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Benævnelse: Addukter af isocyanatoalkyl-trialkoxyasilane og alifatiske, alkylforgrenede dioler eller polyoler

Fremdragne publikationer:
EP-A1- 1 802 716
WO-A1-2008/131715
Description

The present invention relates to coating compositions produced from low molecular mass adducts of isocyanatoalkyltrialkoxyisilanes and aliphatic alkyl-branched diols or polyols, which are preferably liquid at temperatures of greater than 0°C, especially scratch-resistant clearcoats.

Modern coatings of all kinds, especially finishes in the automotive sector, are subject to exacting requirements in terms of scratch resistances. Numerous approaches have been made in the past to obtain the highest scratch resistance of topcoats via combinations of PU crosslinking and silane crosslinking (WO 2008/074489A1, WO 2008/110292A3, WO 2006/042658A, WO 2008/110230A, EP1273640A, DE 102004050747). Isocyanate-free systems as well have been described in this field (EP 1802716B1, WO 2008/131715A1, WO 2008/034409). Generally speaking, the scratch resistance is dependent on the crosslinking density, in other words on the amount of silane monomers or -Si(OR)₃- groups. Relatively low solids contents in the coating formulations are disadvantages to these technologies, attributable to the relatively high molecular weights of the silane-functional crosslinkers.

Suitability for achieving very high amounts of -Si(OR)₃ groups is possessed by low molecular mass adducts of diols and isocyanatopropyltrialkoxyisilanes. Adducts of that kind are described, for example, in WO 2008/034409 or WO 2008/131715. A problem with the known systems is the often inadequate flexibility of the resultant coatings. A further problem is the high crystallization tendency and low compatibility of adducts of isocyanatopropyltrialkoxyisilanes and low molecular mass diols, meaning that, at the often desired curing temperatures of below 100°C, there is a likelihood of levelling problems and surface defects in the resultant coating film as a result of crystallization-associated incompatibilities between the coating components.
In the prior art cited above, therefore, the clearcoats, for the automotive sector, for example, are generally heat-cured at temperatures above 100°C.

EP 1 780 231 A1 discloses powder coatings and adhesive formulations, which use adducts of isocyanatoalkoxysilanes and linear or branched diols or polyols.

It is an object of the present invention to provide improved starting materials which are suitable for producing scratch-resistant coatings, more particularly high-gloss, scratch-resistant clearcoats. A further aim is to ensure sufficient flexibility in the coatings obtained, while retaining the stated profile of properties over a broad temperature range for application and curing of the liquid coatings, especially at temperatures in the range below 100°C.

The object is achieved by means of coating compositions comprising low molecular mass adducts of isocyanatoalkyltrialkoxy silanes and aliphatic branched diols or polyols, which are preferably liquid at temperatures above 0°C. In coating compositions, especially in clearcoats, which can be cured over a wide temperature range, the adducts lead to surprisingly scratch-resistant coatings featuring outstanding levelling and gloss.

The present invention provides coating compositions comprising adducts from the reaction of compounds of the formula (I)

\[ \text{OCN}-(\text{Alkyl})-\text{Si(Alkoxy)}_3 \quad (I) \]

with compounds of the formula (II)

\[ \text{HO}-(\text{R})-\text{OH} \quad (II) \]

in which Alkyl denotes linear or branched alkylene chains having 1-4 carbon atoms, Alkoxy, simultaneously or independently at each occurrence, denotes methoxy, ethoxy,
propoxy or butoxy groups, and R denotes a branched alkylene or
cycloalkylene radical having not more than 20, more
particularly 2 to 20, carbon atoms, and R can be hydroxy-
substituted. With particular preference the adducts are liquid
at temperatures of more than 0°C.

The reaction of components (I) and (II) for forming the
adducts takes place more particularly with the ratio of OH
groups from compound (II) to NCO groups from compound (I)
being from 0.8:1 to 1.2:1, preferably 0.9:1 to 1.1:1, with
stoichiometric reaction being especially preferred. With
particular preference, therefore, there is complete reaction
of all of the OH groups of the compounds of the formula (II)
with NCO groups of the compounds of the formula I.

In the stated reaction, the NCO groups of the compounds of the
formula (I) react with the OH groups of the compounds of the
formula (II) to form -NH-CO-O- groups, which link the
compounds of the formulae (I) and (II) to one another.

Suitable compounds of the formula (I) OCN-(Alkyl)-Si(Alkoxy)₃
include in principle all of the possible compounds described
above. With particular preference, Alkoxy is selected from
trimethoxy and triethoxy groups.

Examples of suitable compounds of the formula (I) are
isocyanatoalkylalkoxysilanes which more particularly are
selected from the group consisting of
3-isocyanatopropyltrimethoxysilane,
3-isocyanatopropyltriethoxysilane,
3-isocyanatopropyltriisopropoxysilane,
2-isocyanatoethyltrimethoxysilane,
2-isocyanatoethyltriethoxysilane,
2-isocyanatoethyltriisopropoxysilane,
4-isocyanatobutyltrimethoxysilane,
4-isocyanatobutyltriethoxysilane,
4-isocyanatobutyltriisopropoxysilane,
isocyanatomethyltrimethoxysilane,
isocyanatomethyltriethoxysilane and/or isocyanatomethyltriisoproxyxysilane.

Particular preference is given to using 3-isocyanatopropyltrialkoxyxilanes, more particularly 3-isocyanatopropyltrimethoxysilane and/or isocyanatopropyltriethoxysilane as compounds of the formula (I).

Suitable compounds of the formula (II) HO-(R)-OH in which R is a branched alkylene or cycloalkylene radical having not more than 20, in particular 2 to 20, carbon atoms, and R can be hydroxy-substituted, are, in particular, aliphatic branched diols or polyols. The compounds of the formula (II) preferably have a molecular weight of 76 to 314 g/mol, more preferably of 90 to 206 g/mol.

The compounds of the formula (II) are preferably selected from the group consisting of 2,2,4-trimethylhexane-1,6-diol and 2,4,4-trimethylhexane-1,6-diol alone or as any desired mixtures of these isomers, 2,2-dimethylbutane-1,3-diol, 2-methylpentane-2,4-diol, 3-methylpentane-2,4-diol, 2,2,4-trimethylpentane-1,3-diol, 2-ethylhexane-1,3-diol, 2,2-dimethylhexane-1,3-diol, 3-methylpentane-1,5-diol, 2-methylpentane-1,5-diol, 2,2-dimethylpropane-1,3-diol (neopentyl glycol), 1,1,1-trimethylolpropane, 3(4),8(9)-bis(hydroxymethyl)tricyclo[5.2.1.02,6]decane (Dicidol) and/or 2,2-bis(4-hydroxycyclohexyl)propane. Particular preference is given to using 1,1,1-trimethylolpropane, 3-methylpentane-1,5-diol, neopentyl glycol, 2,2,4-trimethylhexane-1,6-diol and 2,4,4-trimethylhexane-1,6-diol, alone or as any desired mixtures of these isomers. The stated compounds may each be used alone or in the form of mixtures thereof. It is especially preferred to use 2,2,4-trimethylhexane-1,6-diol and 2,4,4-trimethylhexane-1,6-diol, alone or as any desired mixtures of these isomers.

The adducts are generally prepared solventlessly or using non-
protic solvents, and the reaction may take place continuously or batchwise. The reaction can be conducted at room temperature, in other words temperatures in the range of 20 - 25°C, but it is preferred to use higher temperatures, in the range of 30 - 150°C, more particularly in the range of 50 - 150°C. To accelerate the reaction it is possible with advantage to use catalysts that are known in urethane chemistry, such as Sn carboxylates, Bi carboxylates, Zn carboxylates and other metal carboxylates, tertiary amines such as, for example, 1,4-diazabicyclo[2.2.2]octane (DABCO), triethylamine, etc.. The reaction is preferably carried out in the absence of water.

The adducts are, in particular, liquid at temperatures of more than 0°C. These compounds are non-crystallizing compounds of low molecular mass. Depending on the selected stoichiometry of the two reactants, the reaction product may still contain free hydroxyl or isocyanate groups. On the basis of the preferred embodiment, the adducts are substantially free from hydroxyl groups. In solvent-free form, the adducts are of low to medium viscosity and are liquid at 0°C. For better handling, however, the products may also be admixed with solvents, which like alcohols may also be protic. The solids contents of such preparations are preferably > 80% by weight and they have a maximum viscosity of preferably 500 mPas (DIN EN/ISO 3219 23°C).

