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(57) **Abrégé/Abstract:**

The invention relates to a method for producing a product having a long-life surface which is easy to clean. A mixture is applied to the surface, said mixture comprising a hydrolysable, network-forming gel, and the hydrophobic substance. Said gel preferably consists of SiO₂, Al₂O₃, Fe₂O₃, In₂O₃, SnO₂, ZrO₂, B₂O₃ and/or TiO₂ and the hydrophobic substance is preferably chemically linked to the gel network.



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der PCT-Gazette verwiesen.(54) **Title:** COATING WHICH IS EASY TO CLEAN(54) **Bezeichnung:** LEICHT REINIGBARE BESCHICHTUNG(57) **Abstract:** The invention relates to a method for producing a product having a long-life surface which is easy to clean. A mixture is applied to the surface, said mixture comprising a hydrolysable, network-forming gel, and the hydrophobic substance. Said gel preferably consists of SiO₂, Al₂O₃, Fe₂O₃, In₂O₃, SnO₂, ZrO₂, B₂O₃ and/or TiO₂ and the hydrophobic substance is preferably chemically linked to the gel network.(57) **Zusammenfassung:** Es wird ein Verfahren zur Herstellung eines Erzeugnisses mit einer langlebigen leicht reinigbaren Oberfläche beschrieben. Dabei wird auf die Oberfläche eine Mischung aufgetragen, die ein hydrolysierbares, ein netzwerkbildendes Gel sowie die hydrophobe Substanz umfasst. Das Gel wird vorzugsweise aus SiO₂, Al₂O₃, Fe₂O₃, In₂O₃, SnO₂, ZrO₂, B₂O₃ und/oder TiO₂ gebildet und die hydrophobe Substanz wird vorzugsweise mit dem Gelnetzwerk chemisch verknüpft.

WO 02/094729 A1

Easy-to-Clean Coating

Description:

The invention relates to a method for producing a product having an easy-to-clean surface by coating the surface with a hydrophobic substance, as well as the products obtained with the method.

It is generally known to provide objects with dirt-repelling substances. Thus, for example, it is also known to treat surface of glasses, glass ceramics, glazes and also rocks by means of silicones to make them dirt-repellent and water-repellent. This is usually accomplished by rendering the surface of the objects to be treated hydrophobic by applying a liquid composition. For this purpose, a plurality of chemicals are usually used, in particular, however, silicone oils and/or fluorinated silanes. Surfaces which have been treated in this way have shown to be difficult to wet, as a result of which water beads up and runs off. Dirt only adheres slightly to the treated surface and can thus be easily removed. This is especially advantageous for outdoor use since, for example, in the case of skylights and/or glass roofs such as on winter gardens, etc., the deposited dirt is entrained and removed as a result of the rainwater beading up and running off. In this way, it is possible to keep such windows appearing permanently clean without additional cleaning.

However, this method has the disadvantage that the applied chemicals only react and form permanent bonds with OH groups available directly on the substrate material. As there are insufficient reactive OH groups on the surface of objects, in particular glass, without an appropriate pretreatment such as, for example hydrogen/oxygen plasma, only a very thin, mostly monomolecular hydrophobic layer can be produced by means of such methods which is quickly rubbed off during use, in particular

also under a mechanical stress such as e.g. during cleaning and/or abrasion by wind and dust, as a result of which the desired self-cleaning property is lost.

Therefore, attempts have already been made to increase the durability of coatings of this type. For example, EP-A 0 658 825 describes the preparation of a water-repellent multilayer film. Three different sol solutions are thereby produced, mixed, applied to a glass substrate and a gel coating produced on the glass surface. By heating, a metal oxide surface is then produced. A fluoroalkyl silane layer is then applied to this metal oxide layer, as previously described.

A method is described in JP-A 11 092 175 according to which methoxy silane or an ethoxy silane compound containing a fluorocarbon chain is fixed on the surface of small particles having a diameter of 100 nm. The thus modified particles are then dissolved in an aqueous medium and applied to a surface to be coated, the solvent is then removed and the residue baked. In this way, a surface coated with small hydrophobic particles is obtained.

WO 99/64363 describes the preparation of a water-repellent surface in which the surface of the glass is first roughened and all metal ions present on the surface are removed. A water-repellent film is then applied to the previously treated surface in a known manner. By roughening the surface, the thus obtained roughening valleys are filled with the water-repellent agents.

