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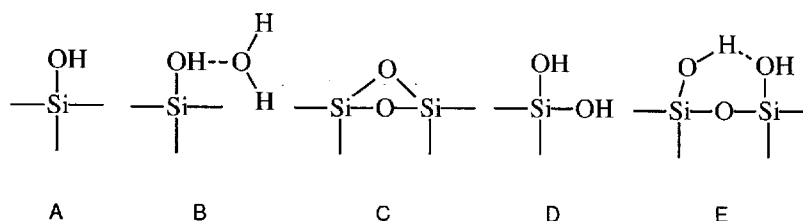


Fig. 1

(57) Abstract: The invention relates to coating systems for preparing a hydrophobic coating. Provided is a coating system that comprises: a surface hydrophobizing component - the fluorocarbon silane containing hydrolysable functional groups; an organic solvent selected from aliphatic ethers, aliphatic ketones and aliphatic alcohols; an inorganic catalyst selected from mineral acids. The coating system allows preparing a hydrophobic coating characterized by high values of contact angles (from 95° to 150°), high rate of the hydrophobic coating formation in a short period of time, the absence of thermal stabilization of the coating after treatment of the substrate with the coating system, as well as by long-term water resistance.



COATING SYSTEM FOR PREPARING A HYDROPHOBIC COATING

TECHNICAL FIELD

The present invention relates to hydrophobic coating systems for coating surfaces of various constructional and household materials to impart protective and decorative properties for long time. The coatings prepared using the coating system of the present invention provide high degree of hydrophobicity and excellent durability properties, including long wear-out time under high humidity, resistance to mechanical impact, erosion, contamination etc. In particular, the present invention provides a two-component coating system with extended shelf life, comprising components C1 and C2 isolated from each other. When mixed immediately prior to coating the surface of a substrate, the components C1 and C2 form on the surface a hydrophobic coating having at least similar, or superior characteristics comparing to the coatings known in the art.

BACKGROUND

The present invention relates to two-component coating systems based on organosilicon compounds, in particular fluorocarbon silanes, also known as fluorosilanes. At the moment, developing protective hydrophobic coatings, i. e. the coatings characterized by water droplet contact angles greater than 90° , is an upcoming trend in the art of water-repellent coatings for various purposes. The coating system and the resulting coating are primarily intended for vehicle windows, brick and concrete constructions, metal and polymeric articles. The distinctive feature of the disclosed coating is its fast formation on a surface of a substrate and a hydrophobicity effect persisting for a long time under constant humidity, pollution and erosion conditions and under mechanical action on the surface.

Perfluoropolyester based coatings, e.g., such as described in EP 0337313; EP 0215492, are known to have high hydrophobicity, chemical resistance and resistance to contamination. However, they do not possess sufficiently high strength and resistance to mechanical impacts, require the presence perfluorinated surfactants in the coating system and are sensitive to exposure time of the coating system on a substrate surface.

One approach to improve the water repellent properties of coatings, i.e. to obtain the effect of hydrophobicity, is to create nanostructured surfaces which are then covered with a fluorine-containing hydrophobizing composition (see, e.g., US 5,324,556; US 5,599,489). The nanostructuring of the surface is performed by various methods, such as plasma treatment (US 5,679,460) or chemically etching the surface (US 7,150,904, US 7,258,731). This approach

is suitable for the treatment of glass, ceramics, metals, polymers and resins. US 2006081394 describes a coating prepared by applying a suspension of fluorinated hydrocarbons and inorganic components with various additives. The treated surface has a superhydrophobic effect with the water droplet contact angle of more than 160°. At the same time, to create nano-dimensional roughness responsible for the superhydrophobic effect, a plasma pre-treatment of the surface is required. This is a significant disadvantage of the process.

Another approach to creating hydrophobic coatings is the preparation of functionalised organosilanes having fluorine-containing hydrocarbon substituents, where the organosilanes are chemically bound to the surface and thereby the coatings have improved properties can be obtained (EP 0947554, US 6,506,496, US 6,673,521, US 6,737,105, RU 2149151; US 7,425,279). Coatings obtained using these compounds exhibit the water droplet contact angle in the range of 90-104° even at a low thickness of the protective layer of about 100 angstroms. However, to obtain such coatings, in some cases, long exposure to temperatures in the range of 90-100 °C is required, which is significant disadvantage of the process.