The adducts of isocyanatoalkyltrialkoxyisilane and branched diols or polyols are used advantageously as a crosslinking component for scratch-resistant clearcoats. In that case, for the purpose of optimizing the mechanical qualities of the coating, they are blended with polymeric binders, which may also carry crosslinkable functional groups. The reactivity of the silane adducts is not sufficient for a curing rate at ambient temperature, of the kind known for two-component PU coatings, for example. To boost the crosslinking rate, therefore, it is preferred to add catalysts.
Suitability for this purpose is possessed by metal chelates or transition-metal chelates, salts thereof or particles thereof, based for example on titanium complexes, aluminium complexes, tin complexes or zirconium complexes, sulfonic acids, phosphoric acid or phosphorous acids and derivatives thereof, carboxylic acids having melting points of more than 60°C, quaternary ammonium carboxylates, or else combinations of the stated compounds.

The coating compositions for use in accordance with the invention may be solvent-free or solvent-containing; with particular preference, the coating compositions to be used are non-aqueous. Non-aqueous in the sense of the present invention means a water content in the coating composition of not more than 1.0% by weight, preferably not more than 0.5% by weight, based on the coating composition. In the case of two-component formulations in particular, the aforementioned small amount of water may be used to accelerate curing. With particular preference, the coating system used is free from water.

The coating compositions obtainable by means of the adducts may be used in particular for the coating of wood, plastic, glass or metal. In this way, highly scratch-resistant coatings which crosslink even at temperatures below 100°C are obtained.

The invention accordingly further provides for the use of adducts from the reaction of compounds of the formula (I)

\[ \text{OCN}-(\text{Alkyl})-\text{Si(Alkoxy)}_x \quad (I) \]

with compounds of the formula (II)

\[ \text{HO}-(\text{R})-\text{OH} \quad (II) \]

in which Alkyl denotes linear or branched alkylene chains having 1-4 carbon atoms, Alkoxy, simultaneously or independently at each occurrence, denotes methoxy, ethoxy, propoxy or butoxy groups, and R denotes a branched alkylene or
cycloalkylene radical having not more than 20, more particularly 2 to 20, carbon atoms, and R can be hydroxy-substituted, as coating compositions or as a constituent of coating compositions, more particularly for producing scratch-resistant clearcoats. With particular preference the adducts are liquid at temperatures of more than 0°C.

The coatings obtained on the basis of the coating compositions specified above are characterized by a high level of resistance towards mechanical stress, and in particular they have a high scratch resistance. A surprise here is that the coatings obtained at the same time have a high flexibility and high gloss.

The coating compositions, which are preferably curable at temperatures of 20 to 100°C, comprising

A) adducts in accordance with the present invention from the reaction of compounds of the formula (I)

\[
\text{OCN-} \text{(Alkyl)} - \text{Si(Alkoxy)}_3 \quad \text{(I)}
\]

with compounds of the formula (II)

\[
\text{HO-} \text{(R)} - \text{OH} \quad \text{(II)}
\]

in which Alkyl denotes linear or branched alkylene chains having 1-4 carbon atoms, Alkoxy, simultaneously or independently at each occurrence, denotes methoxy, ethoxy, propoxy or butoxy groups, and R denotes a branched alkylene or cycloalkylene radical having not more than 20, more particularly 2 to 20, carbon atoms, and R can be hydroxy-substituted,

B) one or more binder components,

C) 0.1 to 4% by weight of at least one catalyst,
D) optionally auxiliaries and additives,

E) optionally organic solvents.

5 The fraction of the adducts as component A) in the coating composition of the invention is more particularly 30-90% by weight, preferably 20% to 80% by weight, based on the coating composition.

10 Furthermore, the coating composition of the invention may optionally comprise one or more binder components. Suitable binder components are in principle all of the kinds of binders known to the skilled person, including, for example, thermoplastic binders, i.e. uncrosslinkable binders, which typically have an average molecular weight of > 10 000 g/mol. It is preferred, however, to use binders which possess reactive functional groups having acidic hydrogen atoms. Suitable binders of the stated kind have, for example, at least one, but preferably two or more hydroxyl group(s).

20 Examples of other suitable functional groups in the binder are trialkoxysilane functionalities.

As binders with functional groups it is preferred to use hydroxyl-containing polymers, more particularly hydroxyl-containing polyesters, polyethers, polyacrylates, polycarbonates and polyurethanes having an OH number of 20 to 500 mg KOH/g and an average molar mass of 250 to 6000 g/mol. Particular preference is given in the context of the present invention to using hydroxyl-containing polyesters or polyacrylates having an OH number of 20 to 150 mg KOH/g and an average molecular weight of 500 to 6000 g/mol as binder components.

The hydroxyl number (OHN) is determined in accordance with DIN 53240-2.

35 In this method, the sample is reacted with acetic anhydride in the presence of 4-dimethylaminopyridine as catalyst, the
hydroxyl groups being acetylated. For each hydroxyl group, this forms one molecule of acetic acid, while the subsequent hydrolysis of the excess acetic anhydride supplies two molecules of acetic acid. The consumption of acetic acid is determined by titrometry from the difference between the main value and a blank value, which must be carried out in parallel. The molecular weight is determined by means of gel permeation chromatography (GPC). The samples were characterized in tetrahydrofuran as eluent in accordance with DIN 55672-1.

As hydroxyl-containing (meth)acrylic copolymers it is possible to use resins having a monomer composition of the kind described for example in WO 93/15849 (page 8, line 25 to page 10, line 5), or else in DE 195 29124. In this case, the acid number to be set in the (meth)acrylic copolymer through proportional use of (meth)acrylic acid as monomer ought to be 0 – 30, preferably 3 – 15 mg KOH/g. The number-average molar weight (determined by gel permeation chromatography against a polystyrene standard) of the (meth)acrylic copolymer is preferably 2000 – 20 000 g/mol; the glass transition temperature is preferably -40°C to +60°C. The hydroxyl content to be set in the (meth)acrylic copolymers for use in accordance with the invention by proportional use of hydroxyalkyl (meth)acrylates is preferably 70 – 250 mg KOH/g, more preferably 90 – 190 mg KOH/g.

Polyester polyols suitable in accordance with the invention are resins having a monomer composition made up of dicarboxylic and polycarboxylic acids and diols and polyols, of the kind described, for example, in Stoye/Freitag, Lackharze [Resins for coatings], C. Hanser Verlag, 1996, page 49 or else in WO 93/15849. As polyester polyols it is also possible to use polyadducts of caprolactone with low molecular mass diols and triols, of the kind available for example under the name CAPA (Perstorp). The arithmetically ascertained number-average molar weight is preferably 500 – 5000 g/mol, more preferably 800 – 3000 g/mol; the average functionality is
preferably 2.0 - 4.0, more preferably 2.0 - 3.5.

Among the urethane and ester group-containing polyols for use in accordance with the invention are also, in principle, those of the kind described in EP 140 186. Preference is given to using urethane and ester group-containing polyols prepared using HDI, IPDI, trimethylhexamethylene diisocyanate (TMDI) or (H₁₂-MDI). The number-average molar weight is preferably 500 - 2000 g/mol; the average functionality is situated in particular in the range of 2.0 - 3.5.

Trialkoxysilane-functional binders as well are suitable for use as component B. Resins of this kind may be obtained by copolymerization of acrylate or methacrylate monomers with acryloyl- or methacryloyl-functional alkyl-trialkoxyisilane derivatives (e.g. Dynasylan® MEMO from Evonik Industries AG), of the kind described for example in WO 92/11328. An alternative synthesis pathway is the derivatization of hydroxyl-containing polyethers, polyesters, polycarbonate diols or polyacrylates with isocyanatopropyltrialkoxyisilane, as described for example in WO 2008/131715 in Examples 3 and 4.

It is of course also possible to use mixtures of the above-described binders. Preferred binders are hydroxyl-containing polyesters and polyacrylates, alone or in mixtures.

The fraction of B) in the coating composition of the invention is 10-80% by weight, based on the coating composition, more particularly 20% to 80% by weight.

The mass ratio of component A) to component B) in the coating composition of the invention is preferably 3:7 to 7:3.

