

COATING COMPOUND OF HIGHLY FUNCTIONAL MATERIALS ON PLANTS BY ECOLOGICAL ENGINEERING TECHNOLOGY AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Taiwan Patent Application No. 110211320, filed on September 27, 2021, in the Taiwan Intellectual Property Office, the content of which are hereby incorporated by reference in their entirety for all purposes.

BACKGROUND OF THE INVENTION

1. Field of Invention

[0002] The invention relates to a plant surface modifying compound and a manufacturing method, and more particularly to a coating compound of highly functional materials on plants by ecological engineering technology and a manufacturing method thereof.

2. Description of the Related Art

[0003] The application of agricultural and horticultural technology has great potential in enhancing efficiency in agricultural production. However, the combination of plant surface modification technology is still in its initial stage in the horticulture industry and biotechnology industry. Although there are techniques for modifying the surface of plants, functional materials can be applied to plants in order to produce special functional properties for horticultural or agricultural applications. However, the current plant surface modification techniques mostly cover the plant surface, resulting in reduced plant surface function and even death, and the functional materials are incapable of staying on the surface of plants for a long period of time. If biological methods are used to modify or implant plant genes, although special functions can be achieved, problems such as genetic pollution are prone to occur.

SUMMARY OF THE INVENTION

[0004] In view of the above, an object of the invention is to provide a coating compound of highly functional materials on plants by ecological engineering technology and a manufacturing method thereof in order to solve the above-mentioned problems of the conventional techniques.

[0005] In order to achieve the foregoing object, the invention discloses a coating compound of highly functional materials on plants by ecological engineering technology at least comprising: a

covering with a functional material and a protector with a polymeric stabilizing material, the covering covers a surface of a plant organ of a plant, wherein the covering further comprises a stomata expansion material, such as fusicoccin, so that the functional material is absorbed into the plant through the stomata of the plant organ.

[0006] The coating compound of highly functional materials on plants by ecological engineering technology of the invention at least comprises: a covering with a functional material, the covering being used to cover a surface of a plant organ of a plant, wherein the covering comprises a stomata expansion material used to promote expansion of a plurality of stomata on the surface of the plant organ, so that the functional material is absorbed into the plant through the stomata of the plant organ, wherein the covering is a water-based material with a variable surface charge and with an adhesiveness of a biogel or a biodegradable gel; and a protector with a polymeric stabilizing material, the protector being used to cover a surface of the covering, wherein the protector is another water-based material with the biogel or the biodegradable gel, and the polymeric stabilizing material is used to stabilize and polymerize the biogel or the biodegradable gel of the protector and/or the covering, so as to increase a quantity and a density of the functional material absorbed by the plant organ.

[0007] Preferably, the plant organ is a leaf, a metamorphic leaf, a stem, an aerial root and/or a flower.

[0008] Preferably, the covering is sprayed, smeared or covered on the plant organ, and the protector is sprayed, smeared or covered on the covering.

[0009] Preferably, the stomata expansion material is fusicoccin, and the fusicoccin has a function of promoting expansion of the stomata of the surface of the plant organ.

[0010] Preferably, a content of the stomata expansion material in the covering is less than or equal to 70 μM .

[0011] Preferably, a particle size of the functional material is 2 μm ~ 5 nm.

[0012] Preferably, the functional material is a nanoscale material, a sub-nanoscale material or a micro-nanoscale material.

[0013] Preferably, a zeta potential formed by a surface charge of the functional material is +0 ~ +60 meV or -0 ~ -60 meV.

[0014] Preferably, the polymeric stabilizing material of the protector is alum ion that stabilizes the biogel or the biodegradable gel by polymerization.

[0015] Preferably, a weight percentage of the polymeric stabilizing material in the protector is less than or equal to 10%.

[0016] Preferably, the biogel is a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue, and the biodegradable gel is polyamide, polyvinylpyrrolidone and/or polyvinyl acetate.

[0017] Preferably, the water-based material of the covering is an acidic water-based substance, wherein the acidic water-based substance is a water-based solvent containing citric acid, succinic acid, tannic acid, salicylic acid, malic acid, ascorbic acid, gallic acid, hydrochloric acid, nitric acid and/or acetic acid.

[0018] Preferably, the water-based material of the covering is an alkaline water-based substance, wherein the alkaline water-based substance is a water-based solvent containing sodium bicarbonate, sodium carbonate, sodium hydroxide, potassium bicarbonate, potassium carbonate and/or potassium hydroxide.

[0019] Preferably, the functional material is needle-shaped or sea urchin-shaped gold nanoparticles.

[0020] In order to achieve the foregoing object, the invention further discloses a manufacturing method for a coating compound of highly functional materials on plants by ecological engineering technology at least comprising: manufacturing a covering with a functional material and manufacturing a protector with a polymeric stabilizing material, wherein the covering covers a surface of a plant organ of a plant, wherein the covering further comprises a stomata expansion material, such as fusicoccin, so that the functional material is absorbed into the plant through the stomata of the plant organ.

[0021] The manufacturing method for a coating compound of highly functional materials on plants by ecological engineering technology of the invention comprises following steps of: mixing a functional material suspension solvent containing a functional material into a water-based solvent using a biogel or a biodegradable gel to form a viscous functional material suspension solvent; mixing the viscous functional material suspension solvent into an acidic or alkaline water-based solvent to form an adhesive functional material suspension with a variable surface charge to be used as a covering with the functional material, the covering being used to cover a surface of a plant organ of a plant, wherein the functional material suspension solvent containing the functional material further comprises a stomata expansion material used to promote expansion of a plurality of stomata on the surface of the plant organ; and mixing a polymeric stabilizing material into another water-based solvent using a biogel or a biodegradable gel to form a protector, the protector being used to cover a surface of the covering, wherein the polymeric stabilizing material is used to stabilize and polymerize the biogel or the biodegradable gel of the protector and/or the covering, so as to increase a quantity and a density of the functional material absorbed by the plant organ.

[0022] Preferably, the biogel of the protector and/or the covering is a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue, and the biodegradable gel is polyamide, polyvinylpyrrolidone and/or polyvinyl acetate.

[0023] Preferably, the stomata expansion material is fusicoccin, and the polymeric stabilizing material is alum ion.

[0024] Preferably, the covering is sprayed, smeared or covered on the plant organ, and the protector is sprayed, smeared or covered on the covering.

[0025] Preferably, a particle size of the functional material is $2\ \mu\text{m} \sim 5\ \text{nm}$.

[0026] 2 Preferably, a zeta potential formed by a surface charge of the functional material is $+0 \sim +60\ \text{meV}$ or $-0 \sim -60\ \text{meV}$.

[0027] Based on the above, the coating compound of highly functional materials on plants by ecological engineering technology and the manufacturing method thereof of the invention are capable of achieving special functions without modifying or implanting plant genes through a brand-new plant surface function modification technology.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] FIG. 1 is a schematic diagram of a coating compound of highly functional materials on plants by ecological engineering technology of the invention, wherein a protector has not been covered on a covering.

[0029] FIG. 2 is a schematic diagram of the coating compound of highly functional materials on plants by ecological engineering technology of the invention, wherein the protector has been covered on the covering.

[0030] FIG. 3 is a schematic diagram of the coating compound of highly functional materials on plants by ecological engineering technology of the invention applied to a surface of a plant organ of a plant.

DETAILED DESCRIPTION OF THE INVENTION

[0031] In order to understand the technical features, content and advantages of the invention and its achievable efficacies, the invention is described below in detail in conjunction with the figures, and in the form of embodiments, the figures used herein are only for a purpose of schematically supplementing the specification, and may not be true proportions and precise configurations after implementation of the invention; and therefore, relationship between the proportions and configurations of the attached figures should not be interpreted to limit the scope of the claims of the

invention in actual implementation. In addition, in order to facilitate understanding, the same elements in the following embodiments are indicated by the same referenced numbers. And the size and proportions of the components shown in the drawings are for the purpose of explaining the components and their structures only and are not intending to be limiting.

[0032] Unless otherwise noted, all terms used in the whole descriptions and claims shall have their common meaning in the related field in the descriptions disclosed herein and in other special descriptions. Some terms used to describe in the present invention will be defined below or in other parts of the descriptions as an extra guidance for those skilled in the art to understand the descriptions of the present invention.

[0033] Moreover, the terms “comprising”, “including”, “having”, and “with” used in the descriptions are all open terms and have the meaning of “comprising but not limited to”.

[0034] Please refer to FIGS. 1 to 3. FIGS. 1 and 2 are respectively schematic diagrams of a coating compound of highly functional materials on plants by ecological engineering technology of the invention; and FIG. 3 is a schematic diagram of the coating compound of highly functional materials on plants by ecological engineering technology of the invention applied to a surface of a plant organ of a plant. Wherein a plant organ 300 in FIG. 3(A) is a leaf, the plant organ 300 in FIG. 3(B) is a stem, and the plant organ 300 in FIG. 3(C) is a flower. A coating compound 1 of highly functional materials on plants by ecological engineering technology of the invention comprises a covering 100 with a functional material 10, and a protector 200 with a polymeric stabilizing material 20. The plant organ 300 of the plant is, for example, a leaf, a metamorphic leaf, a stem, an aerial root and/or a flower. The coating compound 1, the covering 100, and the protector 200 of the invention are not limited to various structural forms, they can be liquid, gel or layered, etc., as long as they can cover the plant organ 300 of the plant, they can be applied to the invention. FIGS. 1 and 2 use the covering 100 and the protector 200 disposing in a layered structure as an example. In the case of the form of a layered structure, it can be optionally maintained in a layered form or crushed into debris or powder to cover the plant organ 300. In addition, the covering 100 and the protector 200 preferably have transparency or light transmittance, if they have light transmittance, they are preferably capable of maintaining an original color of the plant organ 300. Sizes of the covering 100 and the protection 200, such as length, width and thickness, or amount, are not particularly limited as long as they can cover the plant organ 300 of the plant, they can be applied to the invention. Moreover, properties such as density, hardness, or flexibility of the covering 100 and the protector 200 are also not particularly limited, as long as they can cover the plant organ 300 of the plant, they can be applied to the invention.

[0035] In the invention, the covering 100 can be applied to cover a surface 302 of the plant organ 300 of the plant, for example, by spraying, smearing, or covering. Wherein the covering 100 further comprises a stomata expansion material, such as fusicoccin. A content of fusicoccin in the covering 100 is approximately less than or equal to 70 μM . Fusicoccin has a function of promoting expansion of stomata of the surface 302 of the plant organ 300, causing the stomata to open smoothly, which helps the functional material 10 to be absorbed into the plant through the stomata of the plant organ 300. The covering 100 is a water-based material with a variable surface charge and with an adhesiveness of a biogel or a biodegradable gel. Wherein the water-based material referred to in the invention is, for example, a water-based solvent, and can be, for example, a water-based liquid or aerogel. The biogel is, for example, a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue with main ingredients processed from animal skin, and collagen in the bones of mostly deer, cow, rabbit, and pig. The biodegradable gel is, for example, polyamide, polyvinylpyrrolidone and/or polyvinyl acetate. A weight percentage of the biogel or the biodegradable gel in the covering 100 is preferably approximately less than or equal to 40%. The invention adopts the biogel or the biodegradable gel, which can be degraded by itself. After the functional material 10 is absorbed into the plant, the biogel or the biodegradable gel covering the surface 302 of the plant organ 300 can be decomposed or degraded to avoid hindering the growth functions of the plant and damaging the plant. Wherein the water-based material of the covering 100 is, for example, an acidic water-based substance or an alkaline water-based substance, wherein the acidic water-based substance is a water-based solvent containing citric acid, succinic acid, tannic acid, salicylic acid, malic acid, ascorbic acid, gallic acid, hydrochloric acid, nitric acid and/or acetic acid; the alkaline water-based substance is a water-based solvent containing sodium bicarbonate, sodium carbonate, sodium hydroxide, potassium bicarbonate, potassium carbonate and/or potassium hydroxide. Thereby, the covering 100 of the invention is a water-based material with a variable surface charge and with an adhesiveness of the biogel or the biodegradable gel.

[0036] The functional material 10 of the invention is not limited to a specific functional material, and the functional material 10 can be any material with various functions, so as to perform various functions, for example, any material capable of making the plant irradiate without poisoning the plant or making the plant to be provided with more properties can be applied to be used as the functional material 10. For example, if the functional material 10 is needle-shaped or sea urchin-shaped gold nanoparticles, the functional material 10 can be used as an excitation light source, and the plant can emit light after being irradiated with ultraviolet rays. A particle size of the functional material 10 of the invention is much smaller than a pore diameter of the stomata of the plant organ

300. The functional material 10 is a nanoscale material, a sub-nanoscale material or a micro-nanoscale material. A particle size of the functional material 10 is, for example, $2\ \mu\text{m} \sim 5\ \text{nm}$. A zeta potential formed by the surface charge of the functional material 10 is $+0 \sim +60\ \text{meV}$ or $-0 \sim -60\ \text{meV}$. The zeta potential formed by the surface charge will affect a depth of the functional material 10 entering the plant organ 300. A surface of the functional material 10 with a zeta potential of $+0 \sim +60\ \text{meV}$ will help the functional material 10 to enter the palisade cells and even into the chloroplast of the plant. If a zeta potential of the surface of the functional material 10 is $-0 \sim -60\ \text{meV}$, it will help the functional material 10 stay on the plant epidermis to protect the cells. In contrast, plant coating materials in the prior art are mostly only protective agents covering the surface of plants.

[0037] In the invention, the protector 200 can be applied to cover a surface of the covering 100, for example, by spraying, smearing, or covering, wherein the protector 200 has the polymeric stabilizing material 20 used to stabilize and polymerize the biogel or the biodegradable gel of the protector 200 and/or the covering 100 in order to increase a quantity and a density of the functional material 10 absorbed by the plant organ 300. The polymeric stabilizing material 20 of the protector 200 is, for example, alum ion that stabilizes the biogel or the biodegradable gel by polymerization. A weight percentage of the polymeric stabilizing material 20 in the protector 200 is preferably approximately less than or equal to 10%. Wherein the protector 200 is another water-based material with the biogel or the biodegradable gel, wherein a weight percentage of the biogel or the biodegradable gel in the protector 200 is preferably approximately less than or equal to 20%. Wherein the biogel is a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue with main ingredients processed from animal skin, and collagen in the bones of mostly deer, cow, rabbit, and pig; the biodegradable gel is polyamide, polyvinylpyrrolidone and/or polyvinyl acetate.

[0038] Wherein another water-based material of the protector 200 is, for example, an acidic water-based substance or an alkaline water-based substance, wherein the acidic water-based substance is a water-based solvent containing citric acid, succinic acid, tannic acid, salicylic acid, malic acid, ascorbic acid, gallic acid, hydrochloric acid, nitric acid and/or acetic acid; the alkaline water-based substance is a water-based solvent containing sodium bicarbonate, sodium carbonate, sodium hydroxide, potassium bicarbonate, potassium carbonate and/or potassium hydroxide.

[0039] In one exemplary aspect, taking the covering 100 and the protector 200 in a liquid or gel form or even a layered form as an example, a manufacturing method for the covering 100 and the protector 200 of the coating compound 1 of the invention is as follows. Taking the production of the covering 100 as an example, firstly, mixing a functional material suspension solvent containing the

functional material 10 into a water-based solvent using a biogel or a biodegradable gel to form a viscous functional material suspension solvent, wherein the functional material suspension solvent containing the functional material 10 further comprises a stomata expansion material, such as fusicoccin less than or equal to 70 μM , used to promote expansion of a plurality of stomata on the surface 302 of the plant organ 300; and then, mixing the viscous functional material suspension solvent into an acidic or alkaline water-based solvent to form an adhesive functional material suspension with a variable surface charge, which is the functional material suspension solvent to be applied to the plant organ 300 so that the plant organ 300 is covered with the covering 100 of the functional material 10. Taking the production of the protector 200 as an example, mixing the polymeric stabilizing material 20, such as alum ion into a water-based solvent using a biogel or a biodegradable gel to form the protector 200, which can be used to cover the surface of the covering 100 as described above.

[0040] In summary, in the coating compound of highly functional materials on plants by ecological engineering technology of the invention, with the brand-new plant surface function modification technology, the plant surface is capable of effectively producing special physical or chemical functions through the modification technology, and after modification, the plant can still grow naturally, and therefore the invention can be widely applied to natural plants to be capable of effectively advancing technology used in horticultural and agricultural functional plants. In addition, using the plant surface modification technology, the plant surface functions still exist and can coexist. The functional material is capable of maintaining its functions on the plant surface until the plant organ naturally undergoes apoptosis. Through the plant surface modification technology, special functions can be achieved without modifying or implanting plant genes.

[0041] Note that the specification relating to the above embodiments should be construed as exemplary rather than as limitative of the present invention, with many variations and modifications being readily attainable by a person of average skill in the art without departing from the spirit or scope thereof as defined by the appended claims and their legal equivalents.

WHAