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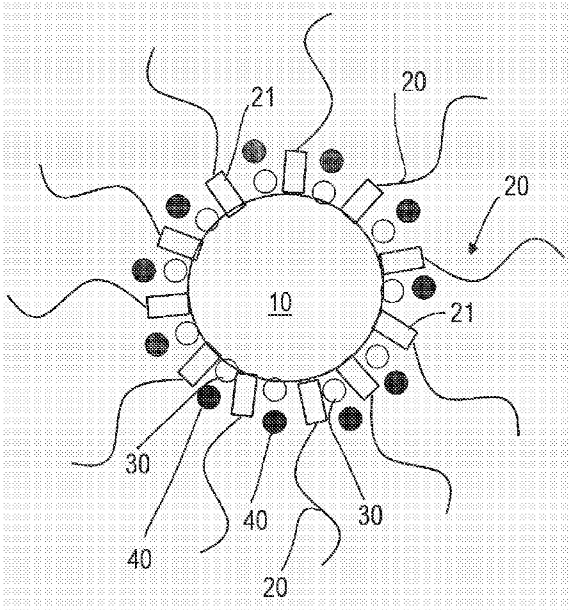

Fig. 5

(57) Abstract: Product containing a nanomaterial compound having general formula AO_x- $(L\text{-}Me^{n+})_i$ $(FA)_j$, wherein AOx indicates a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (0) bound to the metal (A) atom; Me^{n+} is a metal ion; L indicates a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of ($L\text{-}Me^{n+}$) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule (FA) bound to the to a AO_x nanoparticle.

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PRODUCTS COMPRISING AN ANTI-MICROBIAL COMPOSITION BASED ON TITANIUM DIOXIDE NANOPARTICLES

The invention relates to nanomaterials, nanomaterial products comprising nanomaterial composition.

Moreover, the invention relates to nanomaterials, nanomaterial products comprising a nanomaterial composition having antibacterial, antimicrobial, antiviral, antimycotic, germicide, photo-remediating properties.

The invention relates to nanomaterials, nanomaterial products, material and items comprising nanomaterial composition, such as for example plastics, fabrics, tissues and paints.

Furthermore, the invention relates to a product for topical use having antibacterial, antimicrobial, antiviral, antimycotic, germicide properties.

Furthermore, the invention relates to a material provided with a substrate having antibacterial, antimicrobial, antiviral, antimycotic, germicide properties.

Moreover, the invention relates to a plant treating product containing Titanium Dioxide, and a method for obtaining a plant treating product.

The invention further relates to methods for eliminating polluting substances and for eliminating microorganisms near a surface, for example a plant and/or a leaf surface.

As is known, Titanium Dioxide has optimal photocatalytic properties with regard to a multiplicity of organic and inorganic pollutants, moreover Titanium Dioxide has optimal antibacterial, antimicrobial, antiviral, antimycotic, germicide properties.

Owing to these properties, Titanium Dioxide-based products have already been widely used.

Moreover, it is known to combine the properties of the Titanium Dioxide with the properties of some metals having bacterial activity.

The metal ions which have the greatest antibacterial activity are, in decreasing order of potency, ions of the following metals: Hg > Ag > Cu > Zn > Fe > Pb > Bi.
The incorporation of such metals, particularly silver and copper ions, in different materials, enables elimination or reduction of the growth of bacterial colonies.
This effect is particularly advantageous in light of the compatibility of Ag^+ and Cu^{2+} with the human organism and the increasing resistance of many bacteria to antibiotics.
Concerning the mechanism of action of silver, it is known that the antibacterial activity is performed by the univalent positive ion, Ag^+.
Pharmaceuticals products based on silver, e.g. silver sulfadiazine, used to prevent infections in cases of severe burns, function with slow release of Ag^+ ions, which can be reversibly absorbed in bacterial cells, by association with the -SH groups of cysteine in bacterial proteins present in the cell wall.
The cytotoxic action of Ag^+ is also associated with the capability of this ion to displace essential ions from the cells, such as calcium (Ca^{2+}) and zinc (Zn^{2+}). Prior studies (see, e.g., Carr, H.S., Wlodkowski, T.J., and Rosenkranz, H.S., 1973, "Antimicrobial agents and chemotherapy", vol. 4, p. 585) have demonstrated that the antibacterial activity of Ag^+ ions is directly proportional to their concentration, and is effective against a very large number of species of bacteria.
Similar considerations can be done for cupric ions (Cu^{2+}), which are known in agriculture as antibacterial agents.
It is also known to produce nanocrystalline materials with high surface area, based on metal oxides (MO_x), such as titanium dioxide, zinc oxide, stannic oxide (SnO_2), zirconium dioxide, and colloidal silica, which can be deposited on and stably adhered to a variety of substrates.
Also known are nanomaterials based on titanium dioxide which include silver ions, which are obtained by mixing

suspensions of the nanomaterial with solutions containing Ag^+ ions.

The adhesion of the Ag^+ ions to the nanocrystalline structure of the metal oxide is very likely associated with insertion of the ions among the nanocrystals.

Nevertheless the products known have a limited adhesion to a desired support.

For example, some support does not effectively interact with known products.

Therefore, non homogeneous films are applied on such supports and the properties of the product are not conferred homogeneously to the entire surface of a treated support.

Therefore, microorganisms growth centre may develop.

Moreover in agriculture, it is often necessary to treat plants, or fruit trees, or vegetables, or also flowers, with specific products to eliminate bacteria, or fungi, or mildews, or other microorganisms, such as algae, microbes, germs, viruses, protozoas, parasites, or also pests, such as insects, mites, rodents, parasites, and to avoid a proliferation thereof that would adversely affect the quality of the vegetables or of the fruit, or would compromise the entire harvest of the farmer.

Moreover, it is necessary to use on the one hand a product that is efficacious against the specific bacteria, and possibly against many different bacteria, or microorganisms, and on the other hand to use a product that is non-polluting both for the environment and for the fruit or vegetable treated with the product.

Known products are efficacious only against a very limited number of microorganisms, therefore many different products have to be used for protecting a plant.

Moreover, known products are often polluting both for the environment and for the product, such as the plant, for which they are used.

In fact such products may pollute the drainage waters and/or the soil also compromising the subsequent productiveness thereof, and also may be adsorbed from the plant on which they have been applied and therefore pollute the plant and the possible fruits produced by the plant.

Moreover, in order to prevent any subsequent growth, and/or proliferation of microorganisms, the necessity arises to use a product that maintain a certain efficacy over time.

Known products maintains their efficacy for a limited period of time, therefore such products have to be frequently and repeatedly applied to the plants.

Therefore, a considerable waste of time and of money occurs.

Furthermore, known products are easily removed from the surface of the plant treated therewith, for example from the surface of the leaves of the plants, by the water, or rain that wash out such products.

This implies that the plants have to be frequently and repeatedly treated with known products with consequently high costs and wastes of time.

Moreover, known products are transported in drainage water polluting the same.

Furthermore, known products do not have homogeneous structure, therefore, also on the treated substrate, microorganisms proliferation centres can develop, from which infections may spread all over the plant.

An object of the invention is to improve nanomaterial products.

Another object of the invention is to provide materials, such as for example plastics, fabrics, tissues having antibacterial, antiviral, antimycotic, properties.

Another object of the invention is to provide a product for topical use such as a cream, having antibacterial, antiviral, antimycotic, properties.

A further object of the invention is to provide a paint having antibacterial, antiviral, antimycotic, photocatalytic properties.

Another object of the invention is to improve products for treating plants.

Another object of the invention is to provide Titanium Dioxide-based products.

A further object of the invention is to provide Titanium Dioxide-based products having very good adhesion properties and that can be applied to every desired substrate forming a homogeneous film thereon.

A still further object of the invention is to provide a product having good adhesion properties to a lipophylic substrate.

Still another object is to obtain a plant treating product that is efficacious in treating many different possible affections of the plants.

Still another object is to obtain a plant treating product that is efficacious for treating many different kind of plants.

Still another object is to obtain a product that maintains the efficacy over a considerable period of time.

A still another object is to provide a product that can be durably and stably adhered to a desired surface of a plant on which such a product is applied.

A still another object is to provide a plant treating product having a homogeneous structure and allowing a desired surface of a plant on which such a product is applied to be homogeneously covered and also any microorganism proliferation centre to be avoided.

A further object is to obtain a plant treating product suitable to be applied on a desired plants by spraying, and/or by rolling, and/or by brushing.

Another object is to provide a product capable of avoiding any infections, for example due to fungi, microbes, acarus, mites, mildews, sponge, bacteria, insects, etc. to develop on a substrate on which the product is applied, or to which the product is mixed.

In a first aspect of the invention there is provided a product containing at least a nanomaterial compound having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i(FA)_j$.

In a second aspect of the invention, there is provided a method for preparing a product comprising mixing a metal or metalloid oxide AO_x, metal ions Me^{n+}, bifunctional molecule L, that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), fatty acid molecule (FA), so as to obtain a product containing at least a compound having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$.

AO_x is a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (O) bound to the metal (A) atom; Me^{n+} is a metal ion, having antibacterial, antiviral, antimycotic activity; L is a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of ($L\text{-}Me^{n+}$) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the to a AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule bound to the to a AO_x nanoparticle.

The value of the parameter i depends on various factors, such as the size of the nanoparticle of AO_x, the nature of the molecule L, and the method used for preparing the product.

The value of the parameter i, may be the number of ligands L which the nanoparticle AO_x is capable of binding to, when said nanoparticle is contacted with a solution of the ligand L for a time interval comprised in the range of 10 min to 72 hr, preferably in the range 3 to 24 hr.

The value of the parameter i, may be comprised between about 100 and 10000.

The value of the further parameter j depends on various factors, such as the size of the nanoparticle of AO_x, the nature of the molecule L, and the specific fatty acid molecule used.

In terms of weight percentage, the amount of fatty acid bound to the nanoparticles may be comprised between about 10^{-2} and 5% (w/w).

The value of the parameter j, may be comprised between about 10 and 1000, preferably between about 500 and 800.

The fatty acid molecule (FA) is capable of binding the nanoparticle of AO_x when said AO_x nanoparticle is contacted with a solution of (FA) for a time in the range of 10 min to 72 hr, preferably in the range 3 to 24 hr.

The nanomaterial compound according to the invention has particle size in the range 10-5000 nm, preferably a nanomaterial compound having particle size comprised between about 200 nm and 5000 nm is obtained.

The product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i\ (FA)_j$, may contain a very widely variable number of molecules of fatty acid linked to a molecule of AO_X.

The real number of molecules of the fatty acid bound to a AO_x nanoparticle, depends by the size of the nanoparticles and it can be calculated that, in the case of titanium dioxide nanocrystals having diameters of the order of 25-30 nm, at least 500-800 fatty acid molecules can be organized and bound to the surface of each nanoparticle.

The number of fatty acid molecules which can be bound to the or AO_x nanoparticle, depend also by the size of the fatty acid molecules used.

The nanomaterial compounds according to the invention have antibacterial and antiviral activity in the presence or even in the absence of light irradiation.

The value of x is usually 1 or 2; the value of n is usually 1 or 2.

By suitably choosing the atom of the metal ion Me^{n+} and/or the metal or metalloid oxide AO_x, it is possible to magnify the properties of the compound according to the invention, and a composition can be obtained having strong antibacterial, antiviral, antimycotic, microcide, photocatalytic, anti-pollution properties.

AO_x may be for example titanium dioxide (TiO_2), zinc oxide (ZnO), stannic oxide (SnO_2), zirconium dioxide (ZrO_2), and colloidal silica (SiO_2);

Me^{n+} may be chosen between transition metal ions.

In a preferred embodiment, ion Me^{n+} is chosen between Ag^+

and/or Cu^{++}, i.e. metals having antibacterial, antimycotic, antiviral activity.

Bifunctional molecules L may be based on organic compounds.

Bifunctional molecules L may be organic or organometallic molecules, such as complexes of the transition metals.

The ligand L may be provided with different suitable functional groups, first functional group binding to the AO_x oxide, and second functional group binding the Me^{n+} ions.

The first functional group may be chosen in a group comprising: carboxyl (-COOH) (or carboxylate), phosphonic (-PO_3H_2) (or phosphonate), or boronic (-$B(OH)_2$) (or boronate), dipyridyl group, terpyridyl group.

The second functional group may be chosen in a group comprising: Cl^-, Br^-, I^-, S, SH, CNS^-, NH_2, N, CN^- and NCS^-.

Preferably, said dipyridylic or terpyridylic group is substituted by a carboxyl group, more preferably in a para position with respect to the pyridine nitrogen.

The bifunctional ligands L can be selected in a group comprising:

- nitrogen-containing heterocycles having 6 to 18 members, preferably pyridine, dipyridyl, or terpyridyl, possibly substituted with one or more substituents, selected preferably between: carboxyl (-COOH), boronic (-$B(OH)_2$), phosphonic (-PO_3H_2), mercaptan (-SH), and hydroxyl (-OH);
- C_6 to C_{18} aryls, preferably selected from: phenyl, naphthyl, biphenyl, and possibly substituted with one or more substituents selected preferably between: carboxyl (-COOH), boronic (-$B(OH)_2$), phosphonic (-PO_3H_2), mercaptan (-SH), and hydroxyl (-OH);
- C_2 to C_{18} monocarboxylic and dicarboxylic acids, possibly substituted with one or more mercaptan groups (-SH) and/or hydroxyl groups (-OH).
- pyridine, dipyridyl, or terpyridyl, functionalized with carboxyl groups, boronic groups, or phosphonic groups;
- mercaptosuccinic acid, 11-mercaptoundecanoic acid,

mercaptophenol, 6-mercaptonicotinic acid, 5-carboxypentanethiol, mercaptobutyric acid, and 4-mercaptophenylboronic acid.

The metal or metalloid oxides AO_x are capable of adsorbing, by electrostatic or chemical interaction, such as via esteric bonds, to molecules having suitable functional groups, such as the following groups: carboxyl (-COOH) (or carboxylate), phosphonic ($-PO_3H_2$) (or phosphonate), or boronic ($-B(OH)_2$) (or boronate), with which groups the bifunctional molecules L may be provided.

