text{H}_3\text{)}_2\]

\[-\text{CH}_2^- \text{CH}^-\text{(CH}_3\text{)}^- \quad \text{CH}_2^- \text{C(CH}_3\text{)}_2^-\text{CH}_3\]

\[-\text{CH}_2^-\text{t-HCH}_2\text{-CH}\cdot\text{CF}_3\text{CF}_3\]

where \( m = 5-15 \)

\[-(-\text{CH}_2\text{-)}_3\text{ NH-} \quad \text{CH}_2\text{ CH(OH)-} \quad \text{CH}_2\text{ (CF}_\text{t}\text{)}_m\text{CF}_3\]
or adduct thereof with HCl
(preparable from aminosilane and p-chloromethylstyrene)
c) radical of one of the formulae (II) to (VII) or of the formula (X)

\[ \overset{-R^4}{O}\overset{CH_2}{\overset{CH_2}{\overset{CH_2}{O}}}\overset{-R^5}{O} \] \hspace{1cm} (II)

\[ \overset{-R^4}{NH}\overset{C}{\overset{\left(\overset{CH_2}{\overset{CH_2}{\overset{CH_2}{O}}}\right)}{O}}\overset{C}{\overset{C}{\overset{C}{=CH_2}}} \] \hspace{1cm} (III)
Here:

- $R^3$ is hydrogen or the methyl group
- $R^4$ is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms
- $R^5$ is hydrogen or

\[
\begin{align*}
\text{--} & -\text{C--C=CH}_2 \\
& \text{--} \text{CH}_2\text{-O-CH}_2\text{C} & \text{--} \text{C=CH} & \text{--} \\
\end{align*}
\]

where at least one of the radicals $R^8$ in formula (II) is

\[
\begin{align*}
\text{--} & -\text{C--C=CH}_2 \\
& \text{--} \text{CH}_2\text{-O-CH}_2\text{C} & \text{--} \text{C=CH} & \text{--} \\
\end{align*}
\]

- $R^8$ is hydrogen or $\text{CH}_3$ or $\text{CH}_2\text{CH}_3$ or $\text{CH}_2\text{CH}_2\text{OH}$,
- $R^9$ is hydrogen or $\text{COOR}$,
- $p$ is the value 0, 1 or 2.
d) \( R^2 \) can furthermore be a radical of one of the formulae (XI), (XIa) or (XII) to (XX) or of the formula (XVIIIa) or (XXa) or (XXb) or (XXc),

\[
\begin{align*}
\text{OR} & \quad \text{(XI)} \\
\text{OR} & \quad \text{(XIa)} \\
\text{OR} & \quad \text{(XII)} \\
\text{OR} & \quad \text{(XIII)} \\
\text{OR} & \quad \text{(XIV)} \\
\text{OR} & \quad \text{(XV)} \\
\text{OR} & \quad \text{(XVI)}
\end{align*}
\]

where \( f \) is 0 or 1,
in which all of the radicals \( R^{16} \), independently of one another, are H or are

\[
\begin{align*}
\text{O} & \quad \text{OH} \\
\text{O} & \quad \text{OH}
\end{align*}
\]
in which \( A \) is a direct bond or a divalent radical of the formula

\[
\begin{align*}
\text{CH}_2- & \text{CHCHCH}_2\text{O} - R^{17} \\
& R^3 \quad R^3
\end{align*}
\]

where the values of \( u, v \) and \( s \) are chosen so that the equivalent weight of this radical \( R^2 \) is in the range from 100 to 5000, where one or two of \( u, v \) and \( s \) can also assume the value 0 and where the individual units \(-\text{CH}_2\text{CH}_2\text{O}-\) and

\[
\begin{align*}
\text{CH}- & \text{CHCH}_2\text{O} - R^3 \quad R^3
\end{align*}
\]

can be distributed arbitrarily over the chain,

where \( R^{12} \) is \( \text{H} \) or \( \text{C}_2\text{H}_5 \) and

where \( R^{17} \) is \( \text{R} \) or is \(-\text{R}^4\text{NH}_2 \) or is

\[
\begin{align*}
-\text{CH}_2\text{CHNHCHCHCH}_2\text{O} - \text{R}^-\text{Si}(\text{OR})_2 (\text{R}^1) \\
& \text{CH}_3 \quad \text{OH}
\end{align*}
\]

where \( M \) is selected from

\[
\begin{align*}
\text{R}^4\text{O}- & \text{CH}_2\text{CHNHCHCH}_2\text{N}\left(\text{CH}_2\right)_3\text{M} \\
& \text{OH}
\end{align*}
\]

\[
\begin{align*}
\text{R}^4\text{O}- & \text{CH}_2\text{CHNHCHCH}_2\text{N}\left(\text{CH}_2\right)_3\text{M} \\
& \text{OH}
\end{align*}
\]

\[
\begin{align*}
\text{R}^4\text{O}- & \text{CH}_2\text{CHNHCHCH}_2\text{N}\left(\text{CH}_2\right)_3\text{M} \\
& \text{OH}
\end{align*}
\]
-OR, \( NR_2 \), \( \text{O} \) and \( \text{Si}[\text{OSi(CH}_3\text{)}_3)_2 \)

\[ \text{R}^4\text{O}-\text{CH}_2\text{CHCH}_2\text{O}\left\{\text{CH}_2\text{CH}_2\text{O}\right\}_k\left\{\text{CH}_2\text{CH}-\text{O}\right\}_l\text{SiOSi(CH}_3\text{)}_3 \]

\( \text{CH}_3 \)

(XIX)

\[ \text{R}^4\left\{\text{NH-CH}_2\text{CH}_2\right\}_p\text{NH-CHCHCHCH}_\text{RF} \]

(XX)

\[ \text{RHNH-CH}_2\text{CH}_2\text{pNH-CH}\text{RF} \]

(XXa)

5

\[ \text{R}^4\left\{\text{NH-CH}_2\text{CH}_2\right\}_p\text{NH-CHCHCH}_\text{OH} \]

(XXb)

\[ \text{R}^4\text{INH-CH}_2\text{CH}_2\text{J-NH-CH}_2\text{CH-NR} \]

(XXC)

in which \( RF \) is a perfluoroalkyl radical having 5 to 23 carbon atoms.

Here:

\( R^3 \) is hydrogen or the methyl group,
\( R^4 \) is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms,
\( R^{14} \) is hydrogen or a linear or branched alkyl radical having 1 to 16 carbon atoms or a radical of the formula (XIX),
\( R^{10} \) is a divalent radical of one of the formulae (XXI) to (XXIVa),

\[ \text{R}^{13}\text{O-CH}_2\text{CHCH}_2\text{N}-\text{R}^{11}\text{N-CHCHCH}_\text{CH}_2\text{O-} \]

(XXI)

in which \( R^{13} \) is H or \(-\text{CH(CH}_3\text{)}_2\) or is \(-\text{CH}_2\text{-CH(CH}_3\text{)}_2\).
in which \( K \) is a linear or branched alkylene radical having 2 to 18 carbon atoms,

\[
\text{(XXIII)}
\]

in which \( f \) is O or 1,

where each of the radicals \( R^{11} \) is

\[
\text{(XXIV)}
\]

in which \( d \) is a number from 1 to 6,

or is a radical of one of the formulae (XXV) to (XXXI),

\[
\text{(XXV)}
\]

\[
\text{(XXVI)}
\]

\[
\text{(XXVII)}
\]
where all or some of the nitrogen atoms which are present in the formulae specified in this description and which are not part of an amide group may be present in quatemized form.

In the formulae (XXX) and (XXXI), z is in each case a number from 8 to 500, preferably from 8 to 20.

It is particularly preferred if silanes or silane mixtures of the formula (I) are used which contain at least one silane of the formula (I) in which $R^2$ is a radical of the formula (V)

$$\begin{array}{c}
  -R^4-O-C=\overset{\text{O}}{\text{C}}-C=\overset{\text{R^3}}{\text{CH}}_2 \\
\end{array}$$

(III)

Of very good suitability for the dimerization/oligomerization in the presence of water and for the subsequent reaction, described below, with organosiloxanes are silanes of the formula (I) in which all of the radicals $R^1$ independently of one another, are $\text{CH}_3$ or $-\text{CH}_2\text{-CH}_3$ and the radical $R^2$ is a radical of the formula (V).

Furthermore, it has been found that it is advantageous in many cases if silanes with acrylate radicals are used in which the radical $R^3$ is a methyl group, i.e. methacrylic compounds.

