

DESCRIPTION

Title of Invention: MICROORGANISM-CONTROLLING AGENT AND MITICIDAL COMPOSITION

5 Technical Field
 [0001]

 The present invention relates to a microbial control agent, an antimicrobial agent, an antialgal agent, a biofilm formation inhibitor, a microorganism control method, an
10 antimicrobial method, an antialgal method, a biofilm formation-inhibiting method, a miticidal composition, an anti-mite member, and an anti-mite method.

 Background Art
15 [0002]

 The technique of removing microorganisms, mites, and the like adhering to foods, water, household goods, animals, plants, sludge, etc., is very important from the viewpoint of environmental sanitation, durability, etc. In air purification
20 technology, water treatment technology, agricultural factories, and food industries, microorganisms have been removed by microorganism control methods using filtration membranes, such as microfiltration membranes and reverse osmotic membranes, or methods utilizing antimicrobial substances, for example, metals
25 such as silver, copper, and zinc; antibiotics; and organic substances typified by agricultural chemicals, such as imidazole-thiazole. As one of such methods, for example, a technique comprising contacting a textile product with a silver-containing liquid (containing at least one member selected from the group
30 consisting of silver ions and silver colloidal particles) and removing liquid components from the textile product to impart an antimicrobial effect to the textile product has been proposed (see, for example, Patent Literature (PTL) 1).

 Citation List
35 Patent Literature

[0003]

PTL 1: JP2007-31857A

Summary of Invention

5 Technical Problem

[0004]

However, when using methods of controlling the amount of microorganisms by using filtration membranes as described above, high pressure loss, clogging, and like problems occur, 10 which makes it difficult to efficiently remove microorganisms etc. When using antimicrobial techniques utilizing silver ions as disclosed in PTL 1, silver ions elute, which causes a problem in terms of durable antimicrobial effects, and silver ion elution adversely affects the environment. Furthermore, such 15 microorganism control agents comprising silver ions are sought to have further enhanced antimicrobial performance.

[0005]

The present invention was made in view of the above problems. An object of the present invention is to provide a 20 microorganism control agent that has excellent microorganism control performance, in particular, antimicrobial performance, antialgal performance, and biofilm formation-inhibiting performance, and has suppressed metal elution. Another object of the present invention is to provide a miticidal composition, an 25 anti-mite member, and an anti-mite method that have excellent performance to suppress the infestation and growth of mites.

Solution to Problem

[0006]

The present inventors conducted extensive research to 30 achieve the above object. As a result, the inventors found that the above object can be achieved by combining specific types of metal particles. The present invention has been accomplished based on this finding.

[0007]

35 Specifically, the present invention includes, for

example, the subject matter described in the following items.

Item 1. A microorganism control agent comprising platinum particles and metal particles other than platinum particles.

Item 2. The microorganism control agent according to Item 1,
5 wherein the metal particles comprise at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles.

Item 3. The microorganism control agent according to Item 1,
10 wherein the metal particles comprise at least one member selected from the group consisting of silver particles and copper particles.

Item 4. The microorganism control agent according to any one of Items 1 to 3, wherein the platinum particles and the metal particles have a mean particle size of 0.1 to 1000 nm.

15 Item 5. The microorganism control agent according to any one of Items 1 to 4, wherein the platinum particles and the metal particles are supported on a base material.

Item 6. The microorganism control agent according to Item 5,
20 wherein the platinum particles and the metal particles are supported in an amount of 0.01 to 20,000 ng/cm² on the base material.

Item 7. The microorganism control agent according to Item 5 or 6, wherein the base material comprises a resin.

Item 8. The microorganism control agent according to Item 7,
25 wherein the resin comprises at least one member selected from the group consisting of polystyrene resins, vinyl chloride resins, fluorine resins, ABS resins, PET resins, polycarbonate resins, urea resins, olefin resins, and phenolic resins.

Item 9. The microorganism control agent according to any one of
30 Items 5 to 8, wherein the base material is in the form of a sheet, a plate, a block, a net, a perforated sheet, a grain, a rod, a crushed product, or a dish.

Item 10. An antimicrobial agent comprising the microorganism control agent according to any one of Items 1 to 9.

35 Item 11. An antialgal agent comprising the microorganism control

agent according to any one of Items 1 to 9.

Item 12. A biofilm formation inhibitor comprising the microorganism control agent according to any one of Items 1 to 9.

Item 13. A method for controlling a microorganism comprising
5 imparting a microorganism control function to a target object by using the microorganism control agent according to any one of Items 1 to 9.

Item 14. An antimicrobial method comprising imparting antimicrobial properties to a target object by using the
10 microorganism control agent according to any one of Items 1 to 9.

Item 15. An antialgal method comprising imparting antialgal properties to a target object by using the microorganism control agent according to any one of Items 1 to 9.

Item 16. A method for inhibiting biofilm formation, comprising
15 imparting a biofilm formation-inhibiting effect to a target object by using the microorganism control agent according to any one of Items 1 to 9.

Item 17. A miticidal composition comprising platinum particles and metal particles other than platinum particles.

20 Item 18. The miticidal composition according to Item 17, wherein the metal particles comprise at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles.

Item 19. The miticidal composition according to Item 17 or 18,
25 wherein the metal particles comprise at least one member selected from the group consisting of silver particles and copper particles.

Item 20. The miticidal composition according to any one of Items 17 to 19, wherein the platinum particles and the metal particles
30 have a mean particle size of 0.1 to 1000 nm.

Item 21. An anti-mite member (excluding a beekeeping member) comprising the miticidal composition according to any one of Items 17 to 20 applied thereto.

Item 22. An anti-mite method comprising imparting an anti-mite
35 function to a target object (excluding a beekeeping member) by

using the miticidal composition according to any one of Items 17 to 20.

Advantageous Effects of Invention

5 [0008]

The microorganism control agent of the present invention, which comprises platinum particles and particles of a metal other than platinum, has excellent microorganism control performance, which cannot be achieved by using either platinum particles alone or particles of a metal other than platinum alone, 10 in particular, has excellent antimicrobial performance, antialgal performance, and biofilm formation-inhibiting performance, and also has suppressed metal elution. Therefore, the microorganism control agent exhibits excellent microorganism control 15 performance, in particular, excellent antimicrobial properties, antialgal performance, and biofilm formation-inhibiting performance, and also has suppressed metal elution, whereby enhanced durability and prolonged effect can be achieved and environmental impacts can be suppressed. Furthermore, three 20 different effects, which are an antimicrobial effect, an antialgal effect, and a biofilm formation-inhibiting effect, can be provided by treating a base material with the microorganism control agent of the present invention. Because the use of the microorganism control agent can reduce processing work by half 25 and also reduce processing costs, the microorganism control of the present invention is highly useful.

[0009]

The miticidal composition of the present invention, which contains both platinum particles and particles of a metal 30 other than platinum, can have an excellent mite infestation-inhibitory function and a mite growth-inhibitory function, which cannot be provided by either platinum particles alone or particles of a metal other than platinum alone. Since an anti-mite member comprising the miticidal composition has excellent 35 performance to inhibit the infestation and growth of mites, the

anti-mite member can be used for general materials that need to have anti-mite and miticidal properties. For example, the anti-mite member is suitable for use as life-related materials, such as *tatami* (thick straw mats that cover the floor), carpets, wall materials, flooring materials, ceiling materials, furniture, home appliances, food containers, food packing materials, kitchen products, and the like, or can be suitably used as industrial materials, such as members for rearing or keeping plants, animals, insects, etc. (excluding beekeeping members).

Brief Description of Drawings

[0010]

Fig. 1 shows the results obtained in Reference Test Example 1. Fig. 1 shows the relationship between breeding time and the number of living varroa mites.

Fig. 2 shows the results obtained in Reference Test Example 2. Fig. 2 shows the relationship between breeding time and the number of living varroa mites.

Description of Embodiments

[0011]

The embodiment of the present invention is described below in detail.

[0012]

Microorganism Control Agent and Miticidal Composition

The microorganism control agent and miticidal composition according to the present embodiment comprise platinum particles and metal particles other than platinum particles. Hereinafter, the "metal particles other than platinum particles" may be sometimes simply referred to as "the metal particles."

[0013]

Platinum particles are particles comprising platinum (Pt). Platinum particles are usually formed of platinum element and may also comprise an oxide of platinum. Platinum particles may further contain an alloy of platinum and other metal

element(s) .

[0014]

The metal particles are not particularly limited. The metal particles are preferably at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles. Such metal particles are less toxic and have excellent antimicrobial performance and excellent miticidal performance, and have higher effects of preventing the infestation of microorganisms or removing microorganisms and inhibiting the infestation and growth of mites.

[0015]

The metal particles, like platinum particles, are usually formed of at least one metal element selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles. The metal particles may comprise an oxide of the metal element. The metal particles may further comprise an alloy of the metal element and other metal element(s).

[0016]

The metal particles may consist only of one of silver particles, copper particles, nickel particles, and zinc particles, or may comprise two or more kinds of these particles.

[0017]

The metal particles preferably comprise at least one member selected from the group consisting of silver particles and copper particles. When such metal particles are used, particularly excellent antimicrobial performance is exhibited and further enhanced effects of preventing the infestation of microorganisms or removing microorganisms can be achieved. Silver particles are particularly preferable as the metal particles. When silver particles are used, not only excellent microorganism control performance and miticidal performance are provided, but also toxicity, irritation, and like properties other microorganism control agents usually have can be significantly reduced because highly safe metal particles are used and can provide the above effects even when used at a low concentration.

[0018]

The mean particle size of platinum particles and the metal particles is not particularly limited. For example, the particles may be nanoparticles with a particle size of, for example, 0.1 nm or more and 1000 nm or less. The platinum particles and the metal particles with such a mean particle size can more easily exhibit antimicrobial performance and miticidal effects, and when supported on a base material and used, the platinum particles and the metal particles can be more easily supported. Further, a mean particle size of 0.1 nm or more can facilitate atomization of these metals, whereas a mean particle size of 1000 nm or less can more easily inhibit precipitation of metal particles in the case of forming the particles into a liquid or in the process of producing an aqueous dispersion for supporting these particles on a carrier, thus being less likely to cause difficulties in handling etc. The mean particle size of platinum particles and the metal particles herein refers to the measurement results obtained by using a zeta potential measuring instrument (Zetasizer Nano ZS90, produced by Malvern Instruments, Ltd.).

[0019]

The shape of platinum particles and the metal particles is not particularly limited. Examples include spherical particles, polygonal particles, fibrous particles, needle-like particles, flaky particles, porous particles, and the like. The platinum particles and the metal particles may be in an agglomerated state.

[0020]

There is no particular limitation on the platinum particle content and the metal particle content of the microorganism control agent and miticidal composition. From the viewpoint of enhancing the antimicrobial performance and miticidal performance of the microorganism control agent, the platinum particle content and the metal particle content, based on the total mass of the platinum particles and the metal particles defined as 100, are such that the platinum particle

content is, for example, 5 or more, preferably 10 or more, more preferably 20 or more, and particularly preferably 30 or more, and is, for example, 95 or less, preferably 90 or less, more preferably 80 or less, and particularly preferably 70 or less.

5 [0021]

As long as the microorganism control agent and the miticidal composition according to the present embodiment contain platinum particles and the metal particles, the form thereof is not particularly limited. For example, the microorganism control agent and the miticidal composition may be in the form of a dispersion of platinum particles and the metal particles in a medium (a dispersion liquid). In this case, the medium is usually a liquid and may be, for example, water, a lower alcohol, or a mixed solvent thereof.

15 [0022]

The microorganism control agent and the miticidal composition according to the present embodiment may be configured such that platinum particles and the metal particles are supported on a base material. In this case, antimicrobial properties, antialgal properties, biofilm formation-inhibiting performance, miticidal and anti-mite functions, etc., can be imparted to the base material by a simple method (for example, immersion in a liquid and microwave treatment as described below). The microorganism control agent or the miticidal composition formed such that platinum particles and the metal particles are supported on a base material may be referred to as a "microorganism control member."

[0023]

The kind of base material is not particularly limited. From the viewpoint of ease of supporting platinum particles and the metal particles and ease of application to various products as a microorganism control agent, the base material preferably comprises a resin.

[0024]

35 When the base material comprises a resin, the resin

preferably comprises at least one member selected from the group consisting of polystyrene resins, vinyl chloride resins, fluorine resins, ABS resins, PET resins, polycarbonate resins, urea resins, polylactic acid resins, olefin resins, and phenolic resins. When
5 the base material comprises at least one of these resins, platinum particles and the metal particles can be more easily supported on the base material and high antimicrobial performance and high miticidal performance can be exhibited. Examples of the fluorine resins include PTFE (polytetrafluoroethylene) and the
10 like. Examples of the olefin resins include polyethylene, polypropylene resins, and the like.

[0025]

When the base material comprises a resin, the resin is preferably a polycarbonate resin in terms of economy of the metal
15 particles used because a sufficient microorganism controlling effect and miticidal effect can be achieved even with a small amount of platinum particles and the metal particles supported.

[0026]

The amount of platinum particles and the metal
20 particles supported on the base material is not particularly limited. The supported amount may be, for example, 0.001 ng/cm^2 or more, preferably 0.01 ng/cm^2 or more, and more preferably 0.1 ng/cm^2 or more, and may be, for example, $100,000 \text{ ng/cm}^2$ or less, preferably $50,000 \text{ ng/cm}^2$ or less, and more preferably $20,000$
25 ng/cm^2 or less. When the platinum particles and the metal particles are supported in such an amount on the base material, the antimicrobial performance of the microorganism control agent and the miticidal performance of the miticidal composition can be fully exhibited. The amount supported on the base material
30 (ng/cm^2) herein refers to the total of the amount of platinum particles supported (ng/cm^2) and the amount of the metal particles supported (ng/cm^2).

[0027]

The shape of the base material may be, for example, a
35 sheet, plate, block, net, perforated sheet, grain, rod, crushed,

dish, and various product shapes selected according to the intended use. When the base material is in any of these shapes, the microorganism control agent and the miticidal composition can find a wider range of applications and antimicrobial performance and miticidal performance can be more easily provided. For example, when the base material is in the form of a sheet, there is no limitation on the thickness. The base material can be formed to a thickness selected according to the intended use. The base material may have pores inside and may be, for example, hollow or porous.

[0028]

The microorganism control agent and the miticidal composition according to the present embodiment may contain other materials as long as the effect of the present invention is not impaired. Examples of other materials include particles of metal element other than platinum particles and the metal particles, other microorganism control agents (e.g., antimicrobial agents, microbicides, preservatives, antialgal agents, and antifungal agents), pH adjusting agents, antioxidants, light stabilizers, defoaming agents, dispersion stabilizers, lubricants, and the like.

[0029]

Examples of the other microorganism control agents include isothiazoline compounds, benzimidazole compounds, triazole compounds, nitro alcohol compounds, dithiol compounds, thiophene compounds, haloacetylene compounds, phthalimide compounds, haloalkylthio compounds, phenylurea compounds, triazine compounds, guanidinium compounds, quaternary ammonium salt compounds, and the like.

[0030]

Examples of isothiazoline compounds include 2-methyl-4-isothiazolin-3-one, 2-n-octyl-4-isothiazolin-3-one, 5-chloro-2-methyl-4-isothiazolin-3-one, 5-chloro-2-n-octyl-4-isothiazolin-3-one, 4-chloro-2-n-octyl-4-isothiazolin-3-one, 4,5-dichloro-2-n-octyl-4-isothiazolin-3-one, 2-methyl-4,5-trimethylen-4-

isothiazolin-3-one, 1,2-benzisothiazolin-3-one, N-n-butyl-1,2-benzisothiazoline-3-one, and the like.

[0031]

Specific examples of benzimidazole compounds include
5 methyl-2-benzimidazole carbamate (common name: carbendazim), ethyl-2-benzimidazole carbamate, 2-(4-thiazolyl)benzimidazole, and the like.

[0032]

Specific examples of triazole compounds include α -
10 butyl- α -(2,4-dichlorophenyl)-1H-1,2,4-triazole-1-ethanol (common name: hexaconazole), α -[2-(4-chlorophenyl)ethyl]- α -(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol (common name: tebuconazole), α -(4-chlorophenyl)- α -(1-cyclopropyl ethyl)-1H-1,2,4-triazole-1-ethanol (common name: cyproconazole), 1-[[2-
15 (2,4-dichlorophenyl)-4-n-propyl-1,3-dioxolane-2-yl]methyl]-1H-1,2,4-triazole (common name: propiconazole), and the like.

[0033]

Specific examples of nitro alcohol compounds include 2-bromo-2-nitropropane-1,3-diol, 2,2-dibromo-2-nitro-1-ethanol, and
20 the like.

[0034]

Specific examples of dithiol compounds include 4,5-dichloro-1,2-dithiol-3-one and the like.

[0035]

Specific examples of thiophene compounds include 3,3,4-trichlorotetrahydrothiophene-1,1-dioxide, 3,3,4,4-tetrachlorotetrahydrothiophene-1,1-dioxide, and the like.

[0036]

Specific examples of haloacetylene compounds include N-butyl-3-iodopropiolamide, 3-iodo-2-propynyl-N-butyl carbamate, and the like.

[0037]

Specific examples of phthalimide compounds include N-1,1,2,2-tetrachloroethylthio-tetrahydrophthalimide (Captafol), N-trichloromethylthio-tetrahydrophthalimide (Captan), N-
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dichlorofluoromethylthiophthalimide (Fluorfolpet), N-trichloromethylthiophthalimide (Folpet), and the like.

[0038]

Specific examples of haloalkylthio compounds include N-dimethylaminosulfonyl-N-tolyl-dichlorofluoromethanesulfamide (Tolylfluanide), N-dimethylaminosulfonyl-N-phenyl-dichlorofluoromethanesulfamide (Dichlofluanide), and the like.

[0039]

Specific examples of phenylurea compounds include 3-(3,4-dichlorophenyl)-1,1-dimethylurea and the like.

[0040]

Specific examples of triazine compounds include 2-methylthio-4-t-butylamino-6-cyclobutylpropylamino-s-triazine and the like.

15 [0041]

Specific examples of guanidine compounds include 1,6-di-(4'-chlorophenyldiguanide)-hexane, polyhexamethyleneguanidine hydrochloride, and the like.

[0042]

Specific examples of quaternary ammonium salt compounds include hexadecyltrimethylammonium bromide, hexadecyltrimethylammonium chloride, benzalkonium chloride, di-n-decyl-dimethylammonium chloride, 1-hexadecylpyridinium chloride, and the like.

25 [0043]

Such other microorganism control agents can be used singly or in a combination of two or more. The other microorganism control agents are preferably at least one compound selected from the group consisting of benzimidazole compounds, triazole compounds, haloacetylene compounds, and salts of these compounds. Particularly preferable is at least one compound selected from the group consisting of methyl-2-benzimidazolecarbamate, 2-(4-thiazolyl)benzimidazole, α -[2-(4-chlorophenyl)ethyl]- α -(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol, α -butyl- α -(2,4-dichlorophenyl)-1H-1,2,4-triazole-1-

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ethanol, and 3-iodo-2-propynyl-N-butyl carbamate.

[0044]

When the composition comprises one or more other microorganism control agents, the amount of other microorganism control agents is not particularly limited and can be suitably selected according to the dosage form, purpose, and use. For example, the other microorganism control agents can be incorporated in a total amount of 1 to 10000 parts by weight, and preferably 10 to 1000 parts by weight, per 100 parts by weight of the total amount of platinum particles and metal particles other than platinum particles.

[0045]

Examples of pH adjusting agents include acids, bases, and the like. Specific examples of acids include hydrochloric acid, nitric acid, sulfuric acid, lactic acid, acetic acid, citric acid, and the like. Specific examples of bases include sodium hydroxide, potassium hydroxide, sodium carbonate, triethylamine, trimethylamine, ammonia, and the like. Such pH adjusting agents can be used singly or in a combination of two or more.

[0046]

Examples of antioxidants include phenolic antioxidants, amine antioxidants, and the like. Specific examples of phenolic antioxidants include 2,6-di-t-butyl-4-methylphenol, 2,2'-methylenebis(4-methyl-6-t-butylphenol), and the like. Examples of amine antioxidants include alkyldiphenylamine, N,N'-di-s-butyl-p-phenylenediamine, and the like. Such antioxidants can be used singly or, if necessary, can be used in a combination of two or more.

[0047]

Examples of light stabilizers include hindered amine light stabilizers such as bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, and the like. Such light stabilizers can be used singly or, if necessary, in a combination of two or more.

[0048]

Examples of defoaming agents include silicone-based defoaming agents, organic defoaming agents, and the like.

Examples of organic defoaming agents include surfactants, polyethers, higher alcohols, and the like. Such defoaming agents
5 can be used singly or, if necessary, can be used in a combination of two or more.

[0049]

The method of producing the microorganism control agent or the miticidal composition is not particularly limited. For
10 example, when the microorganism control agent or the miticidal composition are in the form of a dispersion of platinum particles and the metal particles in a medium as described above, platinum particles, the metal particles, and medium are prepared and these components are mixed in predetermined amounts to prepare a
15 microorganism control agent or a miticidal composition. When the microorganism control agent or the miticidal composition is prepared, a commercially available mixer or disperser may be appropriately used. The total amount of platinum particles and the metal particles in such a microorganism control agent or
20 miticidal composition may be 0.00001 parts by weight or more, preferably 0.0001 parts by weight or more, and more preferably 0.001 parts by weight or more, and may be, for example, 50 parts by weight or less, preferably 10 parts by weight or less, and more preferably 1 part by mass or less, per 100 parts by mass of
25 the medium. In this case, the mixing ratio of platinum particles and the metal particles (mass of platinum particles : mass of the metal particles), based on the total mass of platinum particles and the metal particles defined as 100, is such that the mass of platinum particles is, for example, 5 or more, preferably 10 or
30 more, more preferably 20 or more, and particularly preferably 30 or more, and is, for example, 95 or less, preferably 90 or less, more preferably 80 or less, and particularly preferably 70 or less.

[0050]

35 The method for producing the microorganism control

agent or the miticidal composition configured such that platinum particles and the metal particles are supported on a base material is also not particularly limited. A microorganism control agent or a miticidal composition configured such that
5 platinum particles and the metal particles are supported on a base material can be produced, for example, by preparing a dispersion of platinum particles and the metal particles beforehand and then allowing platinum particles and the metal particles to be supported on a base material by using the
10 dispersion. Examples of the method for allowing platinum particles and the metal particles to be supported on a base material by using the dispersion include, but are not limited to, a method comprising immersing a base material in the dispersion; a method comprising spraying or applying the dispersion to a base
15 material; a vacuum evaporation method; and the like.

[0051]

When a microorganism control agent or a miticidal composition is produced by the method of immersing a base material in the dispersion, platinum particles and the metal
20 particles may be fixed to the base material by irradiating the base material with microwaves while in the state of being immersed in the dispersion. Similarly, when a microorganism control agent or a miticidal composition is produced by a method comprising spraying or applying the dispersion to the base
25 material, platinum particles and the metal particles may be fixed to the base material by irradiating the base material with microwaves after a coating film of the dispersion is formed, for example, by spraying or application.

[0052]

30 The microwave irradiation as described above allows for uniform coating in a relatively short time and reinforces the support of platinum particles and the metal particles on the base material, whereby platinum particles and the metal particles can be supported on the base material without using a binder. This
35 enables the microorganism control agent and the miticidal

composition to exhibit better antimicrobial and miticidal effects and also has another advantage in that metal element elution can be further inhibited because the support of platinum particles and the metal particles on the base material is reinforced.

5 [0053]

When microwave irradiation is performed, the irradiation intensity can be 0.005 to 0.1 W/cm³. For the microwave irradiation, for example, a commercially available microwave applicator or microwave oven may be used. When microwave
10 irradiation is performed, heating may be appropriately performed. The microwave irradiation time may be appropriately set according to the microwave irradiation intensity and can be, for example, 0.1 to 60 minutes.

[0054]

15 The microorganism control agent and the miticidal composition according to the present embodiment comprise platinum particles and the metal particles as described above, and have excellent antimicrobial performance and miticidal performance.

[0055]

20 For example, the microorganism control agent according to the present embodiment can have an antimicrobial activity value of 2.0 or more against each of *Staphylococcus aureus* and *Escherichia coli* in the antimicrobial test according to JIS Z2801.

[0056]

25 The evaluation of antimicrobial performance can be performed according to JIS Z2801, and a film adhesion method, which is generally known, can be used. This film adhesion method comprises dropping a bacterium-containing liquid onto the surface of a measurement sample, overlaying a film thereon and collecting
30 bacteria from the sample after the lapse of 24 hours, and counting the number of viable bacteria. The measurement result is compared with the number of viable bacteria in a non-processed product to calculate its antimicrobial activity value.

[0057]

35 Not only the film adhesion method but also a shaking

method may be used. The shaking method comprises immersing a sample in a suspension of bacteria, shaking it so as to contact the bacteria with the sample, and counting the number of viable bacteria. The measurement result is compared with the number of viable bacteria in a non-processed product to calculate its antimicrobial activity value. The shaking method can be used for samples to which the film adhesion method cannot be applied.
[0058]

The microorganism control agent according to the present embodiment can have an antimicrobial activity value of 2.0 or more against each of *Staphylococcus aureus* and *Escherichia coli* as determined by the film adhesion method.
[0059]

The microorganism control agent according to the present embodiment (a dispersion of platinum particles and metal particles other than platinum particles) can be used, for example, for subjecting a container for culturing cells, such as a petri dish (hereinafter referred to as "cell culture container") to antimicrobial treatment and biocidal treatment.
[0060]

Cell culture containers that are surface-treated with the microorganism control agent according to the present embodiment have excellent antimicrobial performance. Therefore, although it was conventionally necessary to perform an antimicrobial treatment or the like, for example, by heating or ultraviolet radiation of cell culture containers as a pretreatment for culturing cells, the use of cell culture containers that are antimicrobially or otherwise treated with the microorganism control agent according to the present embodiment allows for cell culturing without performing such a pretreatment, thus saving time and labor for pretreatment, etc.
[0061]

Further, the use of cell culture containers that are antimicrobially or otherwise treated with the microorganism control agent according to the present embodiment enables cell

culturing without affecting cell proliferation.

[0062]

Furthermore, the use of cell culture containers that are antimicrobially or otherwise treated with the microorganism control agent according to the present embodiment inhibits
5 contamination with other bacteria before, after, or during culturing. Therefore, the container is less likely to adversely affect cell culturing and enables efficient cell culturing. More specifically, the addition of an antibiotic, which would usually
10 be used to prevent contamination with bacteria etc. during the culturing, can also be omitted.

[0063]

Cell culture containers may be antimicrobially or otherwise treated with the microorganism control agent according
15 to the present embodiment immediately before cell culturing. Alternatively, cell culture containers may be antimicrobially or otherwise treated with the microorganism control agent according to the present embodiment after or simultaneously with the production of the cell culture containers. The antimicrobial
20 treatment is less likely to be affected by heating treatment or ultraviolet irradiation treatment.

[0064]

By using cell culture containers that are antimicrobially or otherwise treated with the microorganism control agent according to the present embodiment, various cells
25 can be cultured. The type of cells is not limited.

[0065]

The microorganism control agent according to the present embodiment has algae infestation inhibitory performance.
30 The inhibitory effect can be visually confirmed in a test using plant cultivation containers as shown in the Examples given below.

[0066]

The microorganism control agent according to the present embodiment has a biofilm formation-inhibiting performance.
35 A significant reduction in biofilm formation (an invisible level)

can be confirmed in a test using sample plates as shown in the Examples below. The biofilm is also called a biomembrane or slime. A biofilm generally refers to a structure composed of microorganisms and microorganism-derived substances, which is generally formed by the attachment of microorganisms to the surface of a material in an aqueous medium and proliferation of the microorganisms thereon and secretion of macromolecular substances, such as polysaccharides, proteins, or nucleic acids, from the microbial cells. The biofilm formation can be a factor that causes significantly adverse effects in various industries by contamination and corrosion of equipment and flow channels (e.g., pipelines, tubs, etc.), clogging of the system, product defects, energy loss, and the like.

[0067]

The miticidal composition according to the present embodiment has miticidal and ante-mite properties. As shown in the Examples below, the treatment of a base material formed of a resin etc. with the miticidal composition can inhibit the proliferation of mites. Thus, the miticidal composition according to the present embodiment can impart an anti-mite function to a target object.

[0068]

The microorganism control agent and the miticidal composition according to the present embodiment, which contain platinum particles and the metal particles, have excellent antimicrobial performance and miticidal performance. Therefore, even when the microorganism control agent and the miticidal composition contain platinum particles and the metal particles at low concentrations, good antibacterial performance and miticidal performance can be exhibited. Accordingly, as described above, the microorganism control agent and the miticidal composition configured such that platinum particles and the metal particles are supported on a base material can exhibit high antimicrobial performance, high antialgal performance, high biofilm formation-inhibiting ability, and high miticidal performance, even when the

supported amount of platinum particles and the metal particles is small. When the metal particles comprise at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles, particularly
5 excellent antimicrobial performance and miticidal performance can be exhibited; even when the supported amount of the metal particles is small, high antimicrobial performance, high antialgal performance, high biofilm formation-inhibiting ability, and high miticidal performance can be exhibited. That is, when a
10 base material is treated with the microorganism control agent or the miticidal composition according to the present invention, four different effects, i.e., an antimicrobial effect, an antialgal effect, a biofilm formation-inhibiting effect, and a miticidal effect, can all be provided. Furthermore, these metal
15 particles have the advantage of being highly safe.

[0069]

Since antimicrobial products containing platinum alone or a metal other than platinum alone are commercially available, using platinum alone or the metal particles alone was also
20 presumed to have a certain level of antimicrobial effects. However, in the test performed during the process of accomplishing the present invention, no effect was observed when particles of one type of metal alone were used. In contrast, when platinum particles and particles of a metal other than platinum
25 are both present as in the microorganism control agent and miticidal composition according to the present embodiment, excellent microorganism control performance, which would not be achieved by using particles of one type of metal alone, can be achieved, and antimicrobial performance is synergistically
30 enhanced.

[0070]

The microorganism control agent and the miticidal composition, which contain platinum particles and the metal particles, are very unlikely to have metal ion elution, which
35 occurred conventionally. Accordingly, the microorganism control

agent and the miticidal composition can have significantly reduced environmental impacts.

[0071]

The microorganism control agent according to the present embodiment has excellent antimicrobial performance and reduced metal elution. Accordingly, the microorganism control agent can easily impart a microorganism control function to a target object and is suitable for use as a method for controlling a microorganism. Furthermore, the use of the microorganism control agent can reduce processing work by half and can also reduce processing costs and is thus highly useful. Accordingly, the microorganism control agent can find industrial applications (for example, many industrial products or industrial raw materials, such as water-containing pulp, coated paper, coating fluids for paper, coating compositions, binders, adhesives, latexes, inks, etching solutions, soaking water, wood, fibers, wood flour, plastics, cement admixtures, sealing agents, resin emulsions, building raw materials, and the like), and can also find applications in fields in which safety or the like is particularly important, for example, in agricultural fields, such as plant cultivation; food industries, such as antimicrobial bottles; physicochemical materials, such as cell culture substrates; and like applications. In particular, the microorganism control agent is useful as an antimicrobial agent, an antialgal agent, and a biofilm formation inhibitor.

[0072]

Further, an anti-mite member can be formed by applying the miticidal composition according to the present embodiment to a target object. Since such an anti-mite member comprises the miticidal composition containing platinum particles and metal particles other than platinum particles, the anti-mite member has excellent performance to suppress the infestation and growth of mites and thus can be used for general materials that need to have anti-mite or miticidal properties. For example, the anti-mite member is suitable for use as household-related materials,

for example, as *tatami* (thick straw mats that cover the floor), carpets, wall materials, flooring materials, ceiling materials, furniture, home appliances, food containers, food packing materials, kitchen products, and the like, and can also be
5 suitable for use as industrial materials, for example, as members for rearing or keeping plants, animals, insects, etc. (excluding beekeeping members).

Examples

10 [0073]

The present invention is described below in more detail with reference to Examples. However, the scope of the present invention is not limited to the embodiments of the Examples.

[0074]

15 1. Confirmation of Antimicrobial Effect

Preparation Example 1: Preparation of Dispersion of Platinum Particles

0.212 g of potassium chloroplatinate (K_2PtCl_4) was dissolved in 50 mL of pure water to prepare an aqueous potassium
20 chloroplatinate solution. Separately, 0.129 g of sodium citrate was dissolved in 50 mL of pure water to prepare a 0.01 mol/L aqueous sodium citrate solution, whereas 0.881 g of ascorbic acid was dissolved in 50 mL of pure water to prepare a 0.1 mol/L aqueous ascorbic acid solution. After 50 mL of the aqueous
25 potassium chloroplatinate solution was added to 850 mL of pure water, 50 mL of the 0.01 mol/L aqueous sodium citrate solution and 50 mL of the 0.1 mol/L aqueous ascorbic acid solution were added and stirred at 100 rpm for about 5 minutes to allow a reaction to proceed. Subsequently, an ion-exchange membrane
30 treatment was performed and ionic impurities were removed from the platinum particle dispersion to obtain a colloidal solution containing platinum particles. The platinum particles had a particle size of 130 nm as measured with a zeta potential measuring instrument (Zetasizer Nano ZS90, produced by Malvern
35 Instruments, Ltd.). Further, the platinum particles had a

platinum purity of 100% as measured with a TEM/EDS (HITACHI H-7100, accelerating voltage: 100 kV).

[0075]

5 The platinum concentration of the dispersion obtained by the above method was confirmed by ICP-MS (Elan DRC II, produced by PerkinElmer, Inc.). The dispersion was further diluted with water to obtain a dispersion having a platinum particle concentration of 100 mg/L (Dispersion 1).

[0076]

10 Preparation Example 2: Preparation of Dispersion of Silver Particles

0.157 g of silver nitrate (AgNO_3) was dissolved in 50 mL of pure water to prepare an aqueous silver nitrate solution. Separately, 10 wt% aqueous ammonia was prepared, and 0.881 g of
15 ascorbic acid was dissolved in 50 mL of pure water to prepare a 0.1 mol/L aqueous ascorbic acid solution. After 50 mL of a 0.01 mol/L aqueous silver nitrate solution was added to 900 mL of pure water and adjusted to pH 11 with 10 wt% aqueous ammonia. Further, 1 mL of a 0.1 mol/L aqueous ascorbic acid solution was added and
20 the resulting mixture was stirred at 100 rpm for about 5 minutes. Subsequently, an ion-exchange membrane treatment was performed, and ionic impurities were removed from the dispersion of silver particles to obtain a colloidal solution containing silver particles. The particle size as measured with a zeta potential
25 measuring instrument (Zetasizer Nano ZS90, produced by Malvern Instruments, Ltd.) was 130 nm. The silver particles had a silver purity of 100% as measured with a TEM/EDS (HITACHI H-7100, accelerating voltage: 100 kV).

[0077]

30 The silver concentration in the dispersion obtained by the above method was confirmed by ICP-MS (Elan DRC II, produced by PerkinElmer Co., Ltd.) and further diluted with water to obtain a dispersion having a silver particle concentration of 100 mg/L (Dispersion 2).

35 [0078]

Preparation Examples 3 to 7

Dispersion 1 obtained in Preparation Example 1 and Dispersion 2 obtained in Preparation Example 2 were mixed in the proportions shown in Table 1 to prepare mixtures of platinum particles and silver particles (Preparation Examples 3 to 7) for use in the Examples described below.

[0079]

Table 1

	Preparation Example						
	1	3	4	5	6	7	2
Dispersion 1 (platinum particles)	100	90	70	50	30	10	-
Dispersion 2 (silver particles)	-	10	30	50	70	90	100
Metal concentration (mg/L)	100	100	100	100	100	100	100

The numerals (in the rows of Dispersions 1 and 2) in Table 1 show blending proportions with the total mass of platinum particles and silver particles being defined as 100.

[0080]

Preparation Example 8

Dispersion 1 obtained in Preparation Example 1 (dispersion of platinum particles) and Dispersion 3, which was prepared by dispersing Nano copper (produced by Sigma, catalog product No. 774111, particle size: 40 to 60 nm, 99%) in water, were mixed in predetermined amounts to prepare a mixture containing platinum particles and copper particles at a blending ratio by mass of 70/30 and having a total concentration of these metal particles of 100 mg/L.

[0081]

Preparation Example 9

Dispersion 1 obtained in Preparation Example 1 (dispersion of platinum particles) and Dispersion 4, which was prepared by dispersing nickel particles (produced by Sigma, catalog product No. 577995, particle size < 100 nm, 99%) in water, were mixed in predetermined amounts to prepare a mixture containing platinum particles and nickel particles at a blending ratio by mass of 70/30 and having a total concentration of these

metal particles of 100 mg/L.

[0082]

Preparation Example 10

Dispersion 1 (dispersion of platinum particles)

5 obtained in Preparation Example 1 and Dispersion 5 containing
zinc oxide particles (produced by Sigma, catalog product No.
721085, particle size: <130 nm, 40%) were mixed in predetermined
amounts to prepare a mixture containing platinum particles and
zinc oxide particles at a mixing ratio by mass of 70/30 and
10 having a total concentration of these metal particles of 100 mg/L.
[0083]

Table 2 shows the formulations of Preparation Examples
8 to 10.

[0084]

15 Table 2

	Preparation Example		
	8	9	10
Dispersion 1 (platinum particles)	70	70	70
Dispersion 3 (copper particles)	30	-	-
Dispersion 4 (nickel particles)	-	30	-
Dispersion 5 (zinc oxide particles)	-	-	30
Metal concentration in dispersion (mg/L)	100	100	100

The numerals (in the rows of Dispersions 1, 3, 4, and
5) in Table 2 show blending proportions with the total mass of
platinum particles and particles of a metal other than platinum
being defined as 100.

20 [0085]

Example 1

Eight parts by mass of a base material made of
polytetrafluoroethylene resin (PTFE resin) (having a net-like
structure with openings of 1 mm square and a size of 2 x 3 cm)
25 was sampled, washed with pure water, and then immersed in the
mixture prepared in Preparation Example 3 above. The mixture in
which the base material was in an immersed state was then placed
in a microwave device for testing (Multiwave 3000, produced by
PerkinElmer, Inc.) and subjected to a microwave irradiation
30 treatment once under the following microwave irradiation

conditions: irradiation wavelength: 2.45 GHz; irradiation power:
400 W; and irradiation time: 7 minutes. The base material was
then removed from the mixture and washed with pure water and
dried at room temperature overnight to obtain a microorganism
5 control agent.

[0086]

Examples 2 to 8

Microorganism control agents were obtained in the same
manner as in Example 1 except that the mixtures prepared in
10 Preparation Examples 4 to 10 were used in place of the mixture
prepared in Preparation Example 3 (Examples 2 to 8).

[0087]

Comparative Example 1

A microorganism control agent was prepared in the same
15 manner as in Example 1 except that Dispersion 1 obtained in
Preparation Example 1 was used in place of the mixture obtained
in Preparation Example 3.

[0088]

Comparative Example 2

20 A microorganism control agent was prepared in the same
manner as in Example 1 except that Dispersion 2 obtained in
Preparation Example 2 was used in place of the mixture obtained
in Preparation Example 3.

[0089]

25 Antimicrobial Evaluation

The test samples obtained in the Examples and
Comparative Examples were subjected to an antimicrobial test by
the film adhesion method in accordance with the measurement
method of JIS Z2801. The test was performed using *Staphylococcus*
30 *aureus* and *Escherichia coli* as bacterial cells. Table 3 shows the
results.

[0090]

Table 3

	Comp. Ex. 1	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Comp. Ex. 2	Ex. 6	Ex. 7	Ex. 8
<i>S. aureus</i>	0.0	2.8	>5.2	>4.5	3.5	2.0	0.0	2.9	1.8	1.0

<i>E. coli</i>	0.0	3.0	>7.0	>7.4	>4.8	2.4	0.0	2.0	1.5	1.2
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The numerals in Table 3 show antimicrobial activity values as measured by the film adhesion method.