In view of the small dimensions of the ligands L and of the metal ions Me^{n+}, e.g. ions of silver or copper, which may be on the order of picometers, the result is that each nanoparticle of AO_x can be homogeneously covered by metal ions such as Ag^+ or Cu^{2+} , and by fatty acid molecules as illustrated schematically by way of example in Figure 5.

In another embodiment metal oxide AO_x comprises TiO_2, preferably with Titanium in Anatase form, therefore an anti-pollution, photocatalytic composition can be obtained.

Saturated and unsaturated fatty acids, having one or more double bonds may be efficiently used.

Moreover, omega-3 fatty acid may be successfully used.

The fatty acid chains may reciprocally interact forming intermolecular linking promoting the homogeneous coverage of the treated surface by the product and the homogeneous spreading of the product on the treated surface.

Moreover, in the product having general formula $AO_x-(L-Me^{n+})_i(FA)_j$, different compounds differing by the particular fatty acid bound to a AO_x nanoparticle, may be present.

Moreover, the compound of the product according to the invention may contain many different fatty acids.

Moreover, in the product having general formula $AO_x-(L-Me^{n+})_i(FA)_j$, different compounds differing by the real number of molecules of fatty acid bound to a AO_x nanoparticle, may be present.

For example, saturated fatty acids may be made to react with AO_x nanoparticle, such as for example: Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)_4COOH$), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid ($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$), obtaining products according to the invention.

Furthermore, may be made to react with AO_x nanoparticle, unsaturated fatty acids that have a structure very similar to the structure of the saturated fatty acids, except that one, monounsaturated acids, or more, polyunsaturated acids, "double bonds", i.e., two carbon atoms reciprocally bound by a double bond, are present along the chain of such acids.

Moreover, Omega-3 fatty acids may also be used.

Moreover, fatty acids with linear, or also branched chains may be used, and also fatty acids containing different functional group or groups, comprising, for example acetylenic bonds, epoxy- group/s, hydroxy- group/s, keto-group/s, and also ring functional group/s.

For example may be used: Oleic acid ($CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$), Linoleic acid ($CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$), Alpha-linolenic acid ($CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$, Arachidonic acid ($CH_3(CH_2)_4CH{=}CHCH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_3COOH$), Isopalmitic acid, tuberculostearic acid, Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid ($CH_3(CH_2)_7CH{=}CH(CH_2)_{11}COOH$), Mycoceranic acid, Mycopelinic acid, Mycocerosic acid.

Alpha-linolenic acid, docosahexaenoic acid, and Eicosapentaenoic acids are examples of Omega-3 fatty acids; Linoleic acid and arachidonic acid are Omega-6 fatty acids; Oleic and erucic acid are omega-9 fatty acids.

Amongst the omega-3 fatty acids α-Linolenic acid, Stearidonic acid, Eicosatetraenoic acid, Eicosapentaenoic acid, Docosapentaenoic acid, Docosahexaenoic acid (DHA) can be for example used.

In case, the fatty acid molecule may comprise linoleic and/or oleic acids, known to exhibit an insecticidal effect, so as to further enhance the properties of the product.

According to these aspects of the invention, it is possible to obtain a product having very limited dimensions, i.e. a nano-compound, that can be dispersed in a solvent forming a very homogeneous suspension.

The product according to the invention may be dispersed in both in organic and in inorganic solvents, and also in hydrophilic and lipophilic solvents, obtaining very homogeneous suspensions.

Infact, the presence of the ligand L and of the metal ions Me^{n+} allows a good solvation in polar solvents to be obtained, whilst the fatty acid molecules FA allow a good solvation in non-polar solvents to be obtained.

Suitable additives may be added to the suspension of the product according to the invention, so as to obtain a product suitable to be applied to a desired substrate, for example a paint.

Moreover, the product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i(FA)_j$ may be used for obtaining a paint, preferably a paint having lipophylic solvents.

Moreover, the product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i(FA)_j$ may be mixed to many desired substrate, for example to tissues, linking to the structure of the tissues and thus forming an antibacterial, antiviral tissue having a very homogeneous structure.

Moreover, the product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i(FA)_j$ may be mixed to plastics, so forming a plastic having a very homogeneous structure and antibacterial, antiviral properties.

The fatty acid molecules of the product forming stable bound with the molecules of the plastics.

Moreover, the product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i$

$(FA)_j$ may be mixed to products for topical use, such as creams, gels, night creams, lenitive creams or gels, moisturizing creams or gels, obtaining a topical-treatment product having antibacterial, antiviral, and curative properties.

For example, a topical-treatment product efficacious for example against burns, irritations, inflammations, excoriations, and abrasions of the skin of a user may be obtained, or also a lenitive topical-treatment product, or also a cicatrizing topical-treatment product, may be obtained.

Moreover, the product having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$ may be suitably mixed to any desired known topical-treatment product in form of a cream, gel, powder, microcapsule, efficaciously mixing to the known topical-treatment product.

Moreover, the product having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$ may also be used for obtaining plant treating products.

By suitably choosing the different compounds and/or molecule in the compound having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$ many different kind of plant treating products may be obtained, for example, a biocide, a pesticide, and/or antimycotic, and/or insecticides, and/or algicide, and/or moluscicide, and/or miticide, and/or rodenticide, and/or antimicrobial, and/or germicide, and/or antibacterial, and/or antiviral, and/or antifungal, and/or antiprotoas, and/or antiparasite, and/or preservative, and/or plant growth promoting, and/or anti-polluting, and/or photocatalytic product, may be obtained.

The product having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$ may also be applied in any desired way to any desired support, showing very good adhesion properties to many different supports and forming thereon very homogeneous films.

Therefore, it is possible to confer to the desired support very homogeneous properties, in particular antibacterial, virucidal, insecticidal, photocatalytic properties.

The presence of the Ligand L molecules allow to bind the molecule of the metal ion Me^{n+} to the metal or metalloid oxide AO_x.
The presence of the fatty acid molecules allow to bind the molecule of the metal or metalloid oxide AO_x and also to enhance the adhesion properties of the product obtained to any desired substrate, in particular to a lipophylic substrate.
Moreover the fatty acid molecules enhance the compatibility of the product with many tissues, for example human tissues, or plant tissues, or also tissue having lipophylic functional groups, for example cellulose-based tissues.
In particular, the molecule of the fatty acids, and/or of the omega-3 acids are lipophilic molecules, the cells of the plants and, moreover, the cells of the dermal tissue of the plants, i.e. the outermost covering of a plant that is a outer single-layered group of cells covering a plant, especially the leaf and young tissues of a vascular plant including stems and roots, and the membranes thereof contain lipids and therefore are lipophilic too.
Therefore, the product having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i(FA)_j$ forms links with the cells of the leaves or of the particular area of the plants on which the products have been applied.
The afore mentioned links allow a stable adhesion of the product to the cells and/or tissues of the plants.
Moreover, the fatty acid molecules enhance the compatibility of the product with plastics, or any other substrates having lipophylic functional groups.
Moreover, the fatty acid molecules enhance the compatibility of the product with lipophylic solvents as, for example those used for obtaining paints.
The molecules of the fatty acid allow links with the cells of the lipophylic molecules of the substrate to be formed, therefore greatly enhancing the adhesion of the product thereon, and allowing the product to stably adhere to the

substrate, so as to remain on the substrate for a considerable period pf time.

Therefore, the necessity of further applications of the product are greatly reduced.

The product having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is not, thus, removed from a substrate on which it has been applied by the action of the raining, or by watering, or normal cleansing action.

Moreover a non-polluting product is obtained.

Moreover, applying the product having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ to a desired support, it is possible to treat such a support, removing any microorganisms therefrom, and avoiding any develop centre to develop, removing any polluting substance therefrom.

Moreover using the product having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ it possible to treat the desired support in an environmental safe way, and causing no pollution to the environment.

Moreover, it is obtained a product that covers almost homogeneously the surface of the substrate to which it is applied, and/or mixed, therefore removing almost completely any bacteria, or insects, or any other microorganisms present on such surface, and avoiding almost completely any subsequent proliferation thereof.

Moreover, the homogeneous coverage of the surface of the substrate allows also any microorganism develop centre to be avoided.

Moreover, the homogeneous mixing of the product to the substrate allows also any microorganism develop centre in the substrate to be avoided.

The products according to the first and second aspect of the invention comprise positively charged nanoparticles, and can give rise to suspensions in aqueous solvents or in polar solvents of an organic nature.

Because of the broad spectrum of antibacterial action of materials containing silver and copper ions, the use of such materials as antibacterial, or antiviral, or biocide products is very effective.

Such nanomaterials may exhibit an antibacterial effect either in presence or in absence of light.

In a third aspect of the invention there is provided a method for treating a support comprising applying a product having general formula $AO_x-(L-Me^{n+})_i\ (FA)_j$.

The support may be chosen form any desired support, for example a tissue, a cellulose tissue, a plant substrate, plastics.

By treating the desired support with the product having general formula $AO_x-(L-Me^{n+})_i\ (FA)_j$, an antibacterial, antiviral support it is obtained.

Moreover, a support is obtained having photocatalytic properties, and capable of destroying many polluting agents, both organic and inorganic, and many microorganisms.

Moreover a intimate mixing and/or a homogeneous coverage of the desired support may be obtained, therefore, the above mentioned properties are very homogeneously spread in the support.

In a fourth aspect of the invention there is provided a method for killing microorganisms near a surface comprising applying a product containing at least a compound having general formula $AO_x-(L-Me^{n+})_i\ (FA)_j$.

In an embodiment of the methods according to the aspects second to fourth, it is provided for obtaining said product by preparing a suspension by mixing a solution comprising Titanium Dioxide nanoparticles with a further solution containing the ligand L and, therefore, with a still further solution containing at least one fatty acid FA.

It is possible to prepare a Titanium dioxide-based suspension in a rapid manner and in sufficient quantity to coat the surface that it is desired to treat without it being necessary to store the suspension, thus avoiding the risk that the suspension flocculates.

According to a fifth aspect of the invention, the use of a product comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ for killing at least organism chosen in a group comprising: bacteria, fungi, insects, mildews, sponges, viruses, algae, acaruses, mites, it is provided for.

According to a sixth aspect of the invention, the use of a product comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ for killing at least organism chosen in a group comprising: HSV-1 (Herpes Simplex Virus-1), Adenovirus, Poliovirus, Aviaria virus, Legionella pneumophila, Pseudomonas aeruginosa, Staphilococcus aureus, Enterococcus faecalis, Escherica Coli, Salmonella enteridis D1, Listeria monocytogenes, Candida albicans, Aspergillus niger, Erwinia amilovora, Xanthomonas campestris. Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, is provided for.

According to a seventh aspect of the invention, a paint comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is provided.

The paint further contains at least a solvent, preferably a lipophylic solvent.

Many different kinds of paint may be obtained, for example: varnish, lacquer, latex paint, enamel, fingerpaint, ink, anti-graphiti paint, anti-climb paint, lacquer, fresco paint. Moreover, transparent paints may also be obtained.

Moreover, the paint may also comprise at least a pigment, and/or a dye, giving a colouring effect.

The paints may also contain binder means chosen in a group comprising: synthetic resins, natural resins, acrylics, polyurethanes, polyesters, melamines, epoxy, oils.

The paints may also contain filler means chosen in a group comprising: talc, clay, lime, baryte.

The paints may also contain diluent means, chosen in a group comprising: organic solvents, petroleum distillate, alcohols,

ketones, esters, glycol ethers, water, synthetic resins, synthetic resins having low molecular weight.
The paints may also contain additive means chosen in a group comprising: pigments, dyes, catalysts, thickeners, stabilizers, emulsifiers, texturizers, adhesion promoting means, flatteners.
According to a eighth aspect of the invention, a topical treatment product comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is provided.
According to a ninth aspect of the invention, a tissues comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is provided.
According to a tenth aspect of the invention, a plastic comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is provided.
According to an eleventh aspect of the invention, a substrate provided with coating means comprising a compound having general formula AO_x-(L-Me^{n+})$_i$ (FA)$_j$ is provided.
In a twelfth aspect of the invention there is provided a plant treating product comprising at least a compound having general formula TiO_2-(FA)$_j$, wherein TiO_2 indicates Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.
In a version, the product comprises Titanium Dioxide nanoparticles comprised between about 10 and 5000 nm, fatty acid molecules comprised between about 10^{-2}% (w/w) and 5% (w/w).
In a further version, the product further comprises a surface-active agent comprised between about 0.1 % (w/v) and 5% (w/v), in water.
In a version, the product comprises a colloidal suspension of Titanium Dioxide nanoparticles.
In a further version metal ions may be added to the product in order to enhance the properties thereof.

In a thirteenth aspect of the invention, there is provided a method for preparing a plant treating product comprising mixing a solution containing Titanium Dioxide nanoparticles with a further solution containing at least one fatty acid.
In a version, said mixing comprises obtaining a compound having general formula TiO_2-$(FA)_j$, wherein TiO_2 indicates Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.
In a version, the solution further contains methanol and/or ethanol as solvent.
In a further version, the further solution further contains acetone as solvent.
In a still further version, the further solution contains the at least one fatty acid in an almost pure state.
In a still further version, mixing comprises stirring the solution and the further solution.
In a further version adding metal ions to the solution and/or to the further solution, in order to enhance the properties of the product, is provided.
The plant treating product may be chosen in a group comprising biocides, products for promoting plant growth, insecticides, fungicides, pesticides, bactericides, etc. The value of the parameter j may be comprised between about 100 and 10000.
The product containing the compound having general formula TiO_2-$(FA)_j$ may contain a very widely variable number of molecules of fatty acid linked to a molecule of Titanium Dioxide.
The real number of molecules of the fatty acid bound to a titanium dioxide nanoparticle, or AO_x nanoparticle, depends by the size of the nanoparticles and it can be calculated that, in the case of titanium dioxide nanocrystals having diameters of the order of 25-30 nm, at least 10-1000 fatty acid molecules, preferably 500-800 fatty acid molecules, can be organized and bound to the surface of each nanoparticle.

The number of fatty acid molecules which can be bound to the titanium dioxide nanocrystals, depend also by the size of the fatty acid molecules used.

The fatty acid chains may reciprocally interact forming intermolecular linking promoting the homogeneous coverage of the treated surface by the product and the homogeneous spreading of the product on the treated surface.

Moreover, in the product different compounds having general formula $TiO_2-(FA)_j$ differing by the real fatty acid bound to a titanium dioxide molecule, and/or the number of the molecule of the fatty acid bound to a single titanium dioxide molecule, may be present.

Moreover, many different fatty acids may be used for obtaining the product according to the invention.

For example, saturated fatty acids may be made to react with Titanium Dioxide nanoparticles, such as for example: Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)4COOH$), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid ($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$), obtaining products according to the invention.

Furthermore, may be made to react with Titanium Dioxide nanoparticles, unsaturated fatty acids that have a structure very similar to the structure of the saturated fatty acids, except that one, monounsaturated acids, or more, polyunsaturated acids, "double bonds", i.e, two carbon atoms reciprocally bound by a double bond, are present along the chain of such acids.

Moreover, Omega-3 fatty acids may also be used.

Moreover, fatty acids with linear, or also branched chains may be used, and also fatty acids containing different functional group or groups, comprising, for example acetylenic bonds, epoxy- group/s, hydroxy- group/s, keto- group/s, and also ring functional group/s.

For example may be used: Oleic acid ($CH_3(CH_2)_7CH=CH(CH_2)_7COOH$), Linoleic acid ($CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$), Alpha-linolenic acid ($CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$, Arachidonic acid ($CH_3(CH_2)_4CH=CHCH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_3COOH$), Isopalmitic acid, tuberculostearic acid, Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid ($CH_3(CH_2)_7CH=CH(CH_2)_{11}COOH$), Mycoceranic acid, Mycopelinic acid, Mycocerosic acid.

Alpha-linolenic acid, docosahexaenoic acid, and Eicosapentaenoic acids are examples of Omega-3 fatty acids; Linoleic acid and arachidonic acid are Omega-6 fatty acids; Oleic and erucic acid are omega-9 fatty acids.

Amongst the omega-3 fatty acids α-Linolenic acid, Stearidonic acid, Eicosatetraenoic acid, Eicosapentaenoic acid, Docosapentaenoic acid, Docosahexaenoic acid (DHA) can be for example used.

Furthermore, the product according to the twelfth and thirteenth aspect of the invention may comprise a plant growth promoting product.

In particular, to the plant treating product having general formula TiO_2-$(FA)_j$, oxides of many metallic or non-metallic elements such as, for example, of Li, Be, B, Na, Mg, Co, Ni, cu, P, K, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Zn, Ga, Ge, Se, Zr, or a mixture thereof may be added for further promoting plant growth.

Such elements may be absorbed by the plants, thus promoting the growth thereof.

Such a product may be used for a very wide range of plant type, for example, fruit trees, cereal cultures, rice plants, corn plants, wheat plants, maize plants, tomato, potato, etc.

The content of the afore mentioned metallic or non-metallic oxides may be comprised between about 0.1% to 25% by weight, preferably between about 0.5% to 20%, further preferably between about 5% to 10%, by weight in respect to the quantity of the Titanium dioxide.

Linoleic and oleic acids, known to exhibit an insecticidal effect, may also be used for obtaining the compound having general formula TiO_2-$(FA)_j$.

The molecules of the fatty acids such as linoleic and oleic acids being bound to the molecule of the Titanium Dioxide.

The properties of the fatty acid/s present in the compound having general formula TiO_2-$(FA)_j$ add to the properties of the other molecules of the compound, mostly to the properties of the Titanium, thus magnifying the properties of the product obtained.

In particular, the insecticidal properties of the linoleic and/or oleic acid are added to the properties of the Titanium Dioxide, therefore the product obtained has magnified and highly intensified properties and efficacy.

In a fourteenth aspect of the invention there is provided a method for treating plant comprising applying a product containing at least a compound having general formula TiO_2-$(FA)_j$, wherein TiO_2 indicates Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.

In a fifteenth aspect of the invention there is provided a method for killing microorganisms near a surface of a plant comprising applying a product containing at least a compound having general formula TiO_2-$(FA)_j$, wherein TiO_2 indicates Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.

In a sixteenth aspect of the invention there is provided a method for eliminating polluting substances near a surface of a plant comprising applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$, wherein TiO_2 indicates Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.

According to a seventeenth aspect of the invention, the use of a plant treating product comprising a compound having general formula TiO_2-$(FA)_j$ for killing at least organism chosen in a group comprising: bacteria, fungi, insects, mildews, sponges, viruses, algae, acaruses, mites, it is provided for.

Owing to the aspects of the invention, it is possible to obtain a product that is efficacious for removing several different organisms, such as bacteria, fungi, sponges, and mildews, from a plant treated therewith.

Owing to the features of the Titanium Dioxide particles a very powerful plant treating product may be obtained.

According to an eighteenth aspect of the invention, the use of a plant treating product comprising a compound having general formula TiO_2-$(FA)_j$ for killing at least organism chosen in a group comprising: Pseudomonas, Erwinia amilovora, Xanthomonas campestris. Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans it is provided for.

According to a nineteenth aspect of the invention, the use of a plant treating product comprising a compound having general formula TiO_2-$(FA)_j$ as pesticide, and/or antimycotic, and/or insecticides, and/or algicide, and/or moluscicide, and/or miticide, and/or rodenticide, and/or antimicrobial, and/or germicide, and/or antibacterial, and/or antiviral, and/or antifungal, and/or antiprotoas, and/or antiparasite, and/or preservative, and/or biocide, and/or plant growth promoting, and/or anti-polluting, and/or photocatalytic product, it is provided for.

It is also possible, to obtain products that could be easily applied on a desired surface either by spraying or by any other suitable technique, or be spread on the desired surface.

The products according to the invention have very good adhesion properties, in particular such a product once applied on a plant or on any other vegetable substrate durably and stably adhere thereto.
In particular, the molecule of the fatty acids, and/or of the omega-3 acids are lipophilic molecules, the cells of the plants and, moreover, the cells of the dermal tissue of the plants, i.e. the outermost covering of a plant that is a outer single-layered group of cells covering a plant, especially the leaf and young tissues of a vascular plant including stems and roots, and the membranes thereof contain lipids and therefore are lipophilic too.
Therefore, the plant treating product according to the invention forms links with the cells of the leaves or of the particular area of the plants on which the products have been applied.
The afore mentioned links allow a stable adhesion of the plant treating product according to the invention to the cells and/or tissues of the plants.
The plant treating product according to the invention is not removed from a plant on which it has been applied by the action of the raining, or by watering.
Therefore, the action of the plant treating product according to the invention may be exerted on a plant on which it has been applied for a prolonged interval of time.
In fact, whilst known products for plants are easily removed from the plants by rain, or also by watering, and, therefore, have to be frequently and repeatedly applied on a plant, a plant treating product according to the invention may be applied less frequently.
Tests have shown that a plant treating product according to the invention may be applied every three months on a plant.
Moreover tests have also shown that during the interval of time comprised between two consecutive applications, the plant treating product maintains a good efficacy exerting its own properties on the treated plant.

This implies that less frequent interventions by the farmer, or by the cultivators, are necessary, with consequent considerably money and time savings.

Moreover, the molecules of the plant treating product according to the invention have very limited dimensions, therefore such a product may very homogeneously cover a desired surface, thus forming on such a surface a very homogeneous film that protects almost all the treated surface.

Therefore, the protection conferred by the plant treating product according to the invention to a surface treated therewith extends almost on all the extension of the treated surface.

The presence of nuclei of microorganisms development and/or growth in a plant treated with a product according to the invention is thus avoided.

Furthermore, the molecules of the fatty acid of the different molecules of a plant treating product according to the invention may reciprocally interact forming intermolecular linking.

This further promotes a homogeneous coverage of the treated surface by the product.

This further promotes the homogeneous spreading of the product on the treated surface.

Owing to the invention, a non-polluting plant treating product is obtained.

Moreover, a method for treating plant that is environmental safe and does not cause any pollution to the environment is obtained.

Moreover, it is obtained a plant treating product that covers almost homogeneously the surface of the plant to which it is applied, therefore removing almost completely any bacteria, or insects, or any other microorganisms present on such surface, and avoiding almost completely any subsequent proliferation thereof.

It is also possible to obtain a product which exhibit a strong bactericidal, biocidal, insecticidal, antiviral, antifungal effect and activity.

Such a product may be stably adhered to the substrate to which it is applied.

Ramsewak, R. S., et al. (J. Agric Food Chem 2001, 49, 5852) has already reported that linoleic and oleic acids were insecticidal against Aedes aegvptii larvae and exhibited potent feeding deterrent activity against neonate larvae of Helicoverpa zea, Limantria dispar, Orgyia leucostigma and Malacosoma disstria.

Lee J.J et al (J. Agric Food Chem 2005, 53, 7696) have shown the antifungal activity of 4-phenyl-buthenoic acid against several microrganism which include: Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum and Raistonia solanacearum.

It is also possible to obtain a plant treating product that is very efficacious for removing microorganisms such as, for example Pseudomonas, Erwinia amilovora, Xanthomonas campestris, fungi, from plants, flowers, trees.

Many microorganisms, for example Erwinia amilovora, are very harmful for many various plants, which are affected by a certain pathogenic agent suddenly wither and die.

Moreover, such microorganisms spread very easily and in very short period of time between different plants thus spreading the contagion to many plants.

Moreover, such microorganisms affect plants that are widespread and also basic for the human feeding.

For example, Erwinia amilovora causes diseases known as “fire blight” that is one of the most destructive diseases of apple and pear, causing extensive tree damage when outbreaks do occur.

Epidemics develop quickly, destroying blossoms, vegetative shoots, major limbs and, sometimes, whole trees.

Erwinia amylovora overwinters in cankers on infected limbs. Cankers become active in early spring as temperatures warm and buds begin to develop. Active cankers produce a yellowish to white bacterial ooze that can appear several weeks prior to bloom. During this period, insects (mainly flies) disseminate the bacteria throughout the orchard. During bloom, pollinating insects rapidly move the pathogen from flower to flower initiating the blossom blight phase of the disease. Flowers can become infected within minutes after a rain or heavy dew.

Inoculum produced from infected blossoms is further spread by wind, rain, and insects.

Treating a plant affected and infected by Erwinia Amylovora a product according to the invention, allows eliminating very easily, and in a very fast manner the microorganism infecting the plant, as will be better discussed in the followings with reference to the drawings.

A further spreading or proliferation of the microorganism is also completely avoided.

Therefore, it is possible to save a plant affected by Erwinia Amylovora and to restore the condition thereof, by treating with product according to the invention, and also to avoid any infection to other plants to be spread.

The products according to the invention, are also a non-polluting plant treating product that can be used in agriculture without any limitation due to the environmental laws.

The plant treating product according to the invention may be chosen in a group comprising: pesticides, antimycotics, herbicides, insecticides, algicides, moluscicides, miticides, rodenticides, antimicrobial products, germicides, antibiotics, antibacterials, antivirals, antifungals, antiprotoas, antiparasites, preservatives, plant growth promoting products.

The photocatalytic reactions carried out by the Titanium Dioxide nanoparticles may result in an increase of the carbon Dioxide concentration, which is one of the products obtained by the photocatalytic oxidative reactions, near the Titanium Dioxide nanoparticles, i.e. near the surface of the plant on which the product according to the invention has been applied.

Therefore, the chlorophyllous photosynthesis is promoted, so enhancing the growth of the treated plant.

The Titanium Dioxide nanoparticles of the plant treating product according to the invention may be both in the form of Brookite, and/or Rutile, and/or Anatase, and/or a mixture thereof.

The molecules of the fatty acid bound to the Titanium Dioxide nanoparticles may be of the same fatty acid, or also many different fatty acids may be bound to a Titanium Dioxide nanoparticles.

The products according to the invention show very good adhesion properties, in particular such a product may be successfully applied on plant or any other vegetable substrate and firmly adhere thereto.

The invention can be better understood and implemented with reference to the following examples describing some non-limitative example of preparation methods and to attached figures that illustrate some embodiments thereof by way of non-limitative example, in which:

Figures 1 to 3 are frontal views of bacterial cultures of Erwinia Amylovora treated with products for treating plants according to the invention having different values of the concentration of Titanium Dioxide;

Figure 4 is a schematic representation of a molecule of the plant treating product having general formula $TiO_2(FA)_j$ according to the invention;

Figure 5 is a schematic representation of a molecule of the nanoparticle having general formula $AO_x-(L-Me^{n+})_i(FA)_j$ according to the invention.

The Titanium Dioxide is a semiconductor material with a crystalline structure, having a valence band separated from a conduction band by a given energy difference.

Solid-state Titanium Dioxide has tree allotropic forms named Anatase, Rutile, and Brookite.

Titanium Dioxide in any of the afore mentioned forms and in particular those of Anatase and, in part of Rutile, has photocatalytic, antibacterial, virucidal, fungicidal, properties.

Some of the Titanium Dioxide based compounds show the afore mentioned properties if irradiated by light, for example solar irradiation, or light from another desired energy source, for example a source of ultraviolet (UV) radiation, such as an ultraviolet ray lamp.

Moreover the Anatase form of the Titanium Dioxide is the most active crystalline form from the photocatalytic point of view.

The energy difference between the valence band and the conduction band is for the Anatase form of the Titanium Dioxide of 3.2 eV and that of Rutile is 3.0 eV.

As a result, if a material is composed by a mixture of Anatase and Rutile it can absorb photons with a wavelength equal or shorter than ca 420 nm.

Following light irradiation with an electromagnetic radiation having a wavelength equal or lower than 420 nm, electrons are caused to pass from the valence band, at lower energy, to the conduction band, at higher energy. This occurs in particular when the Titanium Dioxide is hit by the solar radiation, since photons emitted by the sun in the wavelength range from 360 nm to 420 nm can easily reach the earth surface.

The positive charges, called also electronic holes, left in the valence band, are strong oxidizing agents, with a potential of the order of + 2.6 eV vs. the normal hydrogen electrode, and can oxidize most organic contaminants. Such electronic holes can, for example, react with hydroxyl groups covering the surface of the semiconductor or with molecules of water (H_2O) present in the atmosphere generating hydroxyl radicals ($^{\bullet}OH$) which are highly reactive species.

The excess electrons have a reducing power from −0.4 to −0.6 eV which is sufficient to generate the superoxide anion

($O_2^{\bullet-}$) by reaction with oxygen molecules.

The oxidation reaction of the water molecule is shown in the formula (a) and the reduction reaction of the oxygen is shown in the formula (b):

$TiO_2(h^+) + H_2O \rightarrow TiO_2 + {}^{\bullet}OH + H^+$; (a)

$TiO_2(e^-) + O_2 \rightarrow TiO_2 + O_2^{\bullet-}$ (b)

The hydroxyl radical (${}^{\bullet}OH$) is particularly active both for the oxidation of organic and inorganic substances, for example present in the air, as well as for deactivating microorganisms, that may, for example be harmful to cultivated plants and people.

In particular, the organic compounds are oxidized to carbon Dioxide (CO_2) and water (H_2O), the nitrogen compounds are oxidized to nitrate ions (NO_3^-), the sulphur compounds are oxidized to sulphate ions (SO_4^{2-}).

The Titanium Dioxide is furthermore able to decompose many gases or harmful substances such as thiols or mercaptans, formaldehyde, having an unpleasant smell. The decomposition of such gases or substances eliminates the bad smells associated therewith.

The Titanium Dioxide furthermore has an antimicrobial, antibacterial, antiviral, fungicide, anti-mould action that is very effective.

Tests have been conducted on the growth of microorganisms in the presence and absence of a plant treating product according to the invention.

The test results should be described in the following with reference to Figures 1-3.

The tests on the growth of Erwinia Amylovora were conducted on cultures sowed on plates and considering the action of products for treating plants having general formula TiO_2-$(FA)_j$ and containing various concentrations of Titanium Dioxide, namely a first product containing approximately 0.025% w/v, a second product containing approximately 0.125% w/v and a third product containing approximately 0.250% w/v of Titanium Dioxide.

Erwinia Amylovora organisms were cultivated in illuminated liquid terrains for 12 hours at an optimal reproduction temperature of 26°C ± 2°C.
The tests were conducted by applying to each culture the three afore mentioned different products with different concentrations Titanium Dioxide and comparing the development of the microorganisms of Erwinia Amylovora with a control plate containing only the microorganisms culture.
The cultures were exposed to light irradiation for an average period of 12 hours by using a lamp that simulates the solar spectrum as well as under solar light conditions for a comparable period of time.
In the laboratory experiments the light source was placed at a distance comprised between approximately 60 cm and 70 cm from the plates in which the microorganisms were cultivated. The infrared radiation, responsible of overheating, was cut off with water filters.
Water cut off filters were also used in the outdoor experiments under sun light irradiation.
At the end of the experiments, after 12 h of irradiation, constant aliquots of the liquid terrains were taken from each plate and sowed in an agar terrain to determine the number of survived bacteria. The sowed plates were kept at 37 °C for 24 hours and the developed colonies then counted.
The counts showed that in the control plate an uncountable, defined in Table 1 as an infinite number of colonies, of Erwinia Amylovora was observed (Figure 1), whilst in the plates treated with the product having concentrations of Titanium Dioxide of the order of 0.025% (w/v) (Figure 2), and of 0.125% (w/v) (Figure 3), respectively about 650 colonies and no colonies of Erwinia Amylovora were present.
In Figure 2, a plate is shown corresponding to the treatment with a product having a concentration of Titanium Dioxide of 0.025% w/v, that causes a considerably reduction in the number of colonies of Erwinia Amylovora, but that is not sufficient to cause the mortality of all the colonies of

Erwinia Amylovora, about 650 colonies may be counted.

Figure 3, shows a plate corresponding to the treatment with a product having a concentration of Titanium Dioxide of 0.125% w/v, that is sufficient to assure the total mortality of Erwinia Amylovora, no more colonies of Erwinia Amylovora may be found on the plate.

This indicates complete mortality of the bacteria in the presence of the irradiated plates containing Titanium Dioxide at 0.125% (w/v). Titanium Dioxide concentration values higher than 0.125% (w/v) definitely causes complete mortality of the bacteria, therefore the results for such a control plate have not been reported.

Similar results, not shown for sake of brevity, may be obtained by using a product having general formula AO_x-$(L\text{-}Me^{n+})_i(FA)_j$ and containing various concentrations of an antibacterial, antiviral, agent such as, for example Titanium Dioxide, and/or Ag^+ and/or Cu^{++} ions.

In particular, a product having general formula AO_x-$(L\text{-}Me^{n+})_i(FA)_j$ and containing concentration values of the antibacterial agent higher than about 0.125% (w/v) causes complete mortality of the bacteria.

In Table 1 are reported the results obtained in analogous experiments performed with a compound having general formula TiO_2-$(FA)_j$ in the presence of different microorganism, including the bacteria Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, and the fungus Candida Albicans.

Micrprincipal	N. of colonies observed in the presence of products containing different concentrations of Titanium Dioxide [%w/v]			
	Control plate 0.00%	0.025%	0.125%	0.25%
Staphilococcus A.	Infinite	150	0	0

E.Coli	Infinite	0	0	0
Pseudomona A.	Infinite		223	0
Erwinia A.	Infinite	650	0	0
Candida A.	45	1	0	0

Table 1

Similar results, not shown for sake of brevity, may be obtained by using a product having general formula AOx-(L-Men+)i (FA)j and containing various concentrations of an antibacterial, antiviral, antifungal agent such as, for example Titanium Dioxide, and/or Ag^{+} and/or Cu^{++} ions.

The experimental procedure and the experimental conditions used for the experiments on the various microorganisms were almost the same previously discussed with reference to the experiment for the Erwinia Amylovora, and thus will not described in detail.

The values in Table 1 show that a product containing Titanium Dioxide allow a considerable reduction of the number of colonies of the different microorganisms on which experiments have been conducted.

Moreover, a product having a concentration of 0.025% (w/v) of Titanium Dioxide causes a complete mortality of the colonies of Escherica Colii, whilst a concentration of 0.125% (w/v) of Titanium Dioxide is sufficient to cause a complete mortality of the colonies of Staphilococcus Aureus and also of Erwinia Amylovora and of Candida Albicans.

Furthermore, a product having a concentration of 0.250% (w/v) of Titanium Dioxide causes a complete mortality of the colonies of Pseudomonas Aeruginosa.

With reference to Figure 4 a general molecule M of a compound for treating plant having general formula TiO_2-$(FA)_j$, it is shown.

The molecule M comprises a Titanium Dioxide nanoparticle 1 to which a plurality of fatty acids molecules 2 is bound.

Each fatty acids molecule 2 is so oriented that the carboxylic functional group 2a of the molecule of the fatty acid is bound to the Titanium Dioxide nanoparticle 1.

The number of the fatty acids molecules 2 bound to each Titanium Dioxide nanoparticle 1 can be chosen by suitably varying the preparation conditions.

The number of fatty acid molecules 2 which can be adsorbed on the surface of a nanoparticle having a diameter of the order of 30 nm is comprised in the range between 10 and 1000, preferably between about 500 and 800.

Therefore products having a molecular weight varying in a very wide range of values may be obtained.

Moreover products having very different physical properties may also be obtained.

In particular the adhesion properties of the semiconductor nanoparticles on lipophylic surfaces increases by increasing the number of fatty acid molecules adsorbed on their surface.

Moreover, it is possible to bound the Titanium Dioxide nanoparticles 1 to molecules of many different fatty acids, so obtaining different plant treating products that can be used for many different purposes.

Moreover, it is possible to bound a single Titanium Dioxide nanoparticle 1 to the molecules 2 of different fatty acids.

Furthermore products for treating plants may be obtained containing different kind of molecule M, i.e. molecule in which the Titanium Dioxide nanoparticles are bound to many different fatty acids that vary from a molecule M to another.

With reference to Figure 5 a general molecule M1 of a further compound having general formula $AO_x\text{-}(L\text{-}Me^{n+})_i\ (FA)_j$, it is shown.

The molecule M1 comprises a AO_x nanoparticle 10 to which a plurality of fatty acids FA molecules 20 are bound.

Each fatty acids molecule 20 is so oriented that the carboxylic functional group 21 of the molecule of the fatty acid 20 is bound to the AO_x nanoparticle 10.

The number of the fatty acids molecules 20 bound to each AO_x e nanoparticle 10 can be chosen by suitably varying the preparation conditions.

The number of fatty acid molecules 20 which can be adsorbed on the surface of a nanoparticle having a diameter of the order of 30 nm is comprised in the range between 10 and 1000, preferably between about 500 and 800.

Therefore, products having a molecular weight varying in a very wide range of values may be obtained.

Moreover products having very different physical properties may also be obtained.

In particular the adhesion properties of the semiconductor nanparticles on lipophylic surfaces increases by increasing the number of fatty acid molecules adsorbed on their surface.

Moreover, it is possible to bound the AO_x nanoparticles 10 to molecules of many different fatty acids, so obtaining different products that can be used for many different purposes.

Moreover, it is possible to bound a single AO_x nanoparticle 10 to the molecules 20 of different fatty acids.

Furthermore, products may be obtained containing different kind of molecules M1, i.e. molecules in which the AO_x nanoparticles are bound to many different fatty acids that vary from a molecule M1 to another.

The molecule M1 further comprises bifunctional ligand L molecules 30 bound to the AO_x nanoparticles 10.

The number of the ligand molecules 30 depending on various factors such as the specific ligand used, the preparation conditions, etc.

Each ligand molecule 30 is interposed between a AO_x nanoparticle 10 and a metal ion 40 Me^+.

The number of metal ions 40 bound to the AO_x nanoparticle 10 via the ligand molecules 30 depends on many different factors.

The ligand molecules 30, together with the metal ions 40 Me^{+}, are bound to the AO_x nanoparticle 10 and are arranged so that almost all the surface of the AO_x nanoparticle is covered by ligand L and, therefore by ions Me^{+}.

Example 1: Production of suspensions of nanomaterials having antibacterial and antiviral activity

To confer bactericidal activity and antiviral activity on the suspensions of nanomaterials, a first stage of adsorption is carried out wherein the bifunctional ligand L is adsorbed, followed by mixing with an aqueous or alcoholic solution containing Ag^{+} or Cu^{2+} ions.

In general, adsorption of the bifunctional ligand L onto a nanomaterial AO_x described in the present invention requires times on the order of 12-48 hr, whereas the bonding of Ag^{+} or Cu^{2+} ions to the ligand L is stabilized nearly instantly by addition of solutions containing these ions to the suspensions of the nanomaterials functionalized with the ligand L.

The fatty acid molecules can be then bound to the AO_x-(L-Me^{n+})$_i$ functional nanomaterial by addition of solutions containing the fatty acid molecules to the suspensions of AO_x-(L-Me^{n+})$_i$.

The preparation methods described below demonstrate in detail the preparative methodology for obtaining the nanomaterial AO_x-(L-Me^{n+})$_i$ (FA)$_j$ with Ag^{+} and Cu^{2+} ions. The amounts of reagents indicated may be varied within the scope of the present invention.

Example 2: Adsorption of 4-mercaptophenylboronic acid and Ag^{+} ions or Cu^{2+} and oleic acid onto "TiO_2 P25" (supplied by Degussa)

To a solution containing 2×10^{-5} moles of 4-mercaptophenylboronic acid dissolved in 25-100 mL of acetone or ethanol there was added 1 g of TiO_2 P 25 (supplied by Degussa). The suspension was stirred 24- 48 hr. To this suspension was added 2×10^{-5} moles of a soluble silver salt, preferably silver lactate or silver acetate or silver perchlorate, or of a soluble copper salt, preferable, $CuCl_2$, $CuSO_4$ or $CuClO_4$. The suspension obtained was white in color, odorless, and stable over time. To the suspension was added a solution containing from 10^{-4} to 10^{-2} g of oleic acid dissolved in acetone or ethanol. The suspension was stirred for additional 12 h and finally filtered and the solid dried at 40°C giving a final solid product having a composition of general formula AO_x-(L-Me^{n+})$_i$(FA)$_j$, where AO_x is TiO_2, L is 4-mercaptophenylboronic, Me^{n+} is Ag+ or Cu^{2+} and FA is Oleic acid.

Example 3: Coating TiO_2 with 10-Undecenoic Acid

A solution of 50 ml of methanol containing of 1.00 g of TiO_2 is stirred in with 1 ml of pure 10-undecenoic acid (chemical formula CH_2=CH(CH_2)$_8$COOH) for 24 h.

The suspension was then filtered and the solid washed twice with 10 ml portions of methanol and then dried at 40°C.

The infrared spectrum of the solid product clearly shows that the long aliphatic chain carboxylic acid is adsorbed on TiO_2. Relevant bands of the 10-undecenoic acid at ca. 2924, 2853, 1709, 1530 and 1420 are also observed for the sample adsorbed on TiO_2.

Example 4: Coating TiO_2 with Stearic acid

20 ml of an acetone solution containing 500 mg of Stearic acid (chemical formula $CH_3(CH_2)_{16}COOH$, abbreviated as StCOOH) and 500 mg of TiO_2 is stirred overnight.

The solid was washed with two 10 ml portions of acetone and dried at 40°C.

Analysis of the solid sample shown that 50 mg of Stearic acid were adsorbed on 500 mg of TiO_2.

Example 5: Adsorption of Omega-3 fatty acids on TiO_2

Adsorption of Omega-3 fatty acids on Titanium Dioxide nanoparticles was performed by stirring overnight 1.000 g of TiO_2 in 40 ml of an acetone solution containing 1.0 ml of Omega-3 fatty acids, such as for example α-linolenic acid (abbreviated as ALA, chemical formula $C_{18}H_{30}O_2$), Stearidonic acid (chemical formula $C_{18}H_{28}O_2$), Eicosapentaenoic acid (chemical formula $C_{20}H_{30}O_2$, abbreviated as EPA), Eicosatetraenoic acid (chemical formula $C_{20}H_{32}O_2$), Docosahexaenoic acid (chemical formula $C_{22}H_{32}O_2$, commonly known as DHA), Docosapentaenoic acid (chemical formula $C_{22}H_{34}O_2$).

Omega-3 fatty acids are polyunsaturated fatty acids which have a C=C double bond in the ω-3 position.

The solid obtained was then washed with two 10 ml portions of acetone and dried at 40°C.

Therefore the solid sample has been analysed and the analysis shows that 19 mg of Omega-3 fatty acids have been adsorbed on 1.000 g of TiO_2.

Example 6: Adsorption of Lauric acid on TiO_2

Adsorption of Lauric acid (abbreviated as LrCOOH, chemical formula $CH_3(CH_2)_{10}COOH$) on Titanium Dioxide nanoparticles, was performed by stirring overnight 1.000 g of TiO_2 in 20 ml of an acetone solution containing 1.00 g of LrCOOH. The solid was then washed with two 10 ml portions of acetone and dried at 40°C.

Analysis performed on the solid sample shown that 140 mg of LrCOOH were adsorbed on 1.000 g of TiO_2.

Example 7: Adsorption of Myristic acid on TiO_2

Adsorption of Myristic acid (chemical formula $C_{14}H_{28}O_2$, abbreviated as MrCOOH) on Titanium Dioxide nanoparticles was performed by stirring overnight 1.000 g of TiO_2 in 20 ml of an acetone solution containing 1.00 g of MrCOOH.

The solid obtained was then washed with two 10 ml portions of acetone and, therefore dried at 40°C.

The solid has been therefore analysed and the analysis shows that 110 mg of MrCOOH were adsorbed on 1.000 g of TiO_2.

Example 8: Adsorption of Palmitic acid on TiO_2

Palmitic acid (chemical formula $C_{16}H_{32}O_2$, abbreviated as PmCOOH) has been adsorbed on Titanium Dioxide nanoparticles by stirring overnight 1.000 g of TiO_2 in 20 ml of an acetone solution containing 1.00 g of PmCOOH.

The solid obtained was then washed with two 10 ml portions of acetone and dried at 40°C and thus analysed.

Analysis shows that 90 mg of PmCOOH were adsorbed on 1.000 g of TiO_2.

Example 9: Adsorption of Behenic acid on TiO_2

Adsorption of Behenic acid (chemical formula $C_{22}H_{44}O_2$, abbreviated as BnCOOH) on Titanium Dioxide nanoparticles, was performed by stirring overnight 1.000 g of TiO_z in 20 ml of an acetone solution containing 1.00 g of BnCOOH.

The solid was washed with two 10 ml portions of acetone and dried at 40°C.

Analysis of the solid sample shows that 100 mg of BnCOOH was adsorbed on 1.000 g of TiO_2.

According any one of the afore described methods, different products for treating plants according to the invention may be obtained.

Moreover, also different fatty acids may be bound to the Titanium Dioxide nanoparticles, as, for example those previously listed.

Furthermore many different ingredients may be added to the plant treating product according to the invention, so as to obtain different products that can be used for many different uses, and in many different forms.

The plant treating product according to the invention contains between about 0.01% (w/v) and 0.3% (w/v) of Titanium Dioxide.

Furthermore, the plant treating product according to the invention contains between about 10^{-2}% (w/w) and 5% (w/w) of fatty acids with respect to the amount TiO_2.

The plant treating product according to the invention may be distributed in the form of film on plant surfaces, plants, crops, and it is suitable for being distributed by means of spray techniques, or by means of techniques that provide for spreading a film on the surfaces to be treated.

The plant treating product according to the invention remains substantially unaltered in a temperature range comprised between approximately 10°C and approximately

120°C. This temperature range enables the plant treating product according to the invention to be used for treating plants growing in many different environmental condition and subjected to a very wide range of environmental temperatures.

In particular, the plant treating product according to the invention may be used for treating both plants subjected to tropical climate, and polar climate.

The plant treating product according to the invention allows eliminate very effectively any microorganisms infesting and/or affecting a treated plant, and avoid any subsequent growing of such a microorganism, denature bacterial strains or fungi that are particularly harmful for agriculture and also allows polluting agents in the atmospheric air to be removed.

The Titanium Dioxide used may be chosen amongst any available form of the Titanium Dioxide, preferably Titanium Dioxide used comprises approximately 80% Anatase and approximately 20% Rutile, with a density from approximately 3.6 g/cm^3 to approximately 3.9 g/cm^3 and a surface area from approximately 52 m^2/g to approximately 56 m^2/g.

The Titanium Dioxide furthermore has an average dimension of particles from approximately 25 nm to approximately 30 nm and a granulometric distribution that may vary in the range from approximately 5 nm to approximately 50 nm.

The Titanium Dioxide may be of the type commercially known as Degussa P 25.

To the plant treating product according to the invention distilled water having electric conductibility not greater than 1.5 µS and pH comprised in the range between approximately pH 5 and approximately pH 7, may be added.

Furthermore to the plant treating product according to the invention a surface-active agent comprised between approximately 0.1% w/v to approximately 5% w/v may be also added.

The surface-active agent, also known as a surfactant, may be chosen between a glycol, or a polyethylene glycol, or a polyethylene glycol-phenyl-ether, or a polyethylene-glycol-ether, or a polyoxyethylene-stearyl-ether, or a polyethylene-glycol-hexadecyl-ether, or a polyethylene-glycol-octadecyl-ether, or a polyethylene-glycol-dodecyl-ether.

In particular, the surface-active agent can be chosen from a group of non-ionic surfactants comprising: Triton X-45, Triton X-100, Triton X-114, Triton X-165, Triton X-305, Triton X-405, Triton X-705-70, Triton CF10, Brij 30, Brij 35 P, Brij 52, Brij 56, Brij 58 P, Brij 72, Brij 76, Brij 78 P, Brij 92V, Brij 96 V.

The surfactants act as stabilisers of the plant treating product and enable the product to be distributed evenly on any plant substrate.

Owing to the simple formulation of the plant treating product according to the invention, it is possible to prepare the plant treating product according to the invention in a short time and easily.

Triton X 100 is the surfactant that is particularly indicated for agricultural use, since it is known that such a surfactant does not cause undesired effects in the human organism.

CLAIMS

1. Product containing a nanomaterial compound having general formula $AO_x-(L-Me^{n+})_i(FA)_j$, wherein AO_x indicates a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (O) bound to the metal (A) atom; Me^{n+} is a metal ion; L indicates a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of ($L-Me^{n+}$) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule (FA) bound to the to a AO_x nanoparticle.
2. Product according to claim 1, wherein x is comprised between 1 and 2.
3. Product according to claim 1, or 2, wherein said AO_x is chosen between Titanium dioxide (TiO_2), zinc oxide (ZnO), stannic oxide (SnO_2), zirconium dioxide (ZrO_2), and colloidal silica (SiO_2).
4. Product according to claim 3, wherein said AO_x comprises Titanium dioxide (TiO_2) in Anatase form.
5. Product according to claim 3, wherein said AO_x comprises Titanium dioxide (TiO_2) at approximately 80% as Anatase and at approximately 20% as Rutile.
6. Product according to any one of claims 3 to 5, wherein said Titanium Dioxide molecules comprises molecule of the type commercially known as Degussa P 25.
7. Product according to any one of claims 3 to 6, wherein said Titanium Dioxide molecules (TiO_2) have average dimensions comprised between about 10 and 50 nm.
8. Product according to any one of claims 1 to 7, wherein said metal ion (Me^{n+}) is chosen between metals having antibacterial, and/or antiviral, and/or antimycotic activity.
9. Product according to claim any one of claims 1 to 8, wherein said metal ion (Me^{n+}) is chosen between

transition metal ions.

10. Product according to claim any one of claims 1 to 9, wherein said n is 1 or 2.

11. Product according to any one of claims 1 to 10, wherein said metal ion (Me^{n+}) claim is chosen between silver ions Ag^{+}' and/or copper ions, preferably cupric ions Cu^{2+}.

12. Product according to any one of claims 1 to 11, wherein said bifunctional molecule (L) is chosen between organic molecules, preferably between molecules having at least a first functional group binding to said AO_x, and a second functional group binding said Me^{n+} ions.

13. Product according to claim 12, wherein said first functional group may be chosen in a group comprising: carboxyl (-COOH), carboxylate, phosphonic ($-PO_3H_2$), phosphonate, boronic ($-B(OH)_2$), boronate, dipyridyl group, terpyridyl group.

14. Product according to claim 13, wherein said dipyridylic or terpyridylic group is substituted by a carboxyl group, preferably in a para position with respect to the pyridine nitrogen.

15. Product according to any one of claims 12 to 14, wherein said second functional may be chosen in a group comprising: Cl^-, Br^-, I^-, S, SH, CNS^-, NH_2, N, CN^-, NCS^-.

16. Product according to any one of claims 1 to 15, wherein said bifunctional molecule (L) can be selected in a group comprising: nitrogen-containing heterocycles having 6 to 18 members, preferably pyridine, dipyridyl, or terpyridyl, possibly substituted with one or more substituents, selected preferably between: carboxyl (-COOH), boronic ($-B(OH)_2$), phosphonic ($-PO_3H_2$), mercaptan (-SH), and hydroxyl (-OH); C_6 to C_{18} aryls, preferably selected from: phenyl, naphthyl, biphenyl, and possibly substituted with one or more substituents selected preferably between: carboxyl (-COOH), boronic ($-B(OH)_2$), phosphonic ($-PO_3H_2$), mercaptan (-SH), and hydroxyl (-OH); C_2 to C_{18} monocarboxylic and dicarboxylic acids,

possibly substituted with one or more mercaptan groups (-SH) and/or hydroxyl groups (-OH); pyridine, dipyridyl, or terpyridyl, functionalized with carboxyl groups, boronic groups, or phosphonic groups;mercaptosuccinic acid, 11-mercaptoundecanoic acid, mercaptophenol, 6-mercaptonicotinic acid, 5-carboxypentanethiol, mercaptobutyric acid, and 4-mercaptophenylboronic acid.

17. Product according to any one of claims 1 to 16, wherein said parameter i is comprised between about 100 and 10000.

18. Product according to any one of claims 1 to 17, wherein said compound comprises molecule having different value of said parameter i.

19. Product according to any one of claims 1 to 18, wherein said further parameter j is comprised between about 10 and 1000, preferably between about 500 and 800.

20. Product according to any one of claims 1 to 19, wherein said compound comprises molecule having different value of said further parameter j.

21. Product according to any one of claims 1 to 20, wherein FA indicates a plurality of molecules of the same fatty acid.

22. Product according to any one of claims 1 to 21, wherein FA indicates a plurality of molecules of a plurality fatty acids different from one another.

23. Product according to any one of claims 1 to 22, wherein said fatty acid (FA) comprises a long chain fatty acid.

24. Product according to any one of claims 1 to 23, wherein said fatty acid comprises at least a saturated fatty acid.

25. Product according to claim 24, wherein said saturated fatty acid chosen in a group comprising Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)4COOH$), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid

($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$.

26. Product according to any one of claims 1 to 25, wherein said fatty acid comprises at least an unsaturated fatty acid.

27. Product according to claim 26, wherein said unsaturated fatty acid comprises linoleic acid ($CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$), and/or oleic acid($CH_3(CH_2)_7CH=CH(CH_2)_7COOH$).

28. Product according to claim 26, wherein said unsaturated fatty acid chosen in a group comprising Alpha-linolenic acid ($CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$, Arachidonic acid ($CH_3(CH_2)_4CH=CHCH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_3COOH$), Isopalmitic acid, tuberculostearic acid, Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid ($CH_3(CH_2)_7CH=CH(CH_2)_{11}COOH$), Mycoceranic acid, Mycopelinic acid, Mycocerosic acid.

29. Product according to any one of claims 1 to 28, wherein said fatty acid comprises at least an Omega-3 fatty acid.

30. Product according to claim 29, wherein said Omega-3 is chosen in a group comprising α-Linolenic acid (ALA) 18:3, Stearidonic acid 18:4, Eicosatetraenoic acid 20:4, Eicosapentaenoic acid (EPA) 20:5, Docosapentaenoic acid 22:5, Docosahexaenoic acid (DHA) 22:6.

31. Product according to any one of claims 1 to 30, wherein said fatty acid comprises at least an Omega-6 fatty acid.

32. Product according to claim 31, wherein said Omega-6 is chosen in a group comprising Linoleic acid 18:2, Gamma-linolenic acid 18:3, Eicosadienoic acid 20:2, Dihomo-gamma-linolenic acid 20:3, Arachidonic acid 20:4, Docosadienoic acid 22:2, Adrenic acid 22:4, Docosapentaenoic acid 22:5, Calendic acid 18:3.

33. Product according to any one of claims 1 to 32, wherein said fatty acid comprises at least an Omega-9 fatty

acid.

34. Product according to claim 33, wherein said Omega-9 is chosen in a group comprising Oleic acid 18:1, Eicosenoic acid 20:1, Mead acid 20:3, Erucic acid 22:1, Nervonic acid 24:1.

35. Product according to any one of claims 1 to 34, wherein said fatty acid comprises fatty acids containing at least a functional group, preferably chosen in a group comprising acetylenic bonds, epoxy- group/s, hydroxy- group/s, keto-group/s, and also ring functional group/s.

36. Product according to any one of claims 1 to 35, and further comprising a further compound having general formula $TiO_2-(FA)_k$, wherein TiO_2 is Titanium Dioxide molecule, FA is a molecule of a fatty acid, and k is a still further parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.

37. Product according to claim 36, wherein said still further parameter k is comprised between about 10 and 10^3, preferably between about 500 and 800.

38. Product according to claim 36, or 37, wherein said further compound comprises molecule having different value of said still further parameter k.

39. Product according to any one of claims 36 to 38, wherein FA indicates a plurality of molecules of the same fatty acid.

40. Product according to any one of claims 36 to 39, wherein FA indicates a plurality of molecules of a plurality fatty acids different from one another.

41. Product according to any one of claims 1 to 40, wherein said product is a solution, and/or a colloidal suspension, containing Titanium Dioxide, TiO_2, molecules.

42. Product according to claim 41, wherein said solution comprises between about 10^{-2}% (w/w) and 5% (w/w) of said fatty acid FA with respect to the amount of said TiO_2.

43. Product according to claim 41, wherein said solution

comprises between about 0.010% (w/v) and 0.30% (w/v) of Titanium Dioxide.

44. Product according to any one of claims 1 to 43, wherein said fatty acid FA molecule are so oriented that the carboxylic functional group of said fatty acid is bound to said AO_x molecule.