The silanes of the formula (I) are commercially available products or can be prepared by methods which are known to the chemist. Possible syntheses are the reaction of a silane which contains an Si-H bond and 2 or 3 chlorine atoms bonded to Si with allyl compounds, e.g. with allyl chloride and subsequent further reaction with ammonia or an amine (where the terminal
chlorine atom of the original allyl group is substituted by the corresponding nitrogen-containing radical, and subsequent substitution of the chlorine atoms bonded to Si by OR by means of reaction with alcohol. Furthermore, phosphorus-containing silanes of the formula (I) are obtainable through addition of (CH₃O)₂P(O)-H onto bisalkoxy- or trisalkoxysilanes, which contain substituents with C=C double bonds, e.g. onto

\[
\text{Si(OR)}_3^{-R^4-O-C-C≡CH}_2
\]

The preparation of certain fluorine-containing silanes of the formula (I) can take place through reaction of

\[
\text{Si(OR)}_2(R'\text{H})\cdot(\text{CH}_2\text{H})\text{H} + \text{NH}_2
\]


Silanes of the formula (I) in which the radical R₂ is a radical of the formula (V) can be prepared through reaction of (RO)₂Si(ROH) with CH₂=CH(C=CH₂)₂

\[
\text{CH}_2\text{OH} \quad \text{(the last-mentioned compound is obtainable by reaction of one of the 3 OH groups of 1,1,1-tris-methylopropane with (meth)allyl chloride),}
\]

where the Si-H bond adds onto the C=C double bond, then esterification of the two other CH₂OH groups with (meth)acrylic acid and substitution of the chlorine atoms by OR groups by means of reaction with alcohol ROH.

Silanes of the formula (I) in which the radical R₂ is a radical of the formula (I) or of the formula (IV) can be obtained by addition of a lactone, e.g. γ-butyrolactone, onto an aminoalkyldialkoxyxilane and subsequent reaction with (meth)acrylic acid or derivatives thereof.

Silanes of the formula (I) in which the radical R₂ is a radical of the formula (VII) can be prepared through addition of (meth)acrylic acid esters onto aminoalkyldialkoxyxilane.

Silanes of the formula (I) used are preferably silanes in which the radical R₂ contains acrylate units or methacrylate units. Such silanes are commercially available, e.g. from ABCR GmbH &
Co., Karlsruhe, Germany. Furthermore, such silanes can be prepared in accordance with the teaching of DE-A 102 19 734.

Silanes of formula (I) in which the radical \( R^2 \) is a radical of the formula (XI) and \( R^{10} \) is a radical of the formula (XXIII) can be obtained by reacting an amino functional silane (formula (I) where \( R^1 = R \) and \( R^2 = - R^4 \text{NH}_2 \)) with an alkyene diacrylate.

Silanes in which the radical \( R^{10} \) is a radical of one of the formulae (XVII), (XVIII) or (XX) can be obtained by reacting corresponding epoxides with corresponding amines.

Silanes of the formula (XII) where \( R^{14} = \text{alkyl radical} \) can be obtained through reaction of

\[
\begin{align*}
\text{OR} \\
\text{R-Si-R^4-NH}_2 \\
\text{OR}
\end{align*}
\]

with an acrylic acid ester.

Silanes of the formula (I) in which the radical \( R^2 \) contains acrylate units or methacrylate units are commercially available, e.g. from ABCR GmbH & Co., Karlsruhe, Germany. Furthermore, such silanes, e.g. of the formula (XVI), can be prepared by reacting

\[
\begin{align*}
\text{OR} \\
\text{R-Si-R^4-NH}_2 \\
\text{OR}
\end{align*}
\]

with an alkyene carbonate and then with acrylic acid (ester).

In the reaction of the silanes of the formula (I) with water, a catalyst or a mixture of catalysts is optionally co-used. Suitable catalysts are basic or acidic catalysts, such as, for example, potassium hydroxide or mineral acids or catalysts which are specified below for the reaction of the silanes according to the invention with organosiloxane of the formula (VIII).

The reaction of the silanes of the formula (I) or of the mixtures of such silanes with water can be carried out in the normal case at room temperature. However, if appropriate, it is also possible to work at a somewhat elevated temperature, preferably at a temperature which is somewhat higher than the boiling point of the alcohol ROH to be eliminated. The reaction time can be a few minutes to several days depending on the type and amount of the starting compounds. For the case where liquid silanes of the formula (I) are used, processing can be without use of an additional solvent.
Dimeric or oligomeric silanes according to the invention can be used for the modification of carbon nanotubes or for the treatment of sheet materials made of polypropylene fibers or for the modification of epoxy resins.

Dimeric or oligomeric silanes according to the invention or mixtures thereof are particularly well suited for the preparation of new types of polyorganosiloxanes. These new types of polyorganosiloxanes are particularly well suited for the treatment or coating of fabrics and can be prepared through reaction of a dimeric and/or oligomeric silane according to claim 1 or 2 or of a mixture of such silanes with an organosiloxane of the formula (VIII)

$$R^7 (R)_2 Si - O - \left[ Si - O_{x} \right] - Si(R)_2 R^7$$  \hspace{1cm} (VIII)

where R⁶ is a radical R of the specified meaning or is a radical of the formula (IX)

$$\left[ OSi_{y} \right] - O - Si(R)_2 R^7$$ \hspace{1cm} (IX)

For the sake of simplicity, the compounds of the formula (VIII) are referred to below as "polyorganosiloxanes", although for low values of x, they are oligoorganosiloxanes.