[0091]

Example 9

5 A microorganism control agent configured such that platinum particles and silver particles were supported on a base material was obtained in the same manner as in Example 2 except that a base material made of a polycarbonate (PC resin) was used in place of the base material made of PTFE resin.

10 [0092]

Example 10

A microorganism control agent was obtained in the same manner as in Example 2 except that the mixture obtained in Preparation Example 4 was diluted to 1/10 with water and used.

15 [0093]

Example 11

A microorganism control agent was obtained in the same manner as in Example 10 except that a base material made of a polycarbonate (PC resin) was used in place of the base material comprising PTFE resin.

20

[0094]

Example 12

A microorganism control agent was obtained in the same manner as in Example 2 except that the microwave irradiation treatment was performed three times, instead of once, under the following conditions: irradiation wavelength: 2.45 GHz; irradiation power: 400 W; and irradiation time: 7 minutes.

25

[0095]

Example 13

30 A microorganism control agent was obtained in the same manner as in Example 12 except that a base material made of polycarbonate (PC resin) was used in place of the base material made of PTFE resin.

[0096]

Example 14

A microorganism control agent was obtained in the same manner as in Example 2 except that a base material made of polystyrene (PS resin) was used in place of the base material made of PTFE resin, and the microwave irradiation was performed 5 times, instead of once, under the following conditions: irradiation wavelength: 2.45 GHz; irradiation power: 400 W; and irradiation time: 7 minutes.

[0097]

The mixtures of platinum particles and/or silver particles before and after the microwave irradiation in Examples 1 to 5 and Examples 9 to 14 were sampled. The silver ion concentrations were confirmed by using a silver ion detector (produced by Japan Ion Co., Ltd., AGT-131). All of the samples were found to have silver ion concentrations less than the detection limit.

[0098]

Evaluation Method

Measurement of Supported Metal Amount

The supported metal amounts of the microorganism control agents obtained in the Examples and Comparative Examples were measured according to the sulfuric acid ashing method. Specifically, (1) after sulfuric acid was added to a sample, carbonization and ashing were performed. (2) The resulting sample was dissolved in aqua regia. (3) After ashing, aqua regia was added and a dissolution treatment was performed. (4) Using Elan DRC II produced by PerkinElmer, Inc., the metal amount of the obtained solution was measured.

[0099]

Measurement of Metal Elution Amount

10 mL of ion-exchanged water and the microorganism control agent obtained in Example 2 were added to a 100-mL Erlenmeyer flask. The flask was placed in a 35°C constant temperature shaker and shaken under the conditions of a vibration amplitude of 30 mm and a horizontal shaking of 150 rpm for 24

hours. The metal amount in the shaken liquid was measured by IPC-MS (Elan DRC II, produced by PerkinElmer, Inc.). The amount of metal elution from the base material was thus quantified.

[0100]

5 Measurement of Antimicrobial Activity Value

An antimicrobial test was performed by the film adhesion method or the shaking method according to the measurement method of JIS Z2801. The test was performed using *Staphylococcus aureus* and *Escherichia coli*.

10 [0101]

Before measuring the antimicrobial activity values of the microorganism control agents obtained in the Examples, the dispersion obtained in Preparation Example 4 was subjected to the antimicrobial activity test. After culturing for 18 hours, the

15 dispersion had an antimicrobial activity value of 3.9. This result suggests that the dispersion comprising platinum particles and silver particles itself also has excellent antimicrobial effects.

[0102]

Table 4

Example/ Comparative Example 1	Dispersion	Base material	Metal type	Supported amount (ng/cm ²)
Example 2	Preparation Example 4	PTFE	Silver	17.0
			Platinum	15.6
Example 9	Preparation Example 4	PC	Silver	0.72
			Platinum	0.96
Example 10	1:10 dilution of Preparation Example 4	PTFE	Silver	5.6
			Platinum	6.2
Example 11	1:10 dilution of Preparation Example 4	PC	Silver	0.26
			Platinum	0.042
Example 12	Preparation Example 4 (however, the microwave irradiation treatment was performed 3 times)	PTFE	Silver	480
			Platinum	540
Example 13	Preparation Example 4 (however, the microwave irradiation treatment was performed 3 times)	PC	Silver	23
			Platinum	25
Example 14	Preparation Example 4 (however, the microwave irradiation treatment was performed 5 times)	PS	Silver	11,000
			Platinum	9,700
Comparative Example 1	Preparation Example 1	PTFE	Silver	0 (undetected)
			Platinum	15.0
Comparative Example 2	Preparation Example 2	PTFE	Silver	16.5
			Platinum	0 (undetected)

[0103]

Table 5

Sample	Sample amount (g)		Elution amount (ppb)	
	PTFE	Water	Platinum	Silver
Untreated PTFE	0.4669	10.021	< 1	< 1
Treated PTFE (Example 2)	0.4792	10.025	< 1	< 1

[0104]

5 Table 6

Example/ Comparative Example	Dispersion	Base material	Bacterial cells	Antimicrobial activity value
Example 2	Preparation Example 4	PTFE	<i>S. aureus</i>	>4.9
			<i>E. coli</i>	>6.1
Example 9	Preparation Example 4	PC	<i>S. aureus</i>	>5.0
			<i>E. coli</i>	>6.1
Example 10	1:10 dilution of	PTFE	<i>S. aureus</i>	>4.9

	Preparation Example 4		<i>E. coli</i>	>6.1
Example 11	1:10 dilution of Preparation Example 4	PC	<i>S. aureus</i>	>5.0
			<i>E. coli</i>	>6.1
Example 12	Preparation Example 4 (however, the microwave irradiation treatment was performed times)	PTFE	<i>S. aureus</i>	>4.8
			<i>E. coli</i>	>6.0
Example 13	Preparation Example 4 (however, the microwave irradiation treatment was performed 3 times)	PC	<i>S. aureus</i>	>4.9
			<i>E. coli</i>	>6.0
Example 14	Preparation Example 4 (however, the microwave irradiation treatment was performed 5 times)	PS	<i>S. aureus</i>	>5.1
			<i>E. coli</i>	>6.0
Comparative Example 1	Preparation Example 1	PTFE	<i>S. aureus</i>	0.0
			<i>E. coli</i>	0.0
Comparative Example 2	Preparation Example 2	PTFE	<i>S. aureus</i>	0.0
			<i>E. coli</i>	0.0
Untreated product	-	PTFE	<i>S. aureus</i>	0.0
			<i>E. coli</i>	0.0
Untreated product	-	PC	<i>S. aureus</i>	0.0
			<i>E. coli</i>	0.0

* The film adhesion method

[0105]

Table 4 shows the amounts of metals (platinum and silver) supported on base materials in the microorganism control agents obtained in the Examples and Comparative Examples. The results show that in all the Examples, platinum and silver were supported in certain amounts on the base material.

[0106]

Table 5 shows the measurement results of the amount of metal elution from the microorganism control agent obtained in Example 2. This result shows that the amount of metal elution from each type of particles alone in the microorganism control agent of Example 2 was less than the detection limit. In spite of that, as described below, the microorganism control agent obtained in Example 2 exhibited excellent antimicrobial effects as described below.

[0107]

Table 6 shows antimicrobial activity values against bacterial cells (*Staphylococcus aureus* and *Escherichia coli*)

determined by the film adhesion method. Base materials made of PC resin (Examples 9, 11, and 13) achieved equivalent excellent antimicrobial performance in spite of the fact that the supported metal amount is smaller than that of the base material made of PEFE resin (Example).

[0108]

2. Confirmation of Antialgal Effect

Example 15

After the inside of a plant cultivation container (As One Corporation, Violamo Polycarbonate Square Bottle, material: polycarbonate, volume: 150 mL) was washed with pure water, a 100-fold dilution of the mixture obtained in Preparation Example 4 (platinum/silver particle dispersion) with pure water was placed in the container. The container was then placed in a microwave device for testing (Multiwave 3000, produced by PerkinElmer, Inc.) and a microwave irradiation treatment was performed once under the following conditions: irradiation wavelength: 2.45 GHz; irradiation power: 400 W; and irradiation time: 7 minutes. After the platinum/silver particle dispersion was removed from the container and the inside of the container was washed with pure water, the container was dried at room temperature one whole day and night to obtain a plant cultivation container having platinum particles and silver particles supported on the inner surface thereof.