Lately, several patents were published describing multipurpose fluorinated coatings based on perfluoropolyether-modified silanes having hydrolysable groups, mainly alkoxy groups (US 6,200,684, US 6,528,672, US 7,196,212; US 7,413,807). In this case, when the film thickness is from 0.1 to 10 nm, the contact angle of the coating is 114-117°.

Summarising the above, the currently available technical solutions based on fluorocarbon silanes having substituents at the silicon atom, where the substituents are selected from the group: -OCH₃, -OC₂H₅, -OC₃H₇ and -OC₄H₉, -Cl, have limited applicability due to relatively low strength and low resistance of the coatings to mechanical impact, as well as-undesirably long-term exposure times of the compositions after application on the substrate surface.

The requirement for a long-time exposure is caused by the need for pre-hydrolysis of the ether groups -OR to form groups -OH followed by their condensation with similar groups on the substrate surface or with fluorocarbon silane groups to form bonds - Si-O-C- or -Si-O-Si-.

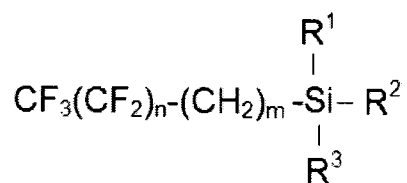
Thus, the object of the present invention is to provide a new cost-effective two-component coating system having a long shell life whilst allowing for the formation of fluorine-containing organosilicon protective hydrophobic coatings on a substrate surface at a short exposure time, and providing a long term hydrophobicity effect under constant humidity, pollution, mechanical impact and abrupt change of air temperature.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, a two-component coating system for producing a hydrophobic coating is provided, wherein the coating system comprises a first component C1 and a second component C2,

where the component C1 comprises:

- (a) a fluorocarbon silane of general formula (I) in an amount of from 0.1 to 10% by weight of the first component:



(I)

wherein

- each of R¹, R² and R³ independently is selected from C₁₋₄ alkyl, C₁₋₄ alkoxy and Cl;
 m is an integer from 1 to 5;
 n is an integer from 3 to 10; and

- (b) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones and aliphatic alcohols – the balance, and

the component C2 comprises:

- (c) a mineral acid in an amount of from 1 to 10% by weight of the second component;
 (d) deionized water in an amount of from 5 to 25% by weight of the second component;
 (e) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones, aliphatic alcohols – the balance.

The inventors of the present invention have surprisingly found that interacting a fluorocarbon silane of the general formula (I), dissolved in a suitable solvent in the amount of from 0.1 to 10% weight by weight of the component C1, with a solution of a mineral acid in the said organic solvent contained in the component C2 results in a rapid polymerization reaction to form a stable and mechanically strong hydrophobic coating on the surface. In particular, as a result of this interaction, chemical groups characteristic for the present inventive coating are formed on the substrate surface as illustrated in Fig. 1. These groups include at least some of the following: free, detached OH groups (silanol (bound) water), silanol groups bound to water by hydrogen bonds (physically bound water), siloxane groups (dehydrogenated oxides); twin (geminal)

groups -OH bound to one silicon atom; reactive vicinal -OH groups prevailing in finely porous silicas, adjacent, closely spaced OH groups bound by a hydrogen bond. These groups are characteristic for a hydrophobic coating according to the present invention.

According to one embodiment, the mineral acid is selected from the group comprising hydrochloric acid, sulfuric acid, disulfuric acid, sulfurous acid, oleum, phosphoric acid, nitric acid. According to the most preferred embodiments, the mineral acid is hydrochloric, sulfuric or phosphoric acid.

Compounds of formula (I) are preferably selected from commercially available fluorocarbon silanes, in particular such as (heptadecafluoro-1,1,2,2-tetrahydrodecyl)dimethylchlorosilane, (heptadecafluoro-1,1,2,2-tetrahydrodecyl)methyldichlorosilane, (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane, (heptadecafluoro-1,1,2,2-tetrahydrodecyl)triethoxysilane, and (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trimethoxysilane, (tridecafluoro-1,1,2,2-tetrahydrooctyl)trimethoxysilane, (tridecafluoro-1,1,2,2-tetrahydrooctyl)triethoxysilane, (tridecafluoro-1,1,2,2-tetrahydrooctyl)dimethylchlorosilane, (tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane, (nonafluoro-1,1,2,2-tetrahydrohexyl)dichlorosilane, (nonafluoro-1,1,2,2-tetrahydrohexyl)dimethoxysilane, and (pentadecafluoro-1,1,2,2,3,3-hexahydrodecyl)trichlorosilane.