In formula (VIII),

x is a number from 0 to 1500, preferably 10 to 1500, and

y is a number from 0 to 500,

also in the formula (VIII) and (IX), all of the radicals R⁷ present are R or OH or are a group OR, where R has the abovementioned meaning, where the organosiloxane of the formula (VIII) preferably contains at least one radical R⁷ which is a hydroxy group.

For the reaction of the dimeric or oligomeric silanes according to the invention or of mixtures of these silanes with polyorganosiloxanes of the formula (VIII), the polyorganosiloxane and the dimeric or oligomeric silane are preferably used in quantitative ratios such that 0.001 to 5 silicon atoms of the dimeric or oligomeric silane are used per silicon atom of the polyorganosiloxane. The polyorganosiloxanes of the formula (VIII) used for this reaction contain at least two radicals R⁷ at the ends of the polysiloxane chain. Each radical R⁷ is a radical R of the abovementioned meaning or is a hydroxy group or a group -OR, where R has the abovementioned meaning. Preferably, at least one of the radicals R⁷ present is an OH group. Polysiloxanes of the formula (VIII) in which two of the radicals R⁷ present are OH are particularly well suited.

The polyorganosiloxanes used for the reaction can also, although this is not expressed in formula (VIII), contain further functional groups in side chains, e.g. amino groups. In this case, one or more of the radicals R⁶ present are a radical with such a functional group.
Furthermore, in addition to polyorganosiloxanes of the formula (VIII), further organosiloxanes can be co-used, e.g. low molecular weight oligodialkylsiloxanes.

It is particularly advantageous if, for the reaction of the dimeric or oligomeric silanes according to the invention with polyorganosiloxane of the formula (VIII), a polyorganosiloxane of the formula (VIII) is used in which two of the radicals R⁷ present are in each case an OH group, and that the reaction is carried out at a temperature in the range from 80 to 120°C.

If, for the reaction of the dimeric or oligomeric silanes according to the invention with polyorganosiloxanes, use is made of those polyorganosiloxanes of the formula (VIII) in which none of the radicals R⁷ is OH, then the reaction takes place under the equilibration conditions known from silicone chemistry, and incorporation of the silane structure into the polysiloxane chain takes place.

If, on the other hand, one or more of the radicals R⁷ present is an OH group, then condensation reactions between these OH groups and OR groups of the dimeric or oligomeric silane can take place with elimination of alcohol ROH.

Preferably, the reaction of the silanes of the formula (I) with polysiloxanes of the formula (VIII) is carried out such that a condensation takes place.

The conditions required for the equilibration and/or condensation reactions are known from the specialist literature on silicones. Preferably, the reactions which lead to the new type of polyorganosiloxanes take place with co-use of a catalyst or catalyst mixture and at a temperature in the range from 80 to 130°C. Suitable catalysts are, if appropriate, Lewis acids or dilute mineral acids. However, preference is given to basic catalysts, such as alkali metal hydroxides or alkoxides, or the catalysts specified below.

As already mentioned, polyorganosiloxanes of the formula (VIII) in which two of the radicals R⁷ present are in each case an OH group are particularly well suited.

The specified polyorganosiloxanes containing hydroxy groups, which are referred to below as "α,ω-dihydroxypolyorganosiloxanes", are thus reacted with dimeric or oligomeric silanes according to the invention. This reaction can, as explained in more detail below, be carried out in such a way that either an equilibration takes place during which structural units of the silanes are incorporated into the chain of the α,ω-dihydroxypolyorganosiloxane. Or else, and this is preferred, the reaction is carried out in such a way that condensation reactions between terminal OH groups of the polysiloxane and the silanes take place. The second variant, namely condensation, is preferred inter alia because it can be carried out under more gentle conditions, i.e. at a lower temperature, than the equilibration reaction. The specified reactions give polyorganosiloxanes which contain units R² originating from the silanes.
In principle, 2 types of reaction mechanisms are conceivable, namely reaction control which leads to equilibration reactions, or reaction control which leads to condensation reactions. It is preferred to carry out the reaction so that only condensation takes place, but no equilibration. The condensation proceeds at lower temperatures. During the condensation, OR groups of the dimeric or oligomeric silanes react with terminal OH groups of the \( \alpha,\alpha \)-dihydroxypolysiloxane with the elimination of alcohol ROH and chain extension.