To achieve a sufficient curing rate at curing temperatures of less than 100°C catalysts C) are used. Suitable catalysts are, in particular, Lewis acids, metal chelates or transition-metal chelates, salts thereof or particles thereof, based for
example on titanium complexes, aluminium complexes, tin complexes or zirconium complexes, sulphonic acids in free or else neutralized or adducted form, of the kind described for example in DE 2356768, phosphoric acid or phosphorous acids and their derivatives (WO 2008/074491, page 18, lines 1 - 17), high-boiling acids, quaternary ammonium carboxylates, or else combinations of the stated compounds. It is preferred to use transition-metal chelates or their salts, high-boiling acids, quaternary ammonium carboxylates, or combinations of the stated compounds.

Use is made as component C) of a catalyst comprising C1) at least one organic carboxylic acid having a melting point of more than 60°C and/or C2) at least one tetraalkylammonium carboxylate.

Suitable organic carboxylic acids having a melting point of more than 60°C (under atmospheric pressure) are compounds which are non-volatile at room temperature. Examples of carboxylic acids for advantageous use are salicylic acid, benzoic acid, citric acid, isophthalic acid, phthalic acid, terephthalic acid and/or trimellitic acid. For the purposes of the present invention, it is preferred to use salicylic acid and benzoic acid.

Use is made as catalyst C2) of a tetraalkylammonium carboxylate. Examples thereof are tetramethylammonium formate, tetramethylammonium acetate, tetramethylammonium propionate, tetramethylammonium butyrate, tetramethylammonium benzoate, tetraethylammonium formate, tetraethylammonium acetate, tetraethylammonium propionate, tetraethylammonium butyrate, tetraethylammonium benzoate, tetrapropylammonium formate, tetrapropylammonium acetate, tetrapropylammonium propionate, tetrapropylammonium butyrate, tetrapropylammonium benzoate, tetrabutylammonium formate, tetrabutylammonium acetate, tetrabutylammonium propionate, tetrabutylammonium butyrate and/or tetrabutylammonium benzoate. The stated tetraalkylammonium carboxylates can be added alone or in
mixtures. It is preferred to use tetraethylammonium benzoate and/or tetrabutylammonium benzoate.

The catalyst component C) in the coating compositions of the invention may consist solely of the aforementioned alternatives C1) or C2), but it is also possible to use any desired mixtures of the catalysts C1) and C2).

Such mixtures of C1) and C2) have in particular a ratio of 9:1 to 1:9 (m/m).

The coating composition of the invention may further comprise typical concentrations of auxiliaries and/or additives D) that are known in coatings technology, such as stabilizers, including light stabilizers, catalysts, fillers, pigments, levelling agents or rheological assistants, such as sag control agents, for example microgels or fumed silica. If necessary, it is also possible, in component D) of the coating compositions of the invention, to incorporate organic or inorganic colour and/or effect pigments that are customary in coatings technology.

In the case of pigment-free coating compositions, i.e. clearcoats, component D) is present preferably in amounts of 0.5% up to 8% by weight, more particularly 1% to 6%, based on the coating composition, in the coating composition of the invention. In the case of pigment and/or filler-containing materials, the amount of component D) may be 5% to 80% by weight, more particularly 10% to 70% by weight, based on the coating composition.

The coating composition of the invention may further comprise organic solvents as component E). Examples of suitable solvents include ketones, esters, alcohols or aromatics.

Component E) is present in the coating composition of the invention preferably in amounts of 20% up to 60% by weight, more particularly 20% to 50%, based on the coating
composition. The amount of component E) is guided by the application viscosity to be set for the coating composition.

The sum total of all of the fractions of components A) to E) makes 100% by weight. The coating compositions of the invention preferably consist of the stated components A) to E).

The coating compositions of the invention are produced by mixing the above-described components. Mixing may take place in mixers known to the skilled person, examples being stirred vessels, dissolvers, bead mills, roll mills, etc., or else continuously by means of static mixers.

The present invention likewise provides metal-coating compositions, more particularly for vehicle bodies, cycles and motorcycles, building components and household appliances, which comprise the adducts or coating compositions.

Coating compositions for glass coatings, plastics coatings, or wood coatings, more particularly clearcoats, comprising the coating compositions of the invention are likewise provided for the present invention.

The coating compositions of the invention are also suitable for multi-coat finishing, such as for clearcoat in automotive OEM finishing.