WO 99/02463 describes the preparation of a scratch-resistant coating in which an organic substance with silicone-like networks is applied to the surface. This is followed by a heat treatment in which the temperature and duration are selected so that the purely organic layer applied is substantially degraded and/or removed, but a compound of inorganic molecules of the support material and organic molecules of the applied substance can form

in the uppermost molecular layers. In this way, an organic substance, for example a methyl group, is directly attached to the silicon atom of the glass surface with formation of a Si-C bond.

DE 695 02671 T2 (WO 95/24053) describes an indicating device with a screen which has a non-absorbing cover layer consisting of a hybrid inorganic-organic material and an inorganic network consisting of silicon dioxide and metal oxide. The polymer chains are thereby intertwined with the inorganic network and form a hybrid inorganic-organic network. However, it was shown that organic components, in particular hydrophobic organic components such as fluoroalkyls, do not set homogeneously in such a layer, but accumulate essentially on the surface facing away from the support layer. For this reason, this outer hydrophobic layer can rub off relatively easily.

All hydrophobic as well as optionally dirt-repellent properties produced with these methods are shown to be insufficiently durable in use and are quickly lost, in particular under mechanical stress.

Therefore, the object of the invention is to provide an easy care object whose easy-care and dirt-repellent finish is durable and which also remains abrasion-resistant under stress, as a result of which the aforementioned easy-care properties on the object or product are retained for a long time.

Moreover, the object of the invention is to provide such a finish for optical elements which do not, or not noticeably, change the optical properties of the element.

According to the invention, this object is attained by the method defined in the claims as well as the product obtained therewith.

According to the invention, it was found that a uniform,

resistant coating or a coating on a product can be obtained having properties which are homogeneous in cross section by providing its surface with a layer which comprises a thin metal oxide network or a metal oxide matrix, a hydrophobic substance being uniformly distributed in the network. The layer is usually a uniform layer consisting of a coherent metal oxide network spread out in a sheet-like manner. The metal oxide networks of the invention can have open or closed pores.

The metal oxide layers according to the invention are formed by thermal treatment of an applied gel layer and remain as a firm finish or coating on the product. In the coating according to the invention, the hydrophobic substance is uniformly distributed, i.e. it is present on the layer side adhering to the support material to the outer layer surface over the cross section in a homogeneous concentration and does not accumulate, exclusively or primarily, on the outer coating surface. In this way, the surface layer also retains the desired properties according to the invention when there is surface abrasion.

The gels used according to the invention are, in particular, metal oxide gels which are produced by a sol-gel process. The gels are thereby formed in situ during the application to the object or product to be coated, as a result of which a uniform continuous gel network is produced on the surface of the object to be coated. Preferred metal oxides are SiO_2 , Al_2O_3 , Fe_2O_3 , In_2O_3 , SnO_2 , ZrO_2 , B_2O_4 [sic] and/or TiO_2 . Hydrogels, alkogels, xerogels and/or aerogels are preferred gels. The result of the addition of the hydrophobic, optionally also oleophobic substance according to the invention to the sol mixture prior to or during formation of the gel is that the hydrophobic substance is uniformly distributed throughout the forming gel network and is chemically bound by polycondensation, for example of its silanol groups. In this way, it is possible to provide the surface thus treated with especially wear-resistant and durable dirt-repellent properties.

The general production of gel layers by means of a sol-gel process is known in itself and has been frequently described. Usually, with this process, a polymer reaction is produced by means of hydrolysis in a solution, preferably an aqueous and/or alcoholic solution, with inorganic metal salts or metal organic compounds such as metal alkoxides, whereby a colloidal suspension, i.e. a sol, is produced. By further hydrolysis, a coherent gel network is formed from the sol. Preferably, the formation of the gel is produced directly during coating. The final formation of the entire gel network is preferably accelerated by heating. Typical temperatures for this are between 0°C and 200°C, preferably between 20°C and 200°C, in particular between room temperature and 170°C, whereby a temperature of 150°C is especially preferred. By selecting the hydrolysis conditions, it is possible to produce very dense, i.e. more or less pore-free gel networks or networks having only the tiniest pores. Metal alkoxides are preferably C₁ - C₄ metal alkoxides, metal methylates and metal ethylates being especially preferred. Among the metal salts, metal nitrates are preferred. The hydrolysis with sol formation is usually started with an excess of distilled water and the sol formation is completed by allowing it to stand at ambient temperature and optionally also at elevated temperature for an extended period of time, for example two to four days.

Generally, suitable hydrophobic substances are all hydrophobic substances which can be incorporated into the forming gel. For the method according to the invention, it is preferable to use those hydrophobic substances which are capable of distributing themselves as uniformly as possible in the gel-forming sol solution. Therefore, the hydrophobic substances used according to the method of the invention are preferably slightly water-soluble in themselves or can be made water-soluble by means of solubilizers or by hydrolysis. In a further preferred embodiment, the oleophobic substances used according to the

invention have a chemical modification which impart water solubility. Modifications of this type are water-soluble groups, e.g. amino residues or acid groups. Examples of this are natural and synthetic oils and/or long-chain fatty acids, in particular fatty acids having a chain with at least six carbon atoms, preferably at least 10 carbon atoms. However, especially preferred are hydrophobic oleophobic substances, in particular silicones and silanes, siloxanes, silicone oils and silicone greases. The silicone compounds used according to the invention can be linear or branched or possibly also contain cyclic silane groups. In a preferred embodiment, they contain a water-solubility imparting function, e.g. an amino group, whose hydrogen atoms can also be optionally substituted.

The hydrophobic substances used according to the invention preferably contain fluorine and have, in particular, at least 5%, preferably at least 10% fluorine atoms (relative to the total number of atoms of the hydrophobic substance finally incorporated after sintering). Preferably, however, they have at least 20% fluorine atoms, at least 30% being especially preferred. Although it was found that the incorporation of the hydrophobic substances according to the invention by the in-situ process results in lasting dirt repellency, it is preferred to chemically link the hydrophobic substances with the gel network by means of reactive groups, in particular by means of reactive silanol groups. Hydrophobic substances with methoxy, ethoxy, propoxy, butoxy or isocyanate groups and chlorosilanes are especially well suited.

The silanes preferred in the method according to the invention have the general formula



wherein x and y independently of each other stand for 0, 1, 2 or 3 and x + y = 3, and a, a' and b, b' independently of each stand

for 0, 1 or 2, and $a + b$ as well as $a' + b' = 2$ and n and m independently of each other denote an integer from 0 to 20 and together add up to a maximum of 30 and R is a straight-chain, branched, saturated or unsaturated (optionally containing heteroatoms) $C_1 - C_8$ alkyl group. Preferred alkyl groups are methyl, ethyl and propyl groups as well as their amino derivatives. According to the invention, silanes which have functional groups comprising heteroatoms or a heteroatom that increase or impart water solubility of the silane, are preferred. The heteroatoms and/or functional groups are incorporated in the backbone of the alkyl carbon chain and/or the fluoroalkyl carbon chain and/or adhere thereto as a substituent. According to the invention, amino alkyl groups and/or amino fluoroalkyl groups are especially preferred.

In a preferred embodiment, $x = 3$ and $y = 0$, so that the above general formula has an end CF_3 group. In a further preferred embodiment of the invention, $a = 2$ and $a' = 0$, so that CF_2 and CH_2 blocks are formed. Of course, there can also be more than 2 blocks in the chain and the CF_2 blocks and CH_2 blocks can be interchanged. However, it is preferred to have the fluorinated blocks ending at the Si atom. Preferred values for n are 1 - 10, in particular 1 - 8, and for m 0 - 10, in particular 0 - 8. In the gel solution to be applied, the weight ratio of the hydrophobic substance to the gel network is preferably 0.01:1 to 1:1, ratios between 0.05:1 and 0.2:1 being preferred.

The mixture of gel and hydrophobic substance according to the invention is applied by means of conventional coating methods, spraying and dip-coating being preferred. The thickness of the coating can thereby be controlled by adjusting the viscosity and the rate at which the object to be coated is withdrawn from the dipping solution. Thus, in a special embodiment, the coating mixture also contains viscosity modifiers such as PVP, PVA and PEO. Layer thicknesses preferably produced according to the

invention are between 0.5 nm - 1 μ m, layer thicknesses of < 200 nm being preferred. After application, the layer is preferably dried at room temperature for at least 1 minute, preferably at least 3 minutes, and then hardened at an elevated temperature at which optionally added substances, such as viscosity modifiers are pyrolyzed or burned. The drying time depends on the layer thickness produced, on the actual temperature and on the vapour pressure of the solvent and is preferably at least 1 minute and is, in particular, at least 3 minutes. The drying times are usually 4 - 6 minutes. The sintering or hardening of the applied layer preferably occurs at temperatures of 150°C - 400°C, preferably at 250°C - 380°C. The duration of the hardening is usually maximum of 1 hour, a maximum of 45 minutes and in particular a maximum of 30 minutes being preferred.

By means of the degree of hydrolysis, it is possible to set the viscosity of the coating solution, in particular the dipping solution, accurately to a drawable value. In this way, with a known viscosity and a known drawing rate, the layer thickness produced in each case can be exactly reproduced. A change in the viscosity when using the coating or dipping solution can be easily adapted to the respectively desired value by diluting it with solvents, e.g. ethanol, or by adding a further hydrolyzable sol-gel solution.

In the method according to the invention, it is also possible to adapt the refractive index of the coating to the support material. This is possible, for example, by mixing various metal oxides. The refractive index of SiO₂ is $n = 1.45$, TiO₂ is $n = 2.3$. In a SiO₂/TiO₂ system, any refractive values desired within these extreme values can be set, depending on the composition. By setting the refractive index and the layer thickness, the method according to the invention is also especially suitable for producing interference coatings, e.g. to reduce reflectivity.

In a special embodiment of the invention, the durable hydrophobic layer is provided with a surface microstructure by means of appropriate measures taken before, during or after the thermal hardening, as a result of which the hydrophobic properties of the coating are enhanced and its cleaning facilitated or the layer is provided with an antireflective effect or this effect is enhanced. Such effects can be achieved by incorporating particles or by embossing. In this way, surface microstructures can be obtained which have, for example, knobs which limit a contact of dirt particles and the surface coated according to the invention to a few contact points as is the case, for example, with the so-called lotus effect. In this way, the desired cleaning effect is further enhanced.

In principle, by means of the method according to the invention, it is possible to coat any materials capable of withstanding the sintering temperatures described above. These include, in particular, metals, plastics, inorganic minerals and rocks, such as e.g. marmor, granite, burned clay. However, it is especially preferred to coat glass and glass ceramics with the method according to the invention. Preferred glasses for this purpose are borosilicate, soda-lime and optical glasses. The method of the invention is especially suitable for producing easy-to-clean flat glasses and, in particular, float glasses, curved glasses, optical lenses, glass tubes, TV and PC screens and front glasses therefor, furthermore, glass ceramic products, motor vehicle glass enclosures, enamelled and/or ceramic products. Preferred flat glasses are, for example, window glass, mirror glasses, shower enclosure glasses, glass shelves, cover glasses for solar collectors, sight glasses, instrument glasses, glass keyboards, touch screen panels, display cover glasses, for example, for mobile telephones and laptops, glasses for stoves, for example baking oven panels, glass baking trays and/or glass baking containers, lamp cover glasses and glasses for refrigerators and furniture. Curved glasses are, for example, spotlight glasses, lamp cover glasses, watch glasses and/or sanitary glasses. Glass

lenses are, for example, spectacle lenses, ocular and objective glasses in optical devices. Glass tubes are, for example, solar collector tubes and wastewater pipes. Vehicle glass enclosures are, for example, windows and instrument covering glasses for automotive vehicles, for rail-borne vehicles such as trains, etc., for ships and airplanes. Enamelled products are, for example, baking trays, sauce pans and sanitary objects such as wash basins, urinals, bathtubs and toilet bowls. Ceramic products are, for example, tiles, roofing tiles and the aforementioned sanitary objects.

The method of the invention is also suitable for coating household items such as drinking glasses, glass cooking utensils and cooking areas made of glass-ceramic as are available, for example, under the trade name CERAN. The method according to the invention was also found to be suitable for coating enamelled cooking utensils, e.g. pots and pans.

However, it is also possible to produce multiple interference-optical layers, for example reflectivity-reducing layers, by means of the method of the invention. Such reflectivity-reducing coatings according to the invention are preferably produced as the outermost layer exposed the surroundings or air.

The invention will be described in greater detail by the following examples.

Example 1 - Preparation of Hydrophobically Modified SiO₂ Dipping Solutions

a) A mixture is produced from 13.6 g tetramethylorthosilicate (CAS:681-84-5 available under the name Dynasil™ M from Degussa, Frankfurt/Germany) and 13.6 g 96% ethanol (mixture A), as well as a mixture of 3.75 g distilled water and 0.15 g 36 HCl (mixture B). Mixture A and B are mixed and stirred for 10 minutes at room

temperature. A mixture of 1.4 g of a water-soluble modified fluoroalkylsiloxane (to CAS 64-17-5 available under the name Dynasytan™ F8800 from Degussa, Frankfurt/Germany) and 175 g 96% ethanol were added while stirring. This mixture is used as a dipping solution.

b) Similar to a), a mixture A consisting of 13.6 g ethylpolysilicate (from tetraethylsilicate, available under the name Dynasyl™ 40 from Degussa AG, Frankfurt/Germany) and 13.6 g 96% ethanol and a mixture B consisting of 3.8 g water and 0.15 g 36% hydrochloric acid is prepared, then the two mixtures are added together and stirred for 10 minutes. A mixture of 1.4 g of a water-soluble modified fluoroalkylsiloxane which contains aminoalkyl-functional substituents (CAS No. 64-17-5, available from Degussa AG, Frankfurt/Germany under the name Dynasytan™ F8800) and 175 g 99.5% ethanol is then added while stirring.

c) A mixture of 254.2 g 99.5% ethanol, 77.6 g water, 7.2 g glacial acetic acid and 90.8 g tetramethylorthosilicate (Dynasil™ M, see above) are stirred together and allowed to stand for 24 hours. 25 g of the concentrate thus obtained are then mixed while stirring with 75 g 99.5% ethanol and then stirred together with a mixture of 100 g 99.5% ethanol and 1.4 g of a fluoroalkyl-functional water-soluble polysiloxane which is made water-soluble by means of aminoalkyl-functional substitution (CAS No. 64-17-5, Dynasytan™ F8800), as a result of which the finished dipping solution is produced.

d) 88.6 ml silicic acid methylester, 80 ml of distilled water and 10 ml glacial acetic acid are stirred into 240 ml ethanol. The solution thus obtained is allowed to stand for 72 hours. It is then diluted with 1.580 ml ethanol and the hydrolysis stopped with 2 ml of a 37% hydrochloric acid. 8.6 ml tridecafluorooctyltriethoxysilane (available under the name Dynasytan F8261 from DEGUSSA-HÜLS, Frankfurt, Germany) are then added while stirring.

The coating was applied according to the invention by means of a single dipping step. It was subsequently dried for five minutes at room temperature and baked at 250°C for a maximum of 30 minutes, as a result of which the silica gel hardened.

Example 2 - Preparation and Testing of a Coating according to the Invention

A clean 2-mm thick, 10 x 20 cm panel of borosilicate glass was immersed at room temperature in the SiO₂ dipping solution described above in Example 1 and was then withdrawn from the solution at a rate of 20 cm/minute. The coating film thus applied was allowed to dry for 5 minutes at room temperature and was then baked for 20 minutes in an oven at 250°C (Table 1, Coating 1) or at 300°C (Table 1, Coating 2). After the baking, the coating of the invention was about 120 nm thick. The hydrophobing process was evaluated by determining the contact angle with water. This was done with a model G 10 contact angle meter of the firm KRÜSS, Hamburg [Germany]. With this method, freshly cleaned glass surfaces show a contact angle of $\leq 20^\circ$, coated glass surfaces, an angle of about 60° and surfaces freshly rendered hydrophobic, an angle of $\geq 100^\circ$.

Immediately after the preparation according to the invention, a value of 110° was measured at room temperature in this manner. Thereafter, a Schrub test was performed as follows: a piece of felt having a contact surface of about 3 cm² and moistened with water was subjected to a total load of $m = 1$ kg and moved back and forth on the test specimen. In this case, a load cycle corresponds to a back and forth movement.

After 500 load cycles by the Schrub test, the contact angle was still 102° , after 1000 cycles it was 103° and after 2000 cycles it was still 100° , within in accuracy of $\pm 3^\circ$.

Example 3 - (Comparative Example) - Hydrophobing by Use of a Fluoroalkylsilane

A hydrophobic glass surface was produced in accordance with the prior art by applying tridecafluorooctyltriethoxysilane (F 8262, available from DEGUSSA-HÜLS): The fluoroalkylsilane was applied to the entire surface with a textile cloth and fixed for 20 minutes at 200° or 250°. Measurement of the contact angle with water showed a value of 108° immediately after preparation. After 500 load cycles by the Schrubbs test (see above), the contact angle was 81°, after 1000 cycles it was 68° and after 2000 cycles it was still 67°. Similar values were also obtained for identically tested hydrophobic glass surfaces from different manufacturers.

Example 4 - (Comparative Example) - Hydrophobing by Use of a Silicone Oil

By applying hydromethylpolysiloxane (Fluid 1107, available from DOW CORNING), a hydrophobic glass surface according to the prior art was produced: The silicone oil was applied to the entire surface with a textile cloth and fixed at 180° for 20 minutes. Measurement of the contact angle with water showed a value of 102° immediately after preparation. After 500 load cycles by the Schrubbs test (see above), the contact angle was 87°, after 1000 cycles it was 71° and after 2000 cycles it was still 51°. Similar values were also obtained for identically tested hydrophobic glass surfaces from different manufacturers.

Example 5 - (Comparative Example) - Performance of Commercially Available Hydrophobic Glass Surfaces

Four commercially available hydrophobic glasses from different manufacturers were subjected to a loading or Schrubbs test as described in Example 2. The test results are summarized in Table

1.

Table 1: Contact Angle with Water in Degrees on Different Hydrophobic Glass Surfaces After n Load Cycles

Preparation/Origin	n = 0	n = 500	n = 1000	n = 2000
Coating 1, according to the invention, Example 2 (250°C)	114	106	102	101
Coating 2, according to the invention, Example 2 (300°C)	110	102	103	100
Example 3 (Comp. Example according to prior art, coated with fluoroalkylsilane)	108	81	68	67
Example 4 (Comp. Example according to prior art, coated with silicone oil)	102	87	71	51
commercially available hydrophobic glass surfaces as per Example 5	90 - 99	54 - 89	50 - 71	-

Easy-to-Clean Coating

Patent Claims:

1. Method for producing a product with a long-lasting, easy to clean surface by coating the surface with a hydrophobic material, characterized in that a mixture is applied to the surface, said mixture comprising a hydrolyzable, network-forming gel and the hydrophobic substance.
2. Method according to claim 1, characterized in that the gel is hardened after it has been applied.
3. Method according to any of the preceding claims, characterized in that the gel is a hydrogel, alkogel, xerogel and/or aerogel.
4. Method according to any of the preceding claims, characterized in that the gel is formed from SiO_2 , Al_2O_3 , Fe_2O_3 , In_2O_3 , SnO_2 , ZrO_2 , B_2O_3 and/or TiO_2 .
5. Method according to any of the preceding claims, characterized in that the hydrophobic substance is chemically linked with the gel network.
6. Method according to any of the preceding claims, characterized in that a silane is used as hydrophobic substance.
7. Method according to any of the preceding claims, characterized in that the silane has the general formula



wherein x and y independently of each other stand for 0, 1, 2 or 3 and $x + y = 3$, and a, a' and b, b' independently of each other stand for 0, 1 or 2, and $a + b$ as well as $a' + b' = 2$ and n and m independently of each other denote an integer from 0 to 20 and together add up to a maximum of 30 and R is a straight-chain, branched, saturated or unsaturated $C_1 - C_8$ alkyl group optionally containing heteroatoms.

8. Method according to any of the preceding claims, characterized in that a metal organic sol solution which is hydrolyzable with gel formation is produced, that a hydrophobic substance is dissolved therein and that this solution is applied to a surface to be treated.
9. Method according to claim 8, characterized in that the solution is applied by dipping, spraying, spinning, rolling, curtain-coating or screen printing.
10. Product with an easy to clean surface which can be obtained according to any of claims 1 to 9.
11. Product according to claim 10, characterized in that it is a window glass, a mirror glass, a shower enclosure glass, a glass shelf, a cover glass for solar collectors, a sight glass, an instrument glass, a glass keyboard, a touch screen panel, a display cover glass, a glass for stoves, a glass for refrigerators or furniture, a spotlight glass, a lamp cover glass, a watch glass, a sanitary glass, a spectacle lens, an ocular and objective glass in optical devices, a solar collector tube, a wastewater pipe, a TV or PC screen, a TV or PC front glass, a window and instrument covering glass for automotive vehicles, for rail, ships or airplanes, a baking tray, a sauce pan, a sanitary object, a floor tile or a roofing tile.