The reaction can be carried out as condensation at a temperature in the range from 80 to 105°C over 3 to 4 hours, preferably under reduced pressure, e.g. at a pressure in the region of 100 mbar. Details of condensation reactions are known from silicone chemistry. In order that condensation can take place at all, the polysiloxane used must have hydroxy groups on at least two chain ends.

Equilibration reactions are likewise well known from the literature on silicone chemistry. During the equilibration, silane units are inserted into the polysiloxane chain. The equilibration thus requires that Si-O-Si bonds in the chain are cleaved. It is evident from this that higher temperatures are required for equilibration than for condensation. The reaction during which polysiloxanes according to the invention are formed is carried out, if equilibration is desired, at a temperature in the range from 110 to 135°C over a time of from 3 to 4 hours. If the polyorganosiloxane of the formula (VIII) contains no OH groups, the equilibration reaction is preferably carried out in the presence of water in order to hydrolyze OR groups to give OH groups.

The reaction which leads to new types of polyorganosiloxanes according to the invention is preferably carried out with co-use of a catalyst or of a mixture of catalysts, both in the case of the reaction in the form of a condensation and also in the form of an equilibration. Suitable catalysts are known from the silicone literature. In some cases, acidic catalysts can be used, e.g. Lewis acids or dilute mineral acids; normally, however, basic catalysts are better suited and therefore preferred. Highly suitable basic catalysts are alkali metal hydroxides, such as NaOH, KOH or LiOH and in particular metal alkoxides. Among the metal alkoxides, alkali metal alkoxides of the formula M(OR) are particularly well suited. These metal alkoxides can be used, for example, as 20 to 30% strength solution in the parent alcohol. Here, M is Na or K and R is an alkyl radical having 1 to 4 carbon atoms.

Further suitable catalysts are 4-dimethylaminopyridine and bicyclic compounds which contain one or more nitrogen atoms as ring members. Examples are 1,5-diazabicyclo[2.2.2.]octane, 1,5-diazabicyclo[4.3.0]non-5-ene and 1,8-diazabicyclo[5.4.0]undec-7-ene. These catalysts are also suitable for the reaction of the silanes of the formula (I) with water.

The new types of polyorganosiloxanes according to the invention which can be prepared by reacting the dimeric or oligomeric silanes according to the invention with polyorganosiloxanes of
the formula (VIII) can be used well inter alia for the treatment of fabrics made of fiber materials. Suitable fiber materials here are wovens, knits or nonwovens made of natural or synthetic fibers, such as, for example, made of cotton, polyester, polypropylene or polyamide or mixtures of such fibers, where in the case of polypropylene a plasma pretreatment may be connected upstream. The application can take place, for example, by means of padding processes or spraying. If appropriate, the application takes place in the form of a coating. The new type of polyorganosiloxanes according to the invention are also highly suitable for the methods of curtain coating known to the person skilled in the art. If the radical R² present in the silanes of the formula (I) has (meth)acrylate units, the curtain coating can be followed by a curing operation in which the acrylate units are polymerized. This can be effected in a known manner by means of electron beams or by UV radiation. Known photoinitiators, such as products of the series IRGACURE® (Ciba Spezialitätenchemie, Basle, Switzerland) or products as specified in US-B1 6 2 1 1 3 0 8 (column 10) can be used for this purpose.

The new type of polysiloxanes according to the invention can also be used for the finishing of precursor fibers, e.g. acrylic fibers, in the manufacture of carbon fibers. Furthermore, they can be used for the modification of epoxy resins for highly diverse application purposes.

The invention will now be illustrated by working examples.

Example 1 (according to the invention): Preparation of a dimeric disilane

31.6 g of a polyether amine (Jeffamin D 230) were added to 67.3 g of 3-glycidyloxypropylmethyldiethoxysilane, and the mixture was heated to 70°C and held at this temperature for 8 hours. A slightly yellowish clear reaction product was obtained which corresponds to the formula (I) from claim 1 where R = CH₃, R¹ = CH₃ and where R² is a radical of the formula (XVII), where A = direct bond and R¹₇ was a radical as defined above. Then, 2.4 g of water were added dropwise to 97.6 g of this product, and the mixture was heated to 85°C and stirred at this temperature for 4 hours. The resulting dimeric disilane was slightly yellowish and somewhat viscous. The polyether amine (Jeffamin D 230) had the following structure:

\[ \text{H}_2\text{N}-(\text{CH}-\text{CH}-)_2-0.4\text{CH}_3\text{H}-\text{CH}_2\text{NH}_2, \]

\[ \text{CH}_3 \]

x had a value of about 2.5.