Even without further utterances, it is assumed that a skilled person will be able to use the above description to its widest extent. Consequently, the preferred embodiments and examples are to be construed merely as a descriptive disclosure which in no way has any limiting effect whatsoever.

The present invention is elucidated in more detail below by way of examples. Alternative embodiments of the present invention are obtainable by analogy.
Examples:

Unless otherwise indicated, the quantities in percent in the examples are given by weight.

Example 1: Preparation of the adducts of the invention

27.4 g of an isomer mixture (about 50/50) of 2,2,4- and 2,4,4-trimethylhexanediol are introduced into a 250 ml 3-necked flask and 0.2 g of dibutyltin dilaurate (DBTDL) is added with stirring. Under a steady stream of nitrogen, the mixture is heated to 60°C in a water bath. Subsequently, with stirring, 72.4 g of 3-isocyanatopropyltrimethoxysilane are added dropwise at a rate such that the temperature does not climb above 70°C. Following complete addition, the reaction mixture is stirred at 60°C for 6 hours. The free NCO content is then < 0.1 %. The product is a clear liquid of medium viscosity.

The amounts of the raw materials used in the further experiments are indicated in Table 1. Example 2 is not in accordance with the invention. The comparative example, using 1,12-dodecanediol, exhibits a pronounced crystallization tendency.

Table 1: Formulas of the examples and physicochemical characteristics of the products

<table>
<thead>
<tr>
<th></th>
<th>Example 1 (inventive)</th>
<th>Example 2 (not inventive)</th>
<th>Example 4 (inventive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPMS: TMH-diol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCO:OH ratio</td>
<td>1.0:1.0</td>
<td>1.0:1.0</td>
<td>1.0:1.0</td>
</tr>
<tr>
<td>Isocyanatopropyltrimethoxysilane</td>
<td>72.4 g</td>
<td>67.6 g</td>
<td>80.1 g</td>
</tr>
<tr>
<td></td>
<td>TMDH-diol</td>
<td>27.4 g</td>
<td>-</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>1,12-dodecanediol</td>
<td>-</td>
<td></td>
<td>32.4 g</td>
</tr>
<tr>
<td>NPG</td>
<td>-</td>
<td>-</td>
<td>19.7 g</td>
</tr>
<tr>
<td>DBTDL</td>
<td>0.2 g</td>
<td>0.2 g</td>
<td>0.2 g</td>
</tr>
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</table>

**Characteristics**

<p>| | | | | |</p>
<table>
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<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>NCO content</td>
<td>%</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>DIN EN/ISO 11909</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity at 23°C</td>
<td>mPa s</td>
<td>543</td>
<td>575</td>
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<td>DIN EN/ISO 3219</td>
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<td>Haze</td>
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<td>DIN EN/ISO 7027</td>
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</tbody>
</table>

**Remark**

- Remains liquid after 4-week storage at 5°C
- Adduct is crystalline solid
- Remains liquid after 4-week storage at 5°C

TMDH-diol = 2,2,4- and 2,4,4-trimethylhexanediol, NPG = neopentyl glycol (2,2-dimethylpropane-1,3-diol), DBTDL = dibutyltin dilaurate

**Example 2:** Coating formulations in accordance with the present invention
Coating formulation

47.45% by weight Setalux 1767 (polyacrylate polyol, Nuplex Resins B.V., solids content 65% in solvent naphtha)

30.8% by weight IPMS adduct (as per example in Table 1)

0.3% by weight TEAB (tetraethylammonium benzoate, catalyst, Aldrich)

10.4% by weight butyl acetate

10.4% by weight xylene

0.05% by weight TEGO® Glide 410 (polyetherpolysiloxane copolymer, Evonik Industries AG)

0.3% by weight Tinuvin® 292 (HALS stabilizer, BASF S.E.)

0.3% by weight Tinuvin® 900 (UV absorber, BASF S.E.)

The clearcoats are produced by mixing the stated components in a closed stirring vessel at room temperature.

The formulated coatings possess spray viscosity (about 20 sec. DIN 4). They are applied in spray application to phosphated steel panels (Gardobond 26S 60 OC, manufacturer: Chemetall, D) and are cured either at room temperature or for 30 minutes at 60°C in a forced-air oven. The dry film coat thickness is 30-40 μm.