The most preferred organosilanes of formula (I) are (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trialkoxysilanes. The preferred alkoxysilanes are methoxy- and ethoxysilanes, since in this cases, as result of applying a coating system on the substrate, a hydrophobic group is formed on the substrate surface thus giving hydrophobic properties to the surface, while a monobasic alcohol not having undesirable corrosive properties and removed in ambient conditions due to the high volatility is formed as a byproduct. The length of the linker that binds a hydrophobic group to a silicon atom in the structure of fluoroorganosilanes of formula I, which is determined by the m value, preferably corresponds to the bond length of from 1 to 5 alkenyl substituents and gives a relatively low mobility to the hydrophobic group relative to the substrate surface. The chain length of the hydrophobic group is determined by the n value. Satisfactory hydrophobic properties are usually achieved when n is from 3 to 10. In the above formula (I), the term "C₁₋₄ alkyl" means a straight or branched alkyl substituent containing from 1 to 4 carbon atoms and the corresponding number of hydrogen atoms to total saturation, in

particular $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, $-\text{C}_3\text{H}_7$, and $-\text{C}_4\text{H}_9$. The term "C₁₋₄ alkoxy" similarly includes a substituent selected from the group comprising $-\text{OCH}_3$, $-\text{OC}_2\text{H}_5$, $-\text{OC}_3\text{H}_7$, and $-\text{OC}_4\text{H}_9$.

According to one embodiment, the content of the fluorocarbon silane is from 0.1 to 10%, more preferably from 0.1 to 5% and most preferably from 0.1 to 1% by weight of the component C1. It has been found that at a concentration within the specified range the amount of the fluorocarbon silane of the general formula (I) is sufficient to form a balanced coating system providing a nanosized polymer compound film on the surface of a substrate or an article to be coated.

According to one embodiment, the weight ratio of the component C1 to the component C2 in the two-component coating system is from 1:1 to 1:10, more preferably from 1:1 to 1:5, and most preferably about from 1:1. It has been found that these ratios are sufficient to allow running a complete reaction on the article surface to form a coating having satisfactory optical properties (transparency) along with said hydrophobic and mechanical properties. At the same time, the shelf life of said two-component coating system significantly exceeds the shelf life of one-component coating systems comprising the above fluorosilanes due to the presence of two mutually isolated components reacting together only when mixed immediately prior to the application to the substrate.

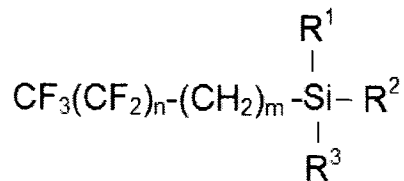
According to yet another embodiment, the solvents in the C1 and C2 components are selected from the group comprising but not limited to aliphatic ethers, aliphatic ketones and aliphatic alcohols. In particular, suitable ethers can be symmetrical and unsymmetrical ethers of general formula $(\text{C}_1\text{-C}_4)_2\text{O}$, such as dimethyl ether, diethyl ether, diisopropyl ether, methyl ethyl ether, methyl isopropyl ether, ethyl propyl ether etc. Suitable aliphatic ketones can be symmetric or asymmetric ketones of general formula $(\text{C}_1\text{-C}_4)_2\text{=O}$, e.g. such as acetone, methyl ethyl ketone, methyl ethyl ketone, methyl propyl ketone, ethyl propyl ketone etc. Suitable aliphatic alcohols can be preferably monohydric alcohols of general formula $(\text{C}_1\text{-C}_4)\text{OH}$, such as methanol, ethanol, propanol, isopropanol, butanol, isobutanols etc. With respect to polar properties and dissolution completeness of the aforementioned fluorosilanes, the most preferred solvent is isopropyl alcohol.

According to the second aspect, a coating obtained using the coating system according to the invention is provided.

According to one embodiment, the coating is obtained by applying the inventive coating system on the article surface or by sequentially applying the components C1 and C2 on the article

surface. In particular, the coating can be obtained by mixing a component C1 with a component C2 and applying the mixture on a substrate surface, wherein the component C1 comprises:

- (a) a fluorocarbon silane of general formula (I) in an amount of from 0.1 to 10% by weight of the first component:



(I)

wherein

- each of R¹, R² and R³ independently is selected from C₁₋₄ alkyl, C₁₋₄ alkoxy and Cl;
 m is an integer from 1 to 5;
 n is an integer from 3 to 10; and

- (b) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones and aliphatic alcohols - the balance, and

the component C2 comprises:

- (c) a mineral acid in an amount of from 1 to 10% by weight of the second component;
 (d) deionized water in amount of from 5 to 25% by weight of the second component;
 (e) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones, aliphatic alcohols – the balance.