Example 2: Addition of acrylate onto aminosilane and preparation of a silane of the formula (I)

51.0 g of Si(CH₃)(OCH₃)₂(CH₂CH₂CH₂NHCH₂CH₂NH₂)
and
49.0 g of acrylic acid ester
were mixed together with stirring (a product with a clear appearance formed), heated to 60°C
and held at 60°C for 4 hours.
This gave a clear, beige-colored and viscous addition product = silane of the formula (I) where
R = CH₃, R¹ = CH₃ and R² = a radical of the formula (XII) where R⁴ =
\[
\left(\frac{CH_2}{3}\right)_3,
\]
p = 1, R³ = H, R¹⁴ = alkyl.
The acrylic acid ester used was a mixture of decyl acrylate and octyl acrylate.

Example 3: (according to the invention)

97.8 g of the resulting addition product (silane) from example 2
and
2.2 g of water
were mixed together with stirring (a product with a clear appearance formed), heated to 85°C
and held at 85°C under gentle reflux for 4 hours. Then, 7.7 g of methanol were distilled off in vacuo to 200 mbar.
This gave a clear, slightly viscous, dimeric silane (yield 92.3 g).

Example 4 (according to the invention)

23 g of \((CH_3O)2Si(CH_3)\left(\frac{CH_2}{3}\right)O-C-C=CH_2
\]
and
1 g of water
were stirred together at room temperature until a clear solution had formed (about 2 hours).
Then, 79 g of α, ω-dihydroxydimethylpolysiloxane (about 40 mPa.s at 20°C) and 0.3 g of
hexamethyldisiloxane and 0.1 g of cone. H₂SO₄ (as catalyst) were added. The mixture was
heated to 90°C, then the pressure was reduced to 0.5 bar and the whole was kept at 90°C for a
further hour. Then, 0.2 g of hexamethyldisiloxane were added, the pressure was increased to
atmospheric pressure and the mixture was stirred for 30 min.
This gave a clear silicone oil (polyorganosiloxane) with a viscosity of from 400 to 600 mPa.s at
20°C.

Example 5 (according to the invention)
8.5 g of water were added dropwise to 91 g of \((\text{C}_2\text{H}_5\text{O})_2\text{Si(\text{CH}_3)-CH}_2\text{CH}_2\text{CH}_2\text{-NH}_2\)
over the course of 30 min. Then, the mixture was heated to 45°C and stirred for 2 hours at this temperature.

23 g of the resulting oligomeric silane were mixed with 77 g of \(\alpha,\omega\)-dihydroxydimethyl-polysiloxane (viscosity about 100 mPa.s at 20°C) and with 0.4 g of an NaOCH₃ solution (1% in methanol). The resulting mixture is heated to 90°C and stirred for 15 minutes at 90°C. Then, the pressure was reduced to 0.2 bar and the mixture was held at 90°C at this pressure for 5.5 hours. The pressure was increased to atmospheric pressure. This gave a cloudy silicone oil.

\[
\text{CH}_2=\text{CH}-\text{C}--\text{O}--\text{CH}_2\text{CH}_2\text{-RF}
\]

where RF is \(\text{CF}_3(\text{CF}_2)_m\) where \(m\) on average 7,

were added to 60 g of this oil, and the whole was stirred for 4 hours at 60°C. This gave a thick yellowish paste which was soluble in methyl isobutyl ketone. Here, the \(\text{NH}_2\) group of the dimeric/oligomeric silane adds onto the \(\text{C}=\text{C}\) double bond of the fluorinated acrylate (Michael addition).
1. A dimeric and/or oligomeric silane preparable by reaction of a silane of the formula (I)

\[
\text{OR} \\
\text{RO-Si-} \\
\text{R}^1 \\
\text{R}^2
\]

(I)

or of a mixture of such silanes, with water, or of a mixture of a silane of the formula (I) and a compound of the formula (Ia), with water,

\[\text{X(OR}^{15})_4\]  

(la)

where X is Si or Ti,

in which all of the radicals \(\text{R}^{15}\), independently of one another, are R or are

\[\begin{align*}
\text{O} & \\
\text{P-O-P-O-R} & \\
\text{OH} & \\
\text{O-R}
\end{align*}\]

or preferably -CH(CH\(_3\))\(_2\),

where 0.5 to 1.5 mol of water are used per mole of silane or silane mixture, to give a dimeric and/or oligomeric product which contains 2 to 200, in particular 2 to 50, particularly preferably 2 to 15, silicon atoms in the molecule or to give a mixture of such dimeric or oligomeric products,

where optionally in a first step firstly two identical or different silanes of the formula (I) are reacted together to give a dimer or oligomer and then this dimer or oligomer is further reacted with water under the abovementioned conditions,

where all of the radicals R present, independently of one another, are the phenyl radical or a branched or unbranched alkyl radical having 1 to 18 Carbon atoms, preferably \(\text{CH}_3\) or \(\text{C}_2\text{H}_5\),