[0109]

Example 16

A plant cultivation container having platinum particles and silver particles on the inner surface thereof was prepared in the same manner as in Example 15 except that a microwave irradiation treatment was performed twice, instead of once, under the following conditions: irradiation wavelength: 2.45 GHz; irradiation power: 400 W; and irradiation time: 7 minutes.

[0110]

Comparative Example 3

A plant cultivation container having platinum particles

supported on the inner surface thereof was obtained in the same manner as in Example 15 except that silver particle-free Dispersion 1 containing only platinum particles and not containing silver particles (Preparation Example 1) was used as the dispersion.

[0111]

Comparative Example 4

A plant cultivation container having silver particles supported on the inner surface thereof was obtained in the same manner as in Example 15 except that platinum-free Dispersion 2 containing only silver particles and not containing silver particles (Preparation Example 2) was used as the dispersion.

[0112]

Antialgal Test

A plant broth (a 100-fold dilution of OAT house No. 8, produced by OAT Agrio Co., Ltd.) was placed into the containers produced in Examples 15 to 16 and Comparative Examples 3 to 4. Cucumber seedlings were placed and allowed to grow in the containers for 8 days. The infestation of algae in the culture was visually checked.

[0113]

Table 7 shows the results of the antialgal test.

[0114]

Table 7

Sample	Example 15	Example 16	Comparative Example 3	Comparative Example 4
Evaluation results	No algae infestation observed.	No algae infestation observed.	Algae infestation observed.	Algae infestation observed.

[0115]

Table 7 shows that no algae infestation was observed in Examples 15 and 16. This result confirms that the microorganism control agent configured such that platinum particles and silver particles were supported on a base material exhibited antialgal effects.

[0116]

3. Confirmation of Biofilm Formation-Inhibiting Effect

Example 17

The microorganism control agent produced in Example 2 (a PTFE base material on which platinum and silver particles were supported) was cut into 5 cm x 5 cm to obtain a test piece.
[0117]

Example 18

A microorganism control agent configured such that platinum and silver particles were supported on a base material (a PTFE base material on which platinum and silver particles were supported) was prepared in the same manner as in Example 2 except that a dispersion of platinum particles and silver particles obtained by 10-fold dilution of the mixture obtained in Preparation Example 4 with pure water was used. This base material was cut into 5 cm x 5 cm to obtain a test piece.
[0118]

Example 19

A microorganism control agent configured such that platinum and silver particles were supported on a base material (a PTFE base material on which platinum and silver particles were supported) was prepared in the same manner as in Example 2 except that a mixture obtained by 100-fold dilution of the mixture of Preparation Example 4 with pure water was used. This base material was cut into 5 cm x 5 cm to obtain a test piece.
[0119]

Comparative Example 5

A PTFE base material on which neither platinum particles nor particles of a metal other than platinum were supported was cut into 5 cm x 5 cm to obtain a test piece.
[0120]

Confirmation Test for Biofilm Inhibitory Effect

10 L of tap water was placed into the constant temperature water tank of a constant temperature water tank equipped with an external circulation device, and self-circulated without being externally circulated by the external circulation

device. One of the test pieces obtained in Examples 17 to 19 and Comparative Example 5 was immersed in this constant temperature water tank, and the water tank was operated for 10 days under the following conditions: operation time: from 9:00 to 17:00 for 8 hours every day; operation temperature: in the range of room temperature to 40°C. Whether a biofilm (membrane-like substance) was formed on the surface of each test piece was then evaluated by visual observation.

[0121]

Table 8 shows the confirmation test of the biofilm inhibitory effect.

[0122]

Table 8

Test piece	Example 17	Example 18	Example 19	Comparative Example 5
Biofilm formation	No	No	No	Yes

[0123]

Table 8 shows that no biofilm formation was observed in Examples 17 to 19. This result confirms that the microorganism control agents configured such that platinum and silver particles are supported on a base material exhibit a biofilm inhibitory effect.

[0124]

4. Confirmation of Miticidal and Anti-mite Effects (1)

Example 20

A test was performed according to JIS L1920: 2007. Specifically, processed samples or unprocessed samples were placed in sample bottles so as to cover the bottom surface with each sample. After mite (*Dermatophagoides pteronyssinus*) medium containing 50 to 80 mites/0.1 g of medium was spread over the samples, the samples were allowed to stand for 4, 6, and 8 weeks. The number of living mites in each sample bottle was then counted to calculate the mite proliferation inhibition %. The processed samples were prepared by treating a base material PE resin pellet (ϕ 10 mm x L 10 mm) with aqueous dispersions of miticidal

compositions having formulations shown in Table 9 (Nos. 1 to 4). All of the samples were prepared by performing microwave irradiation (output: 400 W, time: 14 minutes) treatment.

[0125]

5 The mite repellent percentage was calculated according to the following formula.

Repellent percentage (%) = $[(A-B)/A] \times 100$

wherein A represents the number of mites induced in the unprocessed sample, and B is the number of mites induced in the
10 processed sample.

[0126]

Table 9

Sample No.	1	2	3	4
Pt amount (ppm)	100	10	100	-
Ag amount (ppm)	30	3	-	30
Remarks	original solution	10-fold dilution of sample No. 1		

[0127]

15 Table 10 shows the repellent percentage in the processed samples treated with sample Nos. 1 to 4 shown in Table 9.

[0128]

Table 10

Sample No.	1	2	3	4
Mite repellent percentage (%)	47.4	29.8	14.3	13.2

[0129]

20 This result confirmed that anti-mite members in which platinum and silver particles are supported on a base material exhibit excellent anti-mite effects.

[0130]

5. Confirmation of Miticidal and Anti-mite Effects (2)

25 Reference Test Example 1

A honeycomb produced using PLA (polylactic acid resin) (produced by Kunimine Co., Ltd.) was immersed in sample No. 1 (a mixed dispersion of platinum particles and silver particles)

shown in Table 9 to obtain, as an anti-mite comb, a PLA honeycomb on which platinum particles and silver particles were supported. [0131]

5 The obtained anti-mite honeycomb was placed in an acrylic cage (40 cm in width, 10 cm in depth, and 20 cm in height). Five varroa mites were placed in the cage and reared using an incubator (produced by Panasonic Corporation) at 30°C under a humidity of 70%. Two hours, 4 hours, 6 hours, and 24 hours after the start of rearing, the survival rate of varroa mites was measured. This operation was repeated 6 times to calculate the average survival rate. [0132]

Fig. 1 shows the relationship between the rearing time and the number of living varroa mites. For comparison, Fig. 1 also shows the results of subjecting an unprocessed PLA honeycomb, i.e., a honeycomb on which neither platinum particles nor silver particles were supported (hereinafter referred to as a "blank comb") to the same test as the anti-mite honeycomb (Fig. 1 illustrates a pair of bar graphs in each elapsed time; the left-side bar graph in each elapsed time shows the number of living mites in the anti-mite comb, whereas the right-side bar graph shows the number of living mites in the blank comb.) [0133]

This result confirmed that the number of living varroa mites decreased with the lapse of rearing time in the anti-mite combs, as compared with that in the blank comb. Accordingly, the honeycomb treated with the miticidal composition comprising platinum particles and silver particles is considered to have miticidal and anti-mite effects.

30 [0134]

6. Confirmation of Miticidal and Anti-mite Effects (3)

Reference Test Example 2

The anti-mite comb and the blank comb obtained in the Confirmation of Miticidal and Anti-mite Effects (2) were placed in an acrylic cage (40 cm in width, 10 cm in depth, and 20 cm in

height). Ten varroa mites were placed in the cage and reared using an incubator (produced by Panasonic Corporation) at 30°C under a humidity of 70%. Two hours, 4 hours, 6 hours, and 24 hours after the start of rearing, the combs in which the varroa mites existed was confirmed. This operation was repeated 6 times to calculate the average number of varroa mites existing in each comb.