45. Product according to any one of claims 1 to 44, and further comprising a surface-active agent.

46. Product according to claim 45, wherein said surface-active agent is comprised between about 0.1 % w/v and 5% w/v.

47. Product according to claim 45, or 46, wherein said surface-active agent comprises a ionic surface-active agent.

48. Product according to claim 45, or 46, wherein said surface-active agent comprises a non-ionic surface-active agent.

49. Product according to claim 45, or 46, wherein said surface-active comprises Triton X 100.

50. Product according to claim 48, wherein said non-ionic surface-active agent is chosen in a group comprising: Triton X-45, Triton X-100, Triton X-114, Triton X-165, Triton X-305, Triton X-405, Triton X-705-70, Triton CF10, Brij 30, Brij 35 P, Brij 52, Brij 56, Brij 58 P, Brij 72, Brij 76, Brij 78 P, Brij 92V, Brij 96 V.

51. Product according to claim 46, or 47, wherein said surface-active agent is chosen in a group comprising glycol, polyethylene glycol, polyethylene glycol-phenyl-ether, polyethylene-glycol-ether, polyoxyethylene-stearyl-ether, polyethylene-glycol-hexadecyl-ether, polyethylene-glycol-octadecyl-ether, polyethylene-glycol-dodecyl-ether.

52. Product according to any one of claims 1 to 51, and further containing water comprised between about 97% (v/v) and 99.8% (v/v).

53. Product according to claim 52, wherein said water has an

electric conductibility not greater than 1.5 µS.

54. Product according to claim 52, or 53, wherein said water has a pH comprised between about 5 and 8, preferably of about 7.

55. Product according to any one of claims 1 to 54, wherein said product is chosen in a group comprising pesticides, antimycotics, herbicides, insecticides, algicides, moluscicides, miticides, rodenticides, antimicrobial products, germicides, antibiotics, antibacterials, antivirals, antifungals, antiprotoas, antiparasites, preservatives, biocides, plant growth promoting products, anti-polluting products.

56. Product according to any one of claims 1 to 54, and further comprising at least a component effective in treating at least one of the following microbes and/or insects Pseudomonas, Erwinia amilovora, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

57. Plant treating product comprising a product according to any one of claims 1 to 56.

58. Topical-treatment product comprising a product according to any one of claims 1 to 56.

59. Topical-treatment product according to claim 58, wherein said topical-treatment product is chosen in a group comprising topical-treatment product for treating herpes diseases, acne diseases, skin ulcers, decubitus ulcers, skin irritations, skin inflammations, skin abrasions, skin excoriations, lenitive topical-treatment product, cicatrizing topical-treatment product, burn topical-treatment product, deodorizing topical-treatment product, skincare topical-treatment product, day cream, night cream, cleansing cream, cleansing gel,

moisturizing cream, anti-wrinkle cream, solar cream.

60. Coating product comprising a product according to any one of claims 1 to 56.
61. Coating product according to claim 60, wherein said coating product comprises a paint.
62. Tissue comprising a product according to any one of claims 1 to 56.
63. Tissue according to claim 62, wherein said product is mixed to fibre of said tissue.
64. Tissue according to claim 62, wherein said product is distributed in a structure of said tissue.
65. Tissue comprising a coating product according to claim 60, or 61.
66. Plastic comprising a product according to any one of claims 1 to 56.
67. Plastic according to claim 66, wherein said product is mixed to said plastic.
68. Plastics comprising a coating product according to claim 60, or 61.
69. Substrate provided with coating means containing a coating product according to claim 60, or 61.
70. Plant treating product comprising at least a compound having general formula TiO_2-$(FA)_j$, wherein TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of said FA molecules bound to said Titanium Dioxide molecule.
71. Product according to claim 70, wherein said Titanium dioxide (TiO_2) is in Anatase form.
72. Product according to claim 70, wherein said Titanium dioxide (TiO_2) comprises approximately 80% of Anatase and approximately 20% of Rutile.
73. Product according to any one of claims 70 to 72, wherein said Titanium Dioxide molecules comprises molecule of the type commercially known as Degussa P 25.
74. Product according to any one of claims 70 to 73, wherein

said Titanium Dioxide molecules (TiO_2) have dimensions comprised between about 5 and 100 nm.

75. Product according to any one of claims 70 to 74, wherein said Titanium Dioxide molecules have dimensions comprised between about 10 and 50 nm.

76. Product according to any one of claims 70 to 75, wherein said parameter j is comprised between about 10 and 1000, preferably between about 500 and 800.

77. Product according to any one of claims 70 to 76, wherein said compound comprises molecule having different value of said parameter j.

78. Product according to any one of claims 70 to 77, wherein FA indicates a plurality of molecules of the same fatty acid.

79. Product according to any one of claims 70 to 78, wherein FA indicates a plurality of molecules of a plurality fatty acids different from one another.

80. Product according to any one of claims 70 to 79, wherein said fatty acid (FA) comprises a long chain fatty acid.

81. Product according to any one of claims 70 to 80, wherein said fatty acid comprises at least a saturated fatty acid.

82. Product according to claim 81, wherein said saturated fatty acid chosen in a group comprising Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)4COOH$), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid ($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$.

83. Product according to any one of claims 70 to 82, wherein said fatty acid comprises at least an unsaturated fatty acid.

84. Product according to claim 83, wherein said unsaturated fatty acid comprises Oleic acid ($CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$) and/or Linoleic acid

$(CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH)$.

85. Product according to claim 83, wherein said unsaturated fatty acid chosen in a group comprising Alpha-linolenic acid $(CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$, Isopalmitic acid, tuberculostearic acid, Arachidonic acid $(CH_3(CH_2)_4CH=CHCH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_3COOH)$, Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid $(CH_3(CH_2)_7CH=CH(CH_2)_{11}COOH)$, Mycoceranic acid, Mycopelinic acid, Mycocerosic acid.
86. Product according to any one of claims 70 to 85, wherein said fatty acid comprises at least an Omega-3 fatty acid.
87. Product according to claim 86, wherein said Omega-3 is chosen in a group comprising α-Linolenic acid (ALA) 18:3, Stearidonic acid 18:4, Eicosatetraenoic acid 20:4, Eicosapentaenoic acid (EPA) 20:5, Docosapentaenoic acid 22:5, Docosahexaenoic acid (DHA) 22:6.
88. Product according to any one of claims 70 to 87, wherein said fatty acid comprises at least an Omega-6 fatty acid.
89. Product according to claim 88, wherein said Omega-6 is chosen in a group comprising Linoleic acid 18:2, Gamma-linolenic acid 18:3, Eicosadienoic acid 20:2, Dihomo-gamma-linolenic acid 20:3, Arachidonic acid 20:4, Docosadienoic acid 22:2, Adrenic acid 22:4, Docosapentaenoic acid 22:5, Calendic acid 18:3.
90. Product according to any one of claims 70 to 89, wherein said fatty acid comprises at least an Omega-9 fatty acid.
91. Product according to claim 90, wherein said Omega-9 is chosen in a group comprising Oleic acid 18:1, Eicosenoic acid 20:1, Mead acid 20:3, Erucic acid 22:1, Nervonic acid 24:1.
92. Product according to any one of claims 70 to 91, wherein said fatty acid comprises fatty acids containing at least a functional group.

93. Product according to claims 70 to 92, wherein said functional group is chosen in a group comprising acetylenic bonds, epoxy- group/s, hydroxy- group/s, keto-group/s, and also ring functional group/s.
94. Product according to any one of claims 70 to 93, wherein said product is a solution, and/or a colloidal suspension, containing Titanium Dioxide, TiO_2, molecules.
95. Product according to claim 94, wherein said solution comprises between about 10^{-2}% (w/w) and 5% (w/w) of said fatty acid with respect to the amount of said TiO_2.
96. Product according to claim 95, wherein said solution comprises between about 0.010% (w/v) and 0.30% (w/v) of Titanium Dioxide.
97. Product according to any one of claims 70 to 96, wherein said fatty acid FA molecule are so oriented that the carboxylic functional group of said fatty acid is bound to said AO_x molecule.
98. Product according to any one of claims 70 to 97, and further comprising a surface-active agent.
99. Product according to claim 98, wherein said surface-active agent is comprised between about 0.1 % w/v and 5% w/v.
100. Product according to claim 98, or 99, wherein said surface-active agent comprises a ionic surface-active agent.
101. Product according to claim 98, or 99, wherein said surface-active agent comprises a non-ionic surface-active agent.
102. Product according to claim 98, or 99, wherein said surface-active comprises Triton X 100.
103. Product according to claim 101, wherein said non-ionic surface-active agent is chosen in a group comprising: Triton X-45, Triton X-114, Triton X-165, Triton X-305, Triton X-405, Triton X-705-70, Triton CF10, Brij 30, Brij 35 P, Brij 52, Brij 56, Brij 58 P, Brij 72, Brij

76, Brij 78 P, Brij 92V, Brij 96 V.

104. Product according to claim 98, or 99, wherein said surface-active agent is chosen in a group comprising glycol, polyethylene glycol, polyethylene glycol-phenyl-ether, polyethylene-glycol-ether, polyoxyethylene-stearyl-ether, polyethylene-glycol-hexadecyl-ether, polyethylene-glycol-octadecyl-ether, polyethylene-glycol-dodecyl-ether.

105. Product according to any one of claims 70 to 104, and further containing water comprised between about 97% (v/v) and 99.8% (v/v).

106. Product according to claim 105, wherein said water has an electric conductibility not greater than 1.5 µS.

107. Product according to claim 105, or 106, wherein said water has a pH comprised between about 5 and 8, preferably a pH of about 7.

108. Product according to any one of claims 70 to 107, wherein said product is chosen in a group comprising pesticides, antimycotics, herbicides, insecticides, algicides, moluscicides, miticides, rodenticides, antimicrobial products, germicides, antibiotics, antibacterials, antivirals, antifungals, antiprotoas, antiparasites, preservatives, biocides, plant growth promoting products, anti-polluting products.

109. Product according to any one of claims 70 to 108, and further comprising at least a component effective in treating at least one of the following microbes and/or insects Pseudomonas, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

110. Product according to any one of claims 70 to 109, and further comprising at least a plant growth promoting

component chosen in group comprising metallic and/or non-metallic oxides.

111. Product according to claim 110, wherein said plant growth promoting component comprises an oxide of at least an element chosen in a group comprising Li, Be, B, Na, Mg, Co, Ni, cu, P, K, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Zn, Ga, Ge, Se, Zr, or a mixture thereof.

112. Product according to any one of claims 70 to 111, and further comprising Ag-based compounds conferring anctibacterial property to said product.

113. Product according to claim 112, wherein said Ag-based compound comprises compound containing Ag as Ag^{+} ions.

114. Product according to any one of claims 70 to 113, and further comprising Cu-based compounds conferring anctibacterial property to said product.

115. Product according to claim 114, wherein said Cu-based compound comprises compound containing Cu as Cu^{++} ions.

116. Product according to any one of claims 70 to 115, and further comprising at least an absorbable compound that may be absorbed by a plant substrate.

117. Product according to any one of claims 70 to 116, and further comprising at least an absorbable plant growth promoting component that may be absorbed by a plant substrate.

118. Product according to any one of claims 70 to 117, and further comprising at least a chlorophyllous photosynthesis promoting component.

119. Plant treating product according to any one of claims 70 to 118, wherein FA indicates molecules 10-undecenoic acid ($CH_2=CH(CH_2)_8COOH$).

120. Plant treating product according to any one of claims 70 to 119, wherein said compound having general formula $TiO_2-(FA)_j$ comprises about 50 mg of Stearic acid ($CH_3(CH_2)_{16}COOH$) adsorbed on 500 mg of TiO_2.

121. Plant treating product according to any one of claims 70 to 120, wherein said compound having general formula

TiO_2-$(FA)_j$ comprises about 19 mg of at least one Omega-3 fatty adsorbed on 1.000 g of said TiO_2.

122. Plant treating product according to any one of claims 70 to 121, wherein said compound having general formula TiO_2-$(FA)_j$ comprises about 140 mg of Lauric acid ($CH_3(CH_2)_{10}COOH$) adsorbed on 1.000 g of TiO_2.

123. Plant treating product according to any one of claims 70 to 122, wherein said compound having general formula TiO_2-$(FA)_j$ comprises about 110 mg of MrCOOH adsorbed on 1.000 g of TiO_2.

124. Plant treating product according to any one of claims 70 to 123, wherein said compound having general formula TiO_2-$(FA)_j$ comprises about 90 mg of Palmitic acid ($C_{16}H_{32}O_2$) adsorbed on 1.000 g of TiO_2.

125. Plant treating product according to any one of claims 70 to 124, wherein said compound having general formula TiO_2-$(FA)_j$ comprises about 100 mg of Behenic acid ($C_{22}H_{44}O_2$) adsorbed on 1.000 g of TiO_2.

126. Method for preparing a product comprising mixing a metal or metalloid oxide AO_x, metal ions Me^{n+}, bifunctional molecule L, that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), fatty acid molecule (FA), so as to obtain a product containing at least a compound having general formula AO_x-$(L\text{-}Me^{n+})_i$ $(FA)_j$, wherein AO_x indicates a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (O) bound to the metal (A) atom; Me^{n+} is a metal ion; L indicates a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of (L-Me^{n+}) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the to a AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule (FA) bound to the to a AO_x nanoparticle.

127. Method according to claim 126, wherein said mixing comprises providing a solution, or a suspension,

containing said metal or metalloid oxide AO_x.

128. Method according to claim 127, wherein said AO_x solution, or suspension, is chosen between Titanium dioxide (TiO_2), zinc oxide (ZnO), stannic oxide (SnO_2), zirconium dioxide (ZrO_2), and colloidal silica (SiO_2) solution.

129. Method according to claim 127, wherein said AO_x solution, or suspension, contains Titanium dioxide (TiO_2) in Anatase form.

130. Method according to claim 127, wherein said AO_x solution, or suspension, comprises Titanium dioxide (TiO_2) at approximately 80% as Anatase and at approximately 20% as Rutile.

131. Method according to claim 129, or 130, wherein said solution, or suspension, comprises Titanium Dioxide molecules of the type commercially known as Degussa P 25.

132. Method according to any one of claims 129 to 131, wherein said solution, or suspension, comprises molecules of Titanium Dioxide (TiO_2) having dimensions comprised between about 25 and 30 nm.

133. Method according to any one of claims 128 to 132, wherein said solution comprises a methanol and/or an ethanol solution containing Titanium Dioxide molecules.

134. Method according to claim any one of claims 127 to 133, and further comprising adsorbing said bifunctional ligand L to said solution, or suspension, containing said metal or metalloid oxide AO_x.