\(\text{R}^1\) is R or OR or

\[
\begin{align*}
\text{-CH}_2\text{-NH-}
\end{align*}
\]

where \(\text{R}^2\) is the vinyl radical or a linear or branched alkyl radical having 1 to 18 carbon atoms, which may be substituted by one or more, optionally quatemized, amino groups, amido groups, mercapto groups, epoxy groups, phosphono groups, hydroxy groups or fluorine atoms,

or where

\(\text{R}^2\) is a radical of the formula (II), of the formula (III) or of the formula (IV),
in which both radicals $R^5$ are
\[
-C-C=CH, \\
O \quad R^3 \quad 2
\]
or one of the radicals $R^5$ is $H$ and the other is
\[
-C-C=CH \\
O \quad R^3 \quad 2
\]

\[
-R^4-NH-C\left(\begin{array}{c}
\text{CH}_2 \\
\end{array}\right)_3O-C-C=C=CH_2 \quad (III)
\]

\[
-R^4-NH\left[\begin{array}{c}
\text{CH}_2 \\
\end{array}\right]_p\text{NH}\left(\begin{array}{c}
\text{CH}_2 \\
\end{array}\right)_3O-C-C=C=CH_2 \quad (IV)
\]

where $p$ is $0$, $1$ or $2$,
where $R^3$ is in each case $H$ or $\text{CH}_3$,
or where $R^2$ is a radical of the formula (V)
\[
-R^2-O-C-C=C=CH_2
\]

in which $R^4$ is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms,
or where $R^2$ is a radical of the formula (VI) or of the formula (VII) or of the formula (X)
\[
-f\left\{\text{CH}_2\right\}_2O-\text{CH}_2\left\{\text{CH}_2\right\}_2O-C(\text{CH}_2O-C-C=CH_2)_2 \quad (VI)
\]

\[
-R-NH-\text{CH-CH-} \quad \text{COOR}^8 \quad (VN)
\]
in which $R^8$ is $H$ or $\text{CH}_3$ or $\text{C}_2\text{H}_5$ or $-\text{CH}_2\text{CH}_2\text{OH}$ and $R^9$ is $H$ or $-\text{COOR}^8$

\[
-R-NH-\text{CH}_2\text{CH}_2\text{NH} \quad \text{-CH-CH-} \quad \text{-COOR}^8
\]
or in which $R^2$ is a radical of one of the formulae (XI), (XIIa) or (XII) to (XX) or of the formula (XVIIIa) or formula (XXa) or formula (XXb) or formula (XXc),
where \( p \) is 0, 1 or 2,
\( R^4 \) is a divalent linear or branched hydrocarbon radical having 1 to 4 carbon atoms,
\( R^3 \) is in each case H or \( \text{CH}_3 \),
\( R^{14} \) is H or a linear or branched alkyl radical having 1 to 18 carbon atoms or is a radical of the formula (XIX),
in which the individual units -(\( \text{CH}_2 - \text{CH}_2 - \text{O} \)) and -(\( \text{CHR}^3 - \text{CHR}^3 - \text{O} \)) may be distributed arbitrarily over the chain, in which \( k \) and \( l \) are in each case a number in the range from 1 to 22 and the sum \( k + l \) is in the range from 3 to 25,
in which \( f \) is 0 or 1,
all of the radicals \( R^{16} \), independently of one another, are H or
or

\[
\left(\begin{array}{c}
\text{C} - \text{O} \\
\end{array}\right)_f \text{CH} - \text{CH}_2 - \text{O} - \text{C} - \text{CH} = \text{CH}_2
\]

\[
- \text{R}^4 - \text{O} - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{N} - \left(\begin{array}{c}
\text{CH}_2 \\
\end{array}\right)_3 \text{M}
\]

\[
\text{OH}
\]

\[
\text{R}^{13}
\]

\[
\text{OH}
\]

\[
\text{R}^{13}
\]

\[
\text{M}
\]

where \( M \) is selected from

\[
\text{(XVII)}
\]

in which \( A \) is a direct bond or a divalent radical of the formula

\[
\left(\begin{array}{c}
\text{CH}_2 \\
\end{array}\right) \text{O} - \left(\begin{array}{c}
\text{CH} - \text{O} - \text{V} - \text{R}^1 \\
\end{array}\right) \\
\text{R}^7
\]