[0135]

Fig. 2 shows the relationship between the rearing time and the number of living varroa mites. (Fig. 2 shows a pair of bar graphs in each elapsed time; the left-side bar graph in each elapsed time shows the number of living mites in the anti-mite comb, whereas the right-side bar graph shows the number of living mites in the blank comb.)

[0136]

This result confirmed that the number of living varroa mites significantly decreased with the lapse of rearing time in the anti-mite comb, as compared with that in the blank comb. Accordingly, the honeycomb treated with the miticidal composition comprising platinum particles and silver particles is considered to have a mite repellent effect.

[0137]

7. Confirmation of Cell Culture

Example 21

A polystyrene resin (PS resin) dish (tissue culture dish "FALCON3001," diameter: 35 mm), which is a cell culture container, was washed with pure water and then immersed in a dispersion of platinum particles and silver particles, which is sample No. 2 shown in Table 9, to perform an antimicrobial treatment of the dish. The mixture in which the dish was immersed was then placed in a microwave device for testing (Multiwave 3000, produced by PerkinElmer, Inc.) and subjected to a microwave irradiation treatment once under the following conditions: irradiation wavelength: 2.45 GHz; irradiation power: 400 W; and irradiation time: 7 minutes. The dish was then removed from the

mixture and further immersed in 70% EtOH for several minutes. After the dish was then removed from the 70% EtOH, a sterilization treatment was performed by irradiation with ultraviolet rays for about 1 hour. An antimicrobial cell culture container was thus obtained.

[0138]

Using this cell culture container, cells were cultured under the following conditions.

Cell conditions

- HepG2 cells (human hepatoblastoma cells)
- Medium: WE + 10% FBS
- Culture period: 5 days (no medium replacement)

Cell seeding density:

- 1.5×10^5 cells/dish
- (1.6×10^4 cells/cm²)

Culture conditions

- Culture amount: 2 mL/dish (35 mm)
- Culture: 37°C, 5% CO₂ atmosphere.

[0139]

Example 22

A cell culture container was obtained and cells were cultured under the same conditions as in Example 21 except that sample No. 1 shown in Table 9 was used as the dispersion containing platinum particles and silver particles.

[0140]

Blank Test

Cells were cultured under the same conditions as in Example 21 except that the antimicrobial treatment using the dispersion containing platinum particles and silver particles was not performed.

[0141]

Table 11 shows the amounts of platinum and silver supported on cell culture containers, as well as the antimicrobial results and albumin secretion activity values.

[0142]

The amounts of platinum and silver supported were quantified by ICP-MS after a metal-containing fluid was obtained by dissolving the dish. The amounts of platinum and silver supported were determined in the same manner as in the

5 "Measurement of Supported Metal Amount" described above.
[0143]

The albumin secretion activity value is an index indicating cellular activity. The albumin secretion activity value was measured by the following method. First, the amount of
10 albumin secreted in a culture medium was quantified by enzyme-linked immunosorbent assay (ELISA). This quantitative value was converted into the albumin secretion rate per unit cell. The number of cells was counted by the DNA-DAPI (4,6-diaminodino-2-phenylindole, produced by Wako Pure Chemical Industries, Ltd.)
15 fluorescence method. Specifically, a calibration curve between DNA extracted from certain cells and the fluorescence intensity of DNA-DAPI was prepared. The number of cells cultured was calculated based on this relationship. Based on this cell count, the albumin secretion rate per unit cell was calculated.

20 [0144]

The antimicrobial properties were evaluated according to the following criteria from the antimicrobial activity values determined by the shaking method (35°C ± 1°C) according to the measurement method of JIS Z2801. *E. coli* was used as bacterial
25 cells.

A: The antimicrobial activity value was 2.0 or more and the cell culture container exhibited excellent antimicrobial properties.

B: The antimicrobial activity value was less than 2.0 and the cell culture container did not exhibit antimicrobial properties.

30 [0145]

Table 11

Supported amount	Example 21	Example 22	Blank test
Platinum (ng/cm ²)	50	620	-
Silver (ng/cm ²)	35	410	-
Antimicrobial properties	A	A	B
Albumin secretion activity	5.7	5.2	5.5

value			
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[0146]

Table 11 shows that the cell culture containers of Examples 21 to 22 had high antimicrobial properties and also had cellular activity equivalent to that of the blank test. It is
5 thus confirmed that the antimicrobial treatment does not affect cell culture.

[0147]

Further, using the cell culture container obtained in Example 22, NIH3T3 cells (mouse fibroblasts), HeLa cells (human
10 cervical cancer cells), and hMSC (human mesenchymal stem cells) were cultured under the same conditions. No influence on the culture of these cells was observed (it was confirmed that these cells were cultured without any problems).

CLAIMS

[Claim 1]

A microorganism control agent comprising platinum particles and metal particles other than platinum particles.

5

[Claim 2]

The microorganism control agent according to claim 1, wherein the metal particles comprise at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles.

10

[Claim 3]

The microorganism control agent according to claim 1, wherein the metal particles comprise at least one member selected from the group consisting of silver particles and copper particles.

15

[Claim 4]

The microorganism control agent according to any one of claims 1 to 3, wherein the platinum particles and the metal particles have a mean particle size of 0.1 to 1000 nm.

20

[Claim 5]

The microorganism control agent according to any one of claims 1 to 4, wherein the platinum particles and the metal particles are supported on a base material.

25

[Claim 6]

The microorganism control agent according to claim 5, wherein the platinum particles and the metal particles are supported in an amount of 0.01 to 20,000 ng/cm² on the base material.

30

[Claim 7]

The microorganism control agent according to claim 5 or

35

6, wherein the base material comprises a resin.

[Claim 8]

5 The microorganism control agent according to claim 7,
wherein the resin comprises at least one member selected from the
group consisting of polystyrene resins, vinyl chloride resins,
fluorine resins, ABS resins, PET resins, polycarbonate resins,
urea resins, olefin resins, and phenolic resins.

10 [Claim 9]

The microorganism control agent according to any one of
claims 5 to 8, wherein the base material is in the form of a
sheet, a plate, a block, a net, a perforated sheet, a grain, a
rod, a crushed product, or a dish.

15

[Claim 10]

An antimicrobial agent comprising the microorganism
control agent according to any one of claims 1 to 9.

20 [Claim 11]

An antialgal agent comprising the microorganism control
agent according to any one of claims 1 to 9.

[Claim 12]

25 A biofilm formation inhibitor comprising the
microorganism control agent according to any one of claims 1 to 9.

[Claim 13]

30 A method for controlling a microorganism comprising
imparting a microorganism control function to a target object by
using the microorganism control agent according to any one of
claims 1 to 9.

[Claim 14]

35 An antimicrobial method comprising imparting

antimicrobial properties to a target object by using the microorganism control agent according to any one of claims 1 to 9.

[Claim 15]

5 An antialgal method comprising imparting antialgal properties to a target object by using the microorganism control agent according to any one of claims 1 to 9.

[Claim 16]

10 A biofilm formation-inhibiting method comprising imparting a biofilm formation-inhibiting effect to a target object by using the microorganism control agent according to any one of claims 1 to 9.

[Claim 17]

15 A miticidal composition comprising platinum particles and metal particles other than platinum particles.

[Claim 18]

20 The miticidal composition according to claim 17, wherein the metal particles comprise at least one member selected from the group consisting of silver particles, copper particles, nickel particles, and zinc particles.

[Claim 19]

25 The miticidal composition according to claim 17 or 18, wherein the metal particles comprise at least one member selected from the group consisting of silver particles and copper particles.

[Claim 20]

30 The miticidal composition according to any one of claims 17 to 19, wherein the platinum particles and the metal particles have a mean particle size of 0.1 to 1000 nm.

35

[Claim 21]

An anti-mite member comprising the miticidal
composition according to any one of claims 17 to 20 applied
thereto, with the proviso that the anti-mite member is not a
5 beekeeping member.

[Claim 22]

An anti-mite method comprising imparting an anti-mite
function to a target object by using the miticidal composition
10 according to any one of claims 17 to 20, with the proviso that
the target object is not a beekeeping member.