135. Method according to claim 134, wherein said adsorbing comprises contacting said bifunctional ligand L with said solution, or a suspension, for an interval of time comprised between about 12-48 hours.

136. Method according to claim 134, or 135, wherein said adsorbing comprises stirring said bifunctional ligand L and said solution.

137. Method according to any one of claims 134 to 136, and

further comprising adding an aqueous, or alcoholic solution, containing said metal ion (Me^{n+}).

138. Method according to claim 137, wherein said adding comprises adding an aqueous, or alcoholic solution, containing Ag^+ and/or Cu^{2+} ions.

139. Method according to any one of claims 127 to 138, and further comprising forming a suspension having general formula AO_x-(L-Me^{n+})$_i$.

140. Method according to claim 139, and further comprising further adding at least a solution containing at least said fatty acid (FA) molecules to said suspension having general formula AO_x-(L-Me^{n+})$_i$ so as to obtain the product having general formula AO_x-(L-Me^{n+})$_i$(FA)$_j$.

141. Method according to claim 140, wherein said fatty acid (FA) contains a fatty acid chosen in a group comprising: saturated fatty acids such as: Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)$4COOH), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid ($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$; unsaturated fatty acid such as : linoleic, oleic acid, Alpha-linolenic acid, Arachidonic acid, Isopalmitic acid, tuberculostearic acid, Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid, Mycoceranic acid, Mycopelinic acid, Mycocerosic acid; Omega-3 fatty acid such as: α-Linolenic acid (ALA) 18:3, Stearidonic acid 18:4, Eicosatetraenoic acid 20:4, Eicosapentaenoic acid (EPA) 20:5, Docosapentaenoic acid 22:5, Docosahexaenoic acid (DHA) 22:6; Omega-6 fatty acid such as: Linoleic acid 18:2, Gamma-linolenic acid 18:3, Eicosadienoic acid 20:2, Dihomo-gamma-linolenic acid 20:3, Arachidonic acid 20:4, Docosadienoic acid 22:2, Adrenic acid 22:4, Docosapentaenoic acid 22:5, Calendic acid 18:3; Omega-9 fatty acid such as: Oleic acid 18:1, Eicosenoic acid

20:1, Mead acid 20:3, Erucic acid 22:1, Nervonic acid 24:1; fatty acids containing at least a functional group.

142. Method according to any one of claims 126 to 141, and further comprising still further adding at least a further solution containing at least said a further fatty acid (FA)' different form said fatty acid (FA), so as to obtain a further product having general formula AO_x-(L-Me^{n+})$_i$(FA)'$_d$, in which d is a further parameter indicating the number of further fatty acid molecule (FA)' bound to the to a AO_x nanoparticle.

143. Method according to any one of claims 126 to 142, and further comprising still further adding at least a still further solution containing at least a still further product having general formula TiO_2-(FA)$_k$, in which k is a still further parameter indicating the number of fatty acid molecule (FA) bound to the to a TiO_2 nanoparticle.

144. Method for preparing a plant treating product comprising mixing a solution containing Titanium Dioxide molecule with a further solution containing at least one fatty acid (FA).

145. Method according to claim 144, wherein said preparing comprises obtaining a product having general formula TiO_2-(FA)$_j$, wherein TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule.

146. Method according to claim 144, or 145, and further comprising providing a methanol and/or an ethanol solution containing Titanium Dioxide molecules.

147. Method according to any one of claims 144 to 146, and further comprising providing an acetone solution containing molecules of at least one fatty acid.

148. Method according to any one of claims 144 to 147, wherein said further solution contains said at least one fatty acid in an almost pure state.

149. Method according to any one of claims 144 to 148, wherein said further solution contains molecules of a plurality of fatty acids different from one another.

150. Method according to any one of claims 144 to 149, wherein said mixing comprises bonding said fatty acid FA to said Titanium Dioxide molecule through the carboxylic functional group of said fatty acid.

151. Method according to any one of claims 144 to 150, wherein said further solution contains saturated fatty acid and/or unsaturated fatty acid, and/or Omega-3 fatty acid, and/or Omega-6 fatty acid, and/or Omega-9 fatty acid, and/or fatty acids having linear chains, and/or fatty acids having branched chains, and/or fatty acids containing different functional groups.

152. Method according to any one of claims 144 to 151, wherein said further solution further contains at least a saturated fatty acid chosen in a group comprising Butyric acid ($CH_3(CH_2)_2COOH$), Caproic acid ($CH_3(CH_2)4COOH$), Caprylic acid ($CH_3(CH_2)_6COOH$), Capric acid ($CH_3(CH_2)_8COOH$), Lauric acid ($CH_3(CH_2)_{10}COOH$), Myristic acid ($CH_3(CH_2)_{12}COOH$), Palmitic acid ($CH_3(CH_2)_{14}COOH$), Stearic acid ($CH_3(CH_2)_{16}COOH$), Arachidic acid ($CH_3(CH_2)_{18}COOH$), Behenic acid ($CH_3(CH_2)_{20}COOH$.

153. Method according to any one of claims 144 to 152, wherein said further solution still further contains at least an unsaturated fatty acid chosen in a group comprising Oleic acid ($CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$), Linoleic acid ($CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$), Alpha-linolenic acid ($CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$, Isopalmitic acid, tuberculostearic acid, Arachidonic acid ($CH_3(CH_2)_4CH{=}CHCH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_3COOH$), Phytomonic acid, Eicosapentaenoic acid, Docosahexaenoic acid, Erucic acid ($CH_3(CH_2)_7CH{=}CH(CH_2)_{11}COOH$), Mycoceranic acid, Mycopelinic acid, Mycocerosic acid.

154. Method according to any one of claims 144 to 153, wherein said further solution comprises at least a

Omega-3 fatty acid chosen in a group comprising α-Linolenic acid (ALA) 18:3, Stearidonic acid 18:4, Eicosatetraenoic acid 20:4, Eicosapentaenoic acid (EPA) 20:5, Docosapentaenoic acid 22:5, Docosahexaenoic acid (DHA) 22:6.

155. Method according to any one of claims 144 to 154, wherein said further solution further comprises at least a Omega-6 fatty acid chosen in a group comprising Linoleic acid 18:2, Gamma-linolenic acid 18:3, Eicosadienoic acid 20:2, Dihomo-gamma-linolenic acid 20:3, Arachidonic acid 20:4, Docosadienoic acid 22:2, Adrenic acid 22:4, Docosapentaenoic acid 22:5, Calendic acid 18:3.

156. Method according to any one of claims 144 to 155, wherein said further solution still further comprises at least a Omega-9 fatty acid chosen in a group comprising Oleic acid 18:1, Eicosenoic acid 20:1, Mead acid 20:3, Erucic acid 22:1, Nervonic acid 24:1.

157. Method according to any one of claims 144 to 156, wherein said solution comprises approximately 80% Anatase form and approximately 20% Rutile form of said Titanium Dioxide molecules.

158. Method according to any one of claims 144 to 157, wherein said solution comprises Degussa P 25 as said Titanium Dioxide molecules.

159. Method according to any one of claims 144 to 158, and further comprising adding a surface-active agent to said solution and to said further solution.

160. Method according to any one of claims 144 to 159, and further comprising adding a ionic surface-active agent and/or a non-ionic surface-active agent.

161. Method according to any one of claims 144 to 160, and further comprising adding Triton X 100 as surface-active agent.

162. Method according to any one of claims 144 to 161, and further comprising further adding a surface-active agent

chosen in a group comprising: Triton X-45, Triton X-100, Triton X-114, Triton X-165, Triton X-305, Triton X-405, Triton X-705-70, Triton CF10, Brij 30, Brij 35 P, Brij 52, Brij 56, Brij 58 P, Brij 72, Brij 76, Brij 78 P, Brij 92V, Brij 96 V.

163. Method according to any one of claims 144 to 162, and further comprising still further adding a surface-active agent chosen in a group comprising: glycol, polyethylene glycol, polyethylene glycol-phenyl-ether, polyethylene-glycol-ether, polyoxyethylene-stearyl-ether, polyethylene-glycol-hexadecyl-ether, polyethylene-glycol-octadecyl-ether, polyethylene-glycol-dodecyl-ether.

164. Method according to any one of claims 101 to 163, wherein obtaining a product comprising between about 0.1 % w/v and 5% w/v of a surface-active agent is provided.

165. Method according to any one of claims 144 to 164, wherein obtaining a product comprising water between about 97% (v/v) and 99.8% (v/v) is provided.

166. Method according to any one of claims 144 to 165, wherein forming a product chosen in a group comprising pesticides, antimycotics, herbicides, insecticides, algicides, moluscicides, miticides, rodenticides, antimicrobial products, germicides, antibiotics, antibacterials, antivirals, antifungals, antiprotoas, antiparasites, preservatives, biocides, plant growth promoting products, anti-polluting products, is provided.

167. Method according to any one of claims 144 to 166, wherein forming a product comprising at least a component having pesticide, antimycotic, and/or herbicide, and/or insecticides, and/or algicide, and/or moluscicide, and/or miticide, and/or rodenticide, and/or antimicrobial, and/or germicide, and/or antibiotic, and/or antibacterial, and/or antiviral, and/or antifungal, and/or antiprotoas, and/or antiparasite,

and/or preservative, and/or biocide, and/or plant growth promoting, and/or anti-polluting, and/or photocatalytic properties, is provided.

168. Method according to any one of claims 144 to 167, wherein forming a product comprising at least a component effective in treating at least one of the following microbes Pseudomonas, Erwinia amilovora, Xanthomonas campestris. Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans, is provided.

169. Method according to any one of claims 144 to 168, and further comprising providing at least a plant growth promoting component chosen in group comprising metallic and/or non-metallic oxides.

170. Method according to any one of claims 144 to 169, and further comprising providing at least an absorbable plant growth promoting component that can be absorbed by a plant substrate.

171. Method according to any one of claims 144 to 170, and further comprising further providing Ag based compound, and/or a Cu based compound, to said product and/or to said solution, and/or to said further solution

172. Method according to claim 144 to 171, and further comprising further providing Ag^{+} based compound, and/or a Cu^{++} based compound, to said product and/or to said solution, and/or to said further solution

173. Method according to any one of claims 144 to 172, and further comprising adding at least a chlorophyllous photosynthesis promoting component to said solution, and/or to said further solution, and/or to said product.

174. Method for treating plant comprises applying a product containing at least a compound having general formula

TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant.

175. Method according to claim 174, wherein said applying comprises depositing on said plant a product according to any one of claims 70 to 125.

176. Method for treating plant comprises applying a product containing at least a compound having general formula AO_x-$(L\text{-}Me^{n+})_i(FA)_j$ in which wherein AO_x indicates a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (O) bound to the metal (A) atom; Me^{n+} is a metal ion; L indicates a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of ($L\text{-}Me^{n+}$) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule (FA) bound to the to a AO_x nanoparticle, to a desired substrate of said plant.

177. Method according to claim 176, wherein said applying comprises depositing on said plant a product according to any one of claims 1 to 56.

178. Method according to any one of claims 174 to 177, wherein sad substrate comprises plant leaf, root, the outermost covering of a plant, young tissues of said plant, stems.

179. Method according to any one of claims 174 to 178, wherein said applying comprises spraying said product on said plant.

180. Method according to any one of claims 174 to 179, wherein said applying comprises forming on said substrate a homogeneous film of said product.

181. Method according to any one of claims 174 to 180, wherein said product is chosen in a group comprising

pesticides, antimycotics, herbicides, insecticides, algicides, moluscicides, miticides, rodenticides, antimicrobial products, germicides, antibiotics, antibacterials, antivirals, antifungals, antiprotoas, antiparasites, preservatives, biocides, plant growth promoting products, anti-polluting products.

182. Method according to any one of claims 174 to 181, wherein said product comprises at least a component having pesticide, antimycotic, and/or herbicide, and/or insecticides, and/or algicide, and/or moluscicide, and/or miticide, and/or rodenticide, and/or antimicrobial, and/or germicide, and/or antibiotic, and/or antibacterial, and/or antiviral, and/or antifungal, and/or antiprotoas, and/or antiparasite, and/or preservative, and/or biocide, and/or plant growth promoting, and/or anti-polluting, and/or photocatalytic properties.

183. Method according to any one of claims 174 to 182, wherein said product further comprises at least a component effective in treating at least one of the following microbes, and/or insects Pseudomonas, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

184. Method according to any one of claims 174 to 183, wherein said treating further comprises protecting said plant at least against at least one of the following microbes and/or insects Pseudomonas, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia

solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

185. Method according to any one of claims 174 to 184, wherein said treating further comprises promoting the growth of said plant treated with said product.

186. Method according to any one of claims 174 to 185, wherein said treating further comprises promoting the chlorophyllous photosynthesis of said plant treated with said product.

187. Method for killing microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant.

188. Method according to claim 187, wherein said applying comprises applying a product according to any one of claims 70 to 125 to said substrate.

189. Method for killing microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula AO_x-$(L\text{-}Me^{n+})_i(FA)_j$ wherein AO_x indicates a metal or metalloid oxide in which x indicates the number of the Oxygen atom(s) (O) bound to the metal (A) atom; Me^{n+} is a metal ion; L indicates a bifunctional molecule that could bind both metal oxide or metalloid oxide (AO_x) and the metal ion (Me^{n+}), i is a parameter indicating the number of ($L\text{-}Me^{n+}$) groups bound to the metal oxide AO_x, (FA) is a fatty acid molecule bound to the AO_x nanoparticles, j is a further parameter indicating the number of fatty acid molecule (FA) bound to the to a AO_x nanoparticle.

190. Method according to claim 189, wherein said applying comprises applying a product according to any one of

claims 1 to 56 to said substrate.

191. Method according to any one of claims 187 to 190, wherein said applying comprises spraying said product on said substrate.

192. Method according to any one of claims 187 to 191, wherein said applying comprises rolling said product on said substrate.

193. Method according to any one of claims 187 to 192, wherein said applying comprises brushing said product on said substrate.

194. Method according to any one of claims 187 to 193, wherein said applying comprises forming a homogeneous film of said product in said substrate.

195. Method according to any one of claim 187 to 194, wherein said microorganism is chosen in a group comprising pests, insects, parasite, weeds, algae, rodents, microbes, germs, bacteria, viruses, fungi, protoas.

196. Method according to any one of claims 187 to 195, wherein said microorganism is chosen in a group comprising Pseudomonas, Erwinia amilovora, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

197. Method for killing microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and j is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant, having a concentration of Titanium Dioxide comprised between about 0.010% (w/v) and about 0.30% (w/v).

198. Method for killing Escherica Colii microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and i is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant, having a concentration of Titanium Dioxide of about 0.025% (w/v).

199. Method for killing Staphilococcus Aureus and/or Erwinia Amylovora, and/or Candida Albicans microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and i is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant, having a concentration of Titanium Dioxide of about 0.125% (w/v).

200. Method for killing Pseudomonas Aeruginosa microorganisms near a surface of a plant comprises applying a product comprising at least a compound having general formula TiO_2-$(FA)_j$ in which TiO_2 indicates a Titanium Dioxide molecule, FA indicates a molecule of a fatty acid, and i is a parameter indicating the number of FA molecules bound to a Titanium Dioxide molecule, to a desired substrate of said plant, having a concentration of Titanium Dioxide of about 0.25% (w/v).

201. Method for eliminating polluting substances near a surface of a plant comprises applying a product according to any one of claims 1 to 56 to a desired substrate of said plant.

202. Method for eliminating polluting substances near a surface of a plant comprises applying a product according to any one of claims 70 to 125 to a desired substrate of said plant.

203. Method for preparing a topical treatment product comprising mixing a product according to any one of claims 1 to 56 to a base material of said topical treatment product.

204. Method according to claim 203, wherein said preparing comprises obtaining a topical treatment product chosen in a group comprising topical-treatment product for treating herpes diseases, acne diseases, skin ulcers, decubitus ulcers, skin irritations, skin inflammations, skin abrasions, skin excoriations, lenitive topical-treatment product, cicatrizing topical-treatment product, burn topical-treatment product, deodorizing topical-treatment product, skincare topical-treatment product, day cream, night cream, cleansing cream, cleansing gel, moisturizing cream, anti-wrinkle cream, solar cream.

205. Method for preparing a tissue comprising mixing a product according to any one of claims 1 to 56 to a base structure of said tissue.

206. Method for preparing a tissue comprising applying on base structure of said tissue a product according to any one of claims 1 to 56, and/or a coating product according to claim 60 or 61.

207. Method for preparing a plastic comprising mixing a product according to any one of claims 1 to 56 to a base material of said plastic.

208. Method according to claim 207, wherein said mixing comprising adding said product to said base material in a melt or flowable state.

209. Method for preparing a plastic comprising applying on base material of said plastic a product according to any one of claims 1 to 56, and/or a coating product according to claim 60, or 61.

210. Method for treating a substrate comprising applying on said substrate a product according to any one of claims 1 to 56, and/or a coating product according to claim 60,

or 61, and/or a paint containing a product according to any one of claims 1 to 56.

211. Method according to claim 209, or 210, wherein said applying comprises spraying said product on said substrate.

212. Method according to claim 209, or 210, wherein said applying comprises rolling said product on said substrate.

213. Method according to claim 209, or 210, wherein said applying comprises brushing said product on said substrate.

214. Method according to any one of claims 209 to 213, wherein said applying comprises forming a homogeneous film of said product in said substrate.

215. Use of a tissue according to any one of claims 62 to 65 for preparing napkin means.

216. Use of a plant treating product according to claim 57, or according to any one of claims 70 to 125, for treating plants, flowers, trees.

217. Use of a plant treating product according to claim 57, or according to any one of claims 70 to 125, for killing at least an organism chosen in a group comprising bacteria, fungi, mildew, sponges, viruses, algae, acaruses, mites, insects.

218. Use of a plant treating product according to claim 57, or according to any one of claims 70 to 125, for killing at least a microoganism, and/or insect chosen in a group comprising: Pseudomonas, Erwinia amilovora, Xanthomonas campestris, Aedes aegvptii, Helicoverpa zea, Limantria dispar, Orgyia leucostigma, Malacosoma disstria, Colletotrichum orbiculare, Magnaporte grisea, Pythium ultimum, Pectobacterium carotovorum, Raistonia solanacearum, Erwinia Amylovora, Pseudomonas Aeruginosa, Escherichia Coli, Staphilococcus Aureus, Candida Albicans.

219. Use of a plant treating product according to claim 57,

or according to any one of claims 70 to 125, as pesticide, and/or antimycotic, and/or herbicide, and/or insecticides, and/or algicide, and/or moluscicide, and/or miticide, and/or rodenticide, and/or antimicrobial, and/or germicide, and/or antibiotic, and/or antibacterial, and/or antiviral, and/or antifungal, and/or antiprotoas, and/or antiparasite, and/or preservative, and/or biocide, and/or plant growth promoting, and/or anti-polluting, and/or photocatalytic product.

Fig. 1

Erwinia A. – control plate

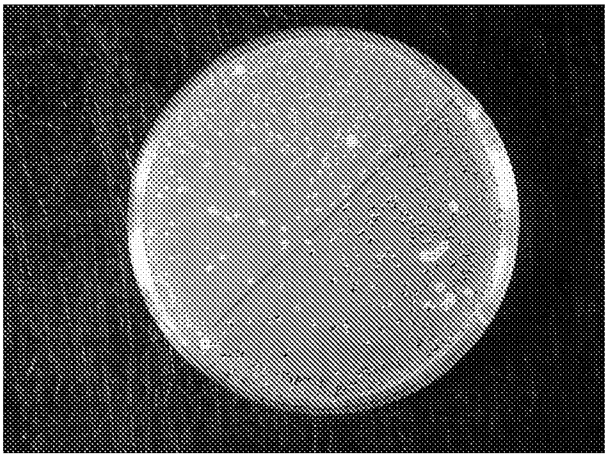

Fig. 2

Erwinia A. – TiO_2 0.025% w/v

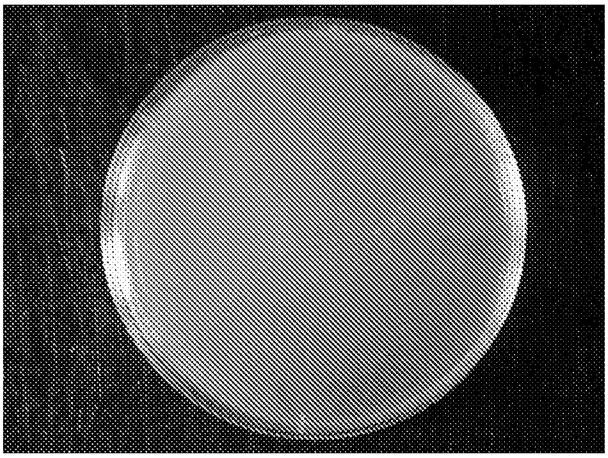

Fig. 3

Erwinia A. – TiO_2 0.125% w/v

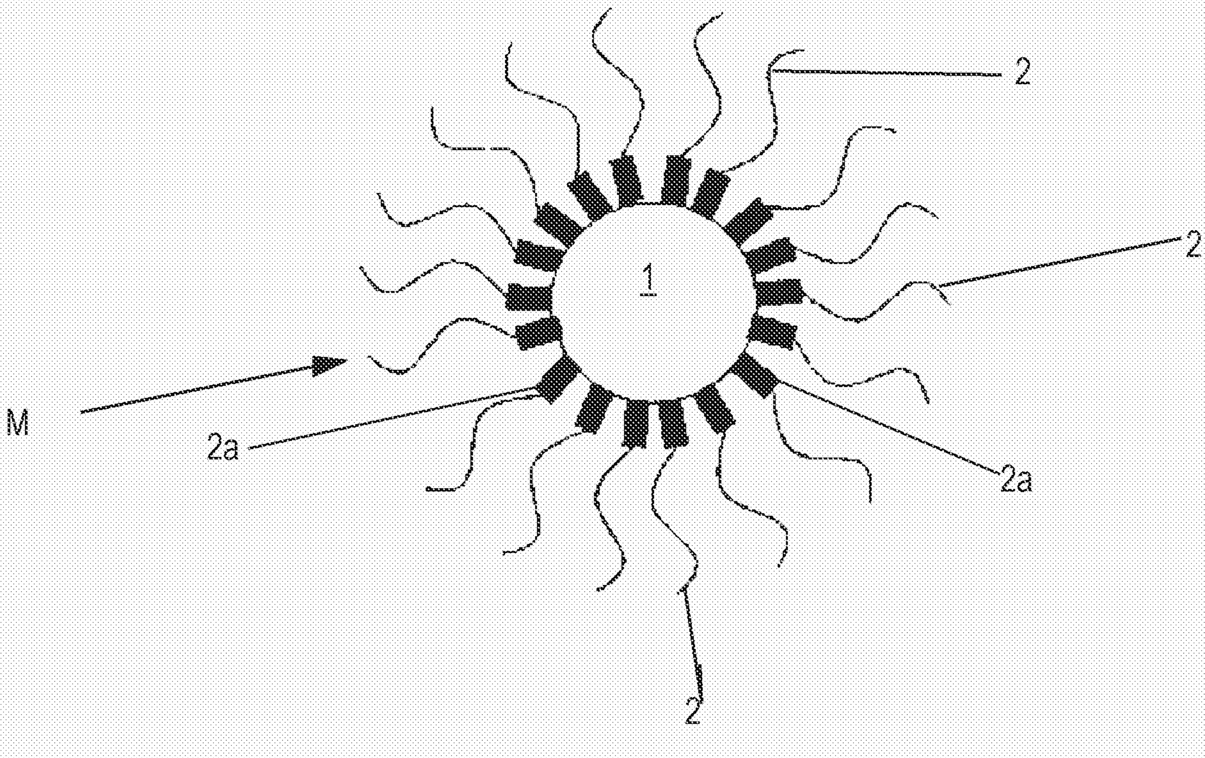

Fig. 4

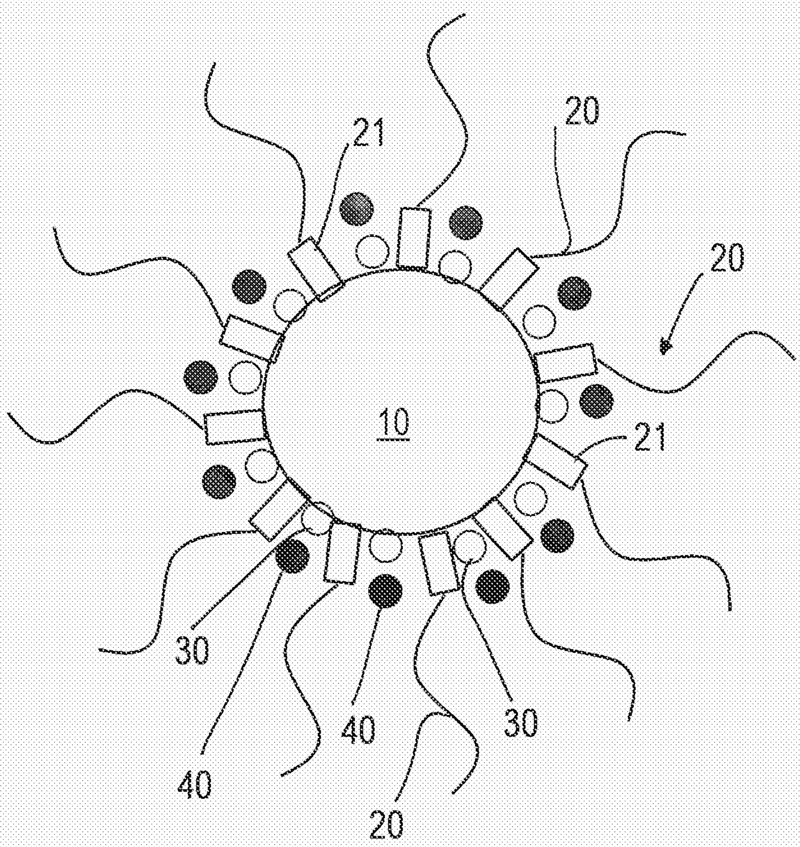

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/054452

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01N59/16 A01N55/08 A01N37/06 A01N37/02 A01N25/26
A01N25/24 A01P1/00

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)
A01N

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 practical, search terms used)

EPO-Internal, WPI Data, CHEM ABS Data, BIOSIS, EMBASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/125496 A (FLAMMA SPA [IT]; MARRA ALESSANDRO [IT]; DONDONI ALESSANDRO [IT]; BIGNO) 30 November 2006 (2006-11-30) page 1, line 1 - line 6 page 1, line 20 - line 23 page 2, line 10 - line 20 page 9, line 11 - line 12 page 10, line 14 - line 15 page 11, line 8 - line 9 page 11, line 28 page 12, line 16 - line 17 page 13, line 4 - line 5 page 13, line 20 - line 21 -----	70

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 February 2008	15/02/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Molina de Alba, José

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/054452

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/060610 A (UNIV COLUMBIA [US]; O'BRIEN STEPHEN [US]; YIN MING [US]) 7 July 2005 (2005-07-07) abstract page 18, line 1 - line 8 page 25, line 7 - line 11 page 26, line 6 - line 7 page 28, line 28 - page 29, line 4	70
X	DATABASE WPI Week 200615 Derwent Publications Ltd., London, GB; AN 2006-137762 XP002467482 & CN 1 676 227 A (TAIXIN CERAMIC IND CO LTD) 5 October 2005 (2005-10-05)	70
Y	abstract	1
X	DATABASE CAPLUS [Online] CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO, US; LIU, GUO-CONG ET AL: "Studies on adsorption and photodegradation of pesticide by Pd/TiO2 nanopowder with quartz crystal microbalance" XP002467481 retrieved from STN Database accession no. 2007:777361 abstract & FENXI CESHI XUEBAO , 26(3), 300-304 CODEN: FCEXES; ISSN: 1004-4957, 2007,	70
Y	US 2005/084464 A1 (MCGRATH KEVIN P [US] ET AL) 21 April 2005 (2005-04-21) paragraph [0025] - paragraph [0026]	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/054452

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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WO 2005060610 A	07-07-2005	NONE	
CN 1676227 A	05-10-2005	NONE	
US 2005084464 A1	21-04-2005	MX PA04009568 A	21-04-2005