where the values of \( u, v \) and \( s \) are chosen such that the equivalent weight of this radical \( R^2 \) is in the range from 100 to 5000, where one or two of \( u, v \) and \( s \) can also assume the value 0 and where the individual units \(-\text{CH}_2 - \text{CH}_2 - \text{O} -\) and \(-\text{CH} - \text{CH} - \text{O} -\)

\[
\text{R}^3 \\
\text{R}^3
\]

can be distributed arbitrarily over the chain,

where \( R^{12} \) is \( \text{H} \) or \( \text{C}_2\text{H}_5 \) and

where \( R^{17} \) is \( \text{R} \) or \(-\text{R}^4 - \text{NH}_2\) or

\[
- \text{CH} \quad \begin{array}{c}
\text{CH-NH-CH-CH-Ch} \\
\text{CH}_3
\end{array} \\
\begin{array}{c}
\text{2O-R-Si(OR)} \\
\text{2(R)} \quad \text{OH}
\end{array} \\
\text{(xviii)}
\]

\[
\text{(XVIIIa)}
\]

where \( M \) is selected from
in which RF is a perfluoroalkyl radical having 5 to 23 carbon atoms,
in which R\textsuperscript{10} is a divalent radical of one of the formulae (XXI) to (XXIVa),
in which R\textsuperscript{13} is H or \text{--CH(CH\textsubscript{3})\textsubscript{2}} or \text{--CH\textsubscript{2}--CH(CH\textsubscript{3})\textsubscript{2}}.
in which $K$ is a linear or branched alkylene radical having 2 to 18 carbon atoms,

$$\text{(XXIII)}$$

$$\begin{align*}
\text{in which } f & \text{ is } 0 \text{ or } 1 \\
\text{where each of the radicals } R^{11} & \text{ is}
\end{align*}$$

$$\begin{align*}
\text{(XXIVa)}
\end{align*}$$

where $d$ is a number from 1 to 6,

$$\begin{align*}
\text{or is a radical of one of the formulae (XXV) to (XXXI),}
\end{align*}$$

$$\begin{align*}
\text{(XXV)}
\end{align*}$$

$$\begin{align*}
\text{(XXVI)}
\end{align*}$$

$$\begin{align*}
\text{(XXVII)}
\end{align*}$$

$$\begin{align*}
\text{(XXVIII)}
\end{align*}$$

$$\begin{align*}
\text{(XXIX)}
\end{align*}$$
in which \( z \) is a number from 8 to 500, preferably from 8 to 20,
where all or some of the nitrogen atoms which are present in the abovementioned formulae
and which are not part of an amide group may be present in quatemized form.

2. The silane as claimed in claim 1, wherein a silane of the formula (I) is used in which all of
the radicals \( R \) present, independently of one another, are -CH\(_3\) or -CH\(_2\)CH\(_3\), preferably
-CH\(_3\), and the radical \( R^2 \) is a radical of the formula (V).

3. A polyorganosiloxane preparable by reaction of a dimeric and/or oligomeric silane as
claimed in claim 1 or 2 or of a mixture of such silanes with an organosiloxane of the formula
(VIII) or with mixtures of such organosiloxanes,

\[
R^7(R)_2SiO\left(\frac{R\cdot Si\cdot O}{R^6}\right)_x Si(R)_2 R^7
\]

where \( R^6 \) is \( R \) or a radical of the formula (IX)

\[
\begin{array}{c}
\text{R} \\
\text{O} \\
\text{R} \\
\end{array}
\]

\[
\begin{array}{c}
\text{OSi} \\
\text{O} \\
\text{Si(R)}_2 \\
\end{array}
\]

where \( x \) is a number from 0 to 1500, preferably from 10 to 1500,
y is a number from 0 to 500,
where all of the radicals \( R^7 \) present are \( R \) or OH or OR, where the organosiloxane of the
formula (VIII) preferably contains at least one radical \( R^7 \) which is a hydroxy group.

4. The polyorganosiloxane as claimed in claim 3, wherein an organosiloxane of the formula
(VIII) is used for the reaction in which two of the radicals \( R^7 \) present are in each case an
OH group, and the reaction is carried out at a temperature in the range from 80 to 120\(^\circ\)C.

5. The polyorganosiloxane as claimed in claim 3 or 4, wherein the organosiloxane and the
dimeric or oligomeric silane are used in quantitative ratios such that 0.001 to 5 silicon
atoms of the dimeric or oligomeric silane are used per silicon atom of the organosiloxane.
6. The use of the polyorganosiloxanes as claimed in one or more of claims 3 to 5 for the treatment or coating of fabrics or of fibers.