According to one embodiment, the substrate is selected from a brick and concrete construction, glass, metal article, plastic article, article of furniture, textile or packaging industry. In a most preferred embodiment, the article is glass, in particular glass of a vehicle.

According to another aspect, a coating formulation is provided which is obtained by mixing the two components of the inventive coating system as described above, comprising the components C1 and C2. In particular, the coating composition can be obtained by mixing component C1 with component C2, or by sequentially applying component C1 and component C2 onto a substrate surface.

According to one embodiment, a hydrophobic coating formulation for surfaces is provided, comprising the two-component coating system as described above in connection with the first aspect, wherein the coating formulation is used as formulated or unformulated chemical-

resistant and lightfast paint for surfaces of mineral building materials, such as concrete, plaster, ceramics, clay, cement, as well as for surfaces of glass, rubber, wood and derived timber products, plastic, metal, paper, composite materials, leather, and as a binder for hardening hydraulic binders.

According to yet another embodiment, the water droplet contact angle on said hydrophobic coating is at least 95° , in particular from 95° to 150° . The "contact angle" means an angle formed between the tangent to the surface of the wetting liquid and the wetted substrate surface, said angle being always calculated from the tangent toward the aqueous phase. The term "water droplet contact angle" as used for the present invention is also used along with the interchangeable terms "contact angle", "a contact angle of a water drop" etc. The coating is considered "hydrophobic" or "water repellent" in the case where the above angle has a value of greater than 90° .

According to yet another embodiment, the coating has a high degree of resistance to mechanical wear, which is characterized by abrasion of the coating in the range of from 1000 to 1500 cycles at a particular predetermined force imposition. At the same time, the coating is considered rubbed when the contact angle of the coated substrate is equal to the contact angle on a substrate surface without a coating.

According to yet another embodiment, the coating has a thickness of from about 1 nm to about 100 μm , more preferably from about 1 nm to about 10 μm , most preferably from about 100 nm to about 1 μm . This coating thickness is sufficient to ensure satisfactory hydrophobic and mechanical properties for a long time (1-2 years) when exposed to the environment (erosion, rain, contamination, mechanical impact etc.).

In a further embodiment of the invention, use of a coating system for coating a surface of a substrate is provided.

According to a still further embodiment, an article of manufacture coated with a coating obtained using the coating system according to the invention is provided.

According to still another embodiment a coated material is provided, comprising a coating obtained using the coating system as described above, wherein the material is selected from the group comprising paper, board, wall-paper, wood, wood composites such as flake board, plastics, foil, concrete, coated or uncoated rendering, plaster, metals, ceramics, stone, brickstone and glass.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1. A schematic illustration of chemical groups formed on the surface when applying the coating system according to the present invention.

Fig. 2. A graph demonstrating dependence of contact angles (contact angles of wetting) for the coating obtained from the coating system according to the present invention versus the number of coating abrasion cycles.

IMPLEMENTATION OF THE INVENTION

Below are the results of a series of experiments demonstrating the effectiveness of the coating system for preparing a coating in accordance with the present invention, as well as the hydrophobic properties assay results for the coating according to the present invention.

Preparing coating systems

A coating system for a hydrophobising a substrate surface was prepared in two steps. On the first step, to a suitable solvent a fluorocarbon silane of formula (I) is added. The mixture is left for 1 hour with continuous stirring. As a result, the component C1 is obtained. On the second step, to a suitable solvent an aqueous solution of a mineral acid is added. Further, the mixture is thoroughly stirred. Thus, the component C2 is obtained. The components C1 and C2 are stored separately and are mixed directly before use. The obtained coating can be applied by any method known to one skilled in the art, including precipitation from a solution or spraying the solution on the surface. In this case, said fluorocarbon silane is commercially available or can be synthesized similarly to the method disclosed in the patent RU2344139 incorporated herein in its entirety.