When using the inventive products, the resultant coatings are of high gloss, free from surface coverings, and resistant to chemicals and scratching. In the case of the non-inventive product from Example 2, RT curing results in a matt surface as a result of formation of a covering. The results obtained are summarized in Table 2.
Table 2: Properties of the coatings

<table>
<thead>
<tr>
<th>Base diol</th>
<th>Dodecanediol</th>
<th>TMH-diol</th>
<th>NPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curing</td>
<td>RT</td>
<td>30 min, 60°C</td>
<td>RT</td>
</tr>
<tr>
<td>Cupping (EN ISO 1520) [mm]</td>
<td>Not testable</td>
<td>3.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Pendulum hardness (König) [s]</td>
<td>owing to crystalline covering on the surface</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>after 1 d</td>
<td>49</td>
<td>18</td>
<td>34</td>
</tr>
<tr>
<td>after 2 d</td>
<td>87</td>
<td>66</td>
<td>97</td>
</tr>
<tr>
<td>after 7 d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ball impact [in lbs] (DIN-EN-ISO 6272-1)</td>
<td>-</td>
<td>60 &gt; 80</td>
<td>&gt; 80</td>
</tr>
<tr>
<td>MEK test [ASTM D 4752] (double rubs, 1kg applied weight)</td>
<td>-</td>
<td>&gt; 150</td>
<td>&gt; 150</td>
</tr>
</tbody>
</table>
Patentkrav

1. Belægningsmidler indeholdende
A) addukter ifølge den foreliggende opfindelse af omsætningen af forbindelser med formel (I)
OCN-(alkyl)-Si(alkoxy)₃ (I)
med forbindelser med formel (II)
HO-(R)-OH (II)
hvor alkyl betegner lineære eller forgrenede alkylenkæder med 1-4 carbonatomer, alkoxy samtidigt eller uafhængigt af hinanden betegner methoxy-, ethoxy-, propoxy- eller butoxy-grupper, og R betegner en forgrenet alkylen- eller cycloalkylengruppe med ikke mere end 20 carbonatomer, idet R kan være hydroxy-substitueret,
B) en eller flere bindemiddelesstanddele,
C) 0,1 til 4 vægt-% baseret på alle andele af bestanddelene A) til E) af i det mindste en katalysator, idet katalysatoren C1) er i det mindste en organisk carboxylsyre med et smeltepunkt over 60 °C, og eller C2) er i det mindste et tetraalkylammoniumcarboxylat,
D) valgfrit hjælpe- og tilsætningsstoffer,
E) valgfrit organiske opløsningsmidler.

2. Belægningsmidler ifølge krav 1, kendetegnet ved, at de kan hærdes ved temperaturer fra 20 til 100 °C.

3. Belægningsmidler ifølge krav 1 eller 2, kendetegnet ved, at der som bestanddel B) anvendes hydroxygruppeholdige polyester, polyethere, polyacrylater, polycarbonater og polyurethaner med et OH-tal fra 20 til 500 mg KOH/g bestemt i henhold til DIN 53240-2 og en gennemsnitlig molarmasse på 250 til 6.000 g/mol.

4. Belægningsmidler ifølge et af de foregående krav, kendetegnet ved, at bestanddel C2) er udvalgt af tetramethylammoniumformiat, tetramethylammoniumacetat, tetramethylammoniumpropionat, tetramethylammoniumbutyrat, tetramethylammoniumbenzoat, tetraethylammoniumformiat,
tetraethylammoniumacetat,  tetraethylammoniumpropionat,
tetraethylammoniumbutyrat,  tetraethylammoniumbenzoat,
tetrapropylammoniumformiat,  tetrapropylammoniumacetat,
tetrapropylammoniumpropionat,  tetrapropylammoniumbutyrat,
tetrapropylammoniumbenzoat,  tetrabutylammoniumformiat,
tetrabutylammoniumacetat,  tetrabutylammoniumpropionat,
tetrabutylammoniumbutyrat og/eller tetrabutylammoniumbenzoat.

5. Metalbelægningssammensætninger
og
belægningssammensætninger til glas-, kunststof- eller
træbelægninger indeholdende belægningsmidler ifølge et eller
flere af kravene 1 til 4.