Using the above described procedure, several formulations containing different ratios of components have been obtained. As an illustration, below presented are the results of the assays series for the properties of the coating obtained using coating system A according to the present invention. The coating system A was prepared by the above procedure using the components C1 and C2 in the ratio of 1: 1 having the following composition:

Component 1 (C1)

| | |
|--|-------|
| Isopropyl alcohol | 99.5% |
| heptadecafluoro-1,1,2,2-tetrahydrodecyl) triethoxysilane | 0.5% |

Component 2 (C2)

| | |
|-------------------|-----|
| Isopropyl alcohol | 80% |
| HCl, 1 M | 5% |
| Deionized water | 15% |

The above coating system was tested on samples of glass to obtain data characterizing the water resistance (i.e., hydrophobicity) and its variation under mechanical impact on the substrate surface. The results obtained for the coating system A were compared with the data obtained for four other commercially available coating systems (Comparative Examples 1-4). The substrates used for applying a coating were the same glass plates of about 100 x 100 mm.

For each plate, the contact angle was measured before and after applying a coating. The difference of these results and the percentage change in the contact angle were calculated. Thus, the water resistance of the glass was determined for different coverings. When measuring the contact angle for each plate five measurement results were obtained, and the mean value was calculated based thereon. Thus, all contact angle values shown herein are mean values of five measurements. Measurement of contact angles was performed using a tensiometer according to standard techniques. The Table 1 shows the hydrophobicity of the coatings expressed in the contact angles of water relative to a glass plate untreated with a coating.

Table 1: Contact angles of various known coatings and the coating system of the present invention

| Contact Angle | Before applying a coating | After applying a coating | Difference | Increase, % |
|---|---------------------------|--------------------------|------------|-------------|
| The coating system according to the present invention (Component A) | 25.34 | 114.02 | 88.68 | 350% |
| Comparative Example 1 («TCnano») | 27.01 | 102.16 | 75.15 | 278% |

| | | | | |
|---|-------|-------|-------|------|
| Comparative Example 2 («RainRepellent») | 27.21 | 99.83 | 72.62 | 267% |
| Comparative Example 3 («TurtleWax») | 29.43 | 94.64 | 65.21 | 222% |
| Comparative Example 4 («Nanolux») | 31.38 | 96.07 | 64.69 | 206% |

On glass plates untreated with a coating, the contact angle was from 25.34° to 31.38°. The largest contact angle of 114.02° was achieved by the coating according to the present invention, the contact angle was also the most increased in a percentage of 350%.

After the above-described contact angle measurement a study of mechanical wear impact on the coating hydrophobicity was conducted. This test used a previously obtained glass plates described above. The effect of mechanical wear was determined using brush cleaning equipment. The test plates were fixed under the machine frame, and a brush was set on the coating to perform standard reciprocating over the coating surface. The brush weight was 459.82 g. One reciprocating motion corresponded to one cycle. The contact angle for each plate was measured at the conclusion of 100 cycles, while if the contact angle was higher than the contact angle of wetting without a coating, the abrasion was continued. The brush was moistened every 100 cycles for investigating the coating resistance to water. The above procedure was repeated until the coating was rubbed, the coating was considered rubbed when the contact angle of the coated plate was equal to the contact angle on the glass plate untreated with a coating, i.e. about 25-31°. It is believed that the boundary between hydrophobicity and hydrophilicity is 90°, therefore, a special attention was paid at the number of cycles when the contact angle was less than 90°.

The results of the abrasion test are shown in Table 2.

Table 2: Test for coating abrasion

| Number of cycles | Coating A | Comparative Example 1 («TCnano») | Comparative Example 2 («RainRepellent») | Comparative Example 3 («TurtleWax») | Comparative Example 4 («Nanolux») |
|------------------|-----------|----------------------------------|---|-------------------------------------|-----------------------------------|
| 0 | 114.02 | 102.16 | 99.83 | 94.64 | 96.07 |
| 100 | 100.87 | 78.02 | 50.38 | 39,40 | 85.35 |
| 200 | 81.78 | 73.30 | 43.80 | 25.44 | 73.75 |
| 300 | 74.73 | 66.51 | 35.59 | 32.18 | 67.31 |
| 400 | 81.63 | 78.26 | 48.72 | 28.96 | 69.46 |
| 500 | 80.46 | 75.85 | 51.88 | 41.90 | 71.37 |

| | | | | | |
|------|-------|-------|-------|-------|-------|
| 600 | 64.02 | 68.76 | 35.00 | 32.71 | 55.86 |
| 700 | 59.04 | 67.43 | 42.89 | 40.17 | 56.63 |
| 800 | 56.75 | 65.28 | 34.10 | 31.46 | 54.49 |
| 900 | 51.19 | 57.11 | 35.66 | 32.62 | 50.52 |
| 1000 | 46.45 | 56.29 | 28.67 | 26.50 | 47.83 |
| 1100 | 45.60 | 51.37 | 30.75 | 25.26 | 38.98 |
| 1200 | 45.37 | 49.85 | 26.13 | 25.55 | 39.02 |
| 1300 | 43.08 | 43.20 | 24.90 | 23.02 | 29.42 |
| 1400 | 39.16 | 33.26 | 32.46 | 26.59 | 29.13 |
| 1500 | 32.33 | 33.48 | 30.62 | 23.46 | 26.61 |
| 1600 | 28.42 | 34.70 | 22.05 | 22.10 | 27.24 |

Fig. 2 shows a graph illustrating the dynamics of the contact angle changes depending on the number of abrasion cycles. These curves are based on data of Table 2. As can be concluded from the analysis of the presented data, the coating system A according to the present invention provided a coating with the highest initial wetting contact angle and retained the highest value during the first 400-500 cycles among all the tested coatings, the coating was fully rubbed by passing around 1500 cycles. Furthermore, the contact angle of wetting for the present coating exceeded 90° during the first 150-180 cycles, while the coatings according to Comparative Examples 1-4 at this number of cycles already lost hydrophobic properties.

The aforementioned data demonstrate that the coating system according to the present invention provides a coating having improved hydrophobic properties in comparison with a number of known and commercially available coatings of the prior art, wherein the hydrophobic effect of the coating is longer.

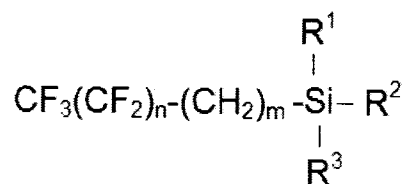
One skilled in the art will appreciate that some embodiments of the present invention can be modified without departing from the spirit of the present invention. Some of these embodiments of the invention are included in the following claims.

WE CLAIM:

1. A coating system for preparing a hydrophobic coating, the coating system comprising a first component C1 and a second component C2, wherein

the first component C1 comprises:

(a) a fluorocarbon silane of general formula (I) in the amount of from 0.1 to 10% by weight of the first component:



(I)

wherein

each of R¹, R² and R³ independently is selected from C₁₋₄ alkyl, C₁₋₄ alkoxy and Cl;
m is an integer from 1 to 5;
n is an integer from 3 to 10; and

(b) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones and aliphatic alcohols, the balance, and

the second component C2 comprises:

(c) a mineral acid in the amount of from 1 to 10% by weight of the second component;
(d) deionized water in the amount of from 5 to 25% by weight of the second component;
(e) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones, aliphatic alcohols, the balance.

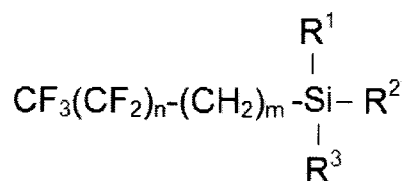
2. The coating system according to claim 1, wherein each of R¹, R² and R³ is ethyl.

3. The coating system according to claim 1, wherein the compound of formula (I) is selected from the group comprising:

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)dimethylchlorosilane,
(heptadecafluoro-1,1,2,2-tetrahydrodecyl)methyldichlorosilane,
(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane,
(heptadecafluoro-1,1,2,2-tetrahydrodecyl)triethoxysilane,
(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trimethoxysilane,

(tridecafluoro-1,1,2,2-tetrahydrooctyl)trimethoxysilane,
 (tridecafluoro-1,1,2,2-tetrahydrooctyl)triethoxysilane,
 (tridecafluoro-1,1,2,2-tetrahydrooctyl)dimethylchlorosilane,
 (tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane,
 (nonafluoro-1,1,2,2-tetrahydrohexyl)dichlorosilane,
 (nonafluoro-1,1,2,2-tetrahydrohexyl)dimethoxysilane, and
 (pentadecafluoro-1,1,2,2,3,3-hexahydrodecyl)trichlorosilane.

4. The coating system according to any one of claims 1 to 3, wherein the compound of formula (I) is (heptadecafluoro-1,1,2,2-tetrahydrodecyl)triethoxysilane.
5. The coating system according to any one of claims 1 to 3, wherein the weight ratio of the component C1 to the component C2 is from 1:1 to 1:10.
6. The coating system according to any one of claims 1 to 3, wherein said fluorocarbon silane is present in the amount of from 0.1 to 1% by weight of the component C1.
7. The coating system according to any one of claims 1 to 3, wherein the solvent in said components C1 and C2 is isopropyl alcohol.
8. The coating system according to any one of claims 1 to 3, wherein the mineral acid is selected from the group comprising hydrochloric acid, sulfuric acid, disulfuric acid, sulfurous acid, oleum, phosphoric acid and nitric acid.
9. A hydrophobic coating prepared using a coating system comprising a first component C1 and a second component C2, wherein the first component C1 comprises:
 - (a) a fluorocarbon silane of general formula (I) in the amount of from 0.1 to 10% by weight of the first component:



(I)

wherein

each of R¹, R² and R³ independently is selected from C₁₋₄ alkyl, C₁₋₄ alkoxy and Cl;
 m is an integer from 1 to 5;

n is an integer from 3 to 10; and

(b) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones and aliphatic alcohols, the balance, and

the second component C2 comprises:

(c) a mineral acid in the amount of from 1 to 10% by weight of the second component;

(d) deionized water in the amount of from 5 to 25% by weight of the second component;

(e) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones, aliphatic alcohols, the balance .

10. The coating according to claim 9, wherein the coating is applied onto the surface of an article selected from a brick or concrete structure, a glass, a metal article, a plastic article, an article of furniture, textile or packaging industries.

11. The coating according to claim 9, wherein the contact angle of a water droplet on said coating is from about 105° to about 150°.

12. The coating according to claim 9, wherein the thickness of said coating is from about 1 nm to about 1 μm.

13. The coating according to any one of claims 9 to 12, wherein the mineral acid is selected from the group comprising hydrochloric acid, sulfuric acid, disulfuric acid, sulfurous acid, oleum, phosphoric acid and nitric acid.

14. The coating according to any one of claims 9 to 12, wherein the compound of formula (I) is selected from the group comprising:

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)dimethylchlorosilane,

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)methyldichlorosilane,

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane,

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)triethoxysilane,

(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trimethoxysilane,

(tridecafluoro-1,1,2,2-tetrahydrooctyl)trimethoxysilane,

(tridecafluoro-1,1,2,2-tetrahydrooctyl)triethoxysilane,

(tridecafluoro-1,1,2,2-tetrahydrooctyl)dimethylchlorosilane,

(tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane,

(nonafluoro-1,1,2,2-tetrahydrohexyl)dichlorosilane,

(nonafluoro-1,1,2,2-tetrahydrohexyl)dimethoxysilane, and (pentadecafluoro-1,1,2,2,3,3-hexahydrodecyl)trichlorosilane.

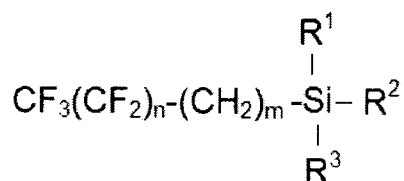
15. A method for preparing a hydrophobic coating on a surface of an article using the coating system according to any one of claims 1 to 8, the method comprising:

mixing the first component C1 with the second component C2 and applying the mixture on a surface of the article, or sequentially applying the components C1 and C2 on a surface of the article.

16. Use of the coating system according to any one of claims 1 to 8 for preparing a hydrophobic coating.

17. A hydrophobic component for a two-component coating system, wherein the hydrophobic component comprises:

(a) a fluorocarbon silane of general formula (I) in the amount of from 0.1 to 10% by weight of the first component:



(I)

wherein

each of R¹, R² and R³ independently is selected from C₁₋₄ alkyl, C₁₋₄ alkoxy and Cl;

m is an integer from 1 to 5;

n is an integer from 3 to 10; and

(b) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones and aliphatic alcohols, the balance,

18. The hydrophobic component of claim 17, for use in combination with the second component comprising:

(c) a mineral acid in the amount of from 1 to 10% by weight of the second component;

(d) deionized water in the amount of from 5 to 25% by weight of the second component;

(e) a solvent selected from the group comprising aliphatic ethers, aliphatic ketones, aliphatic alcohols, the balance.

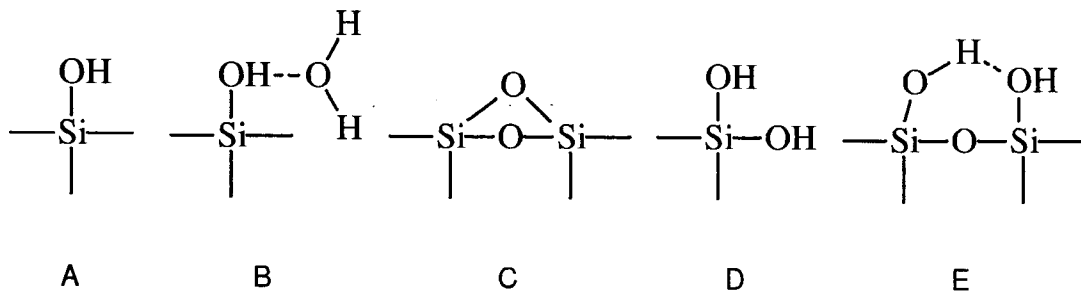


Fig. 1

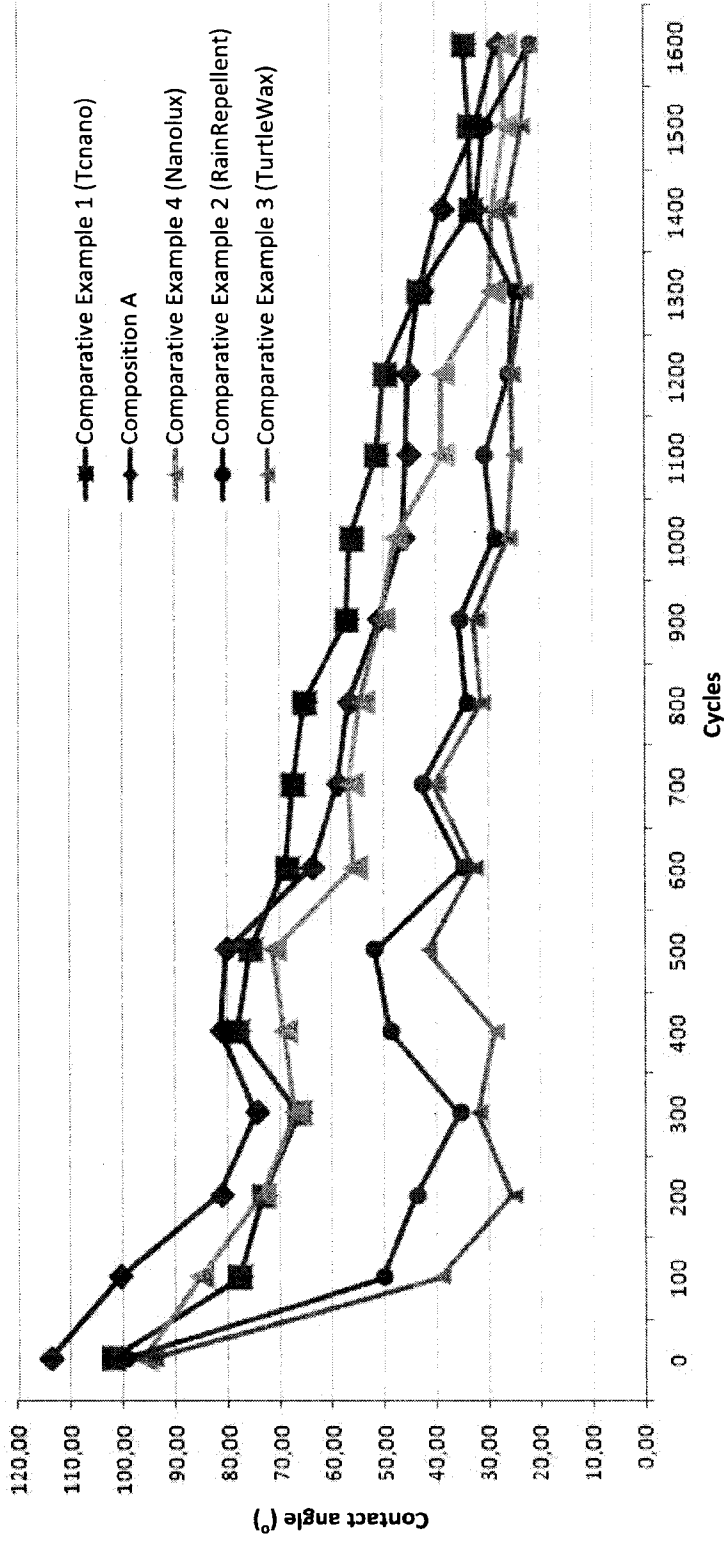


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/RU2015/000802

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C09D183/08 C08K3/24
 ADD.
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 C09D C08K C08G

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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| Date of the actual completion of the international search 5 April 2016 | Date of mailing of the international search report 13/04/2016 |
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| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016 | Authorized officer Queste, Sébastien |
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Information on patent family members

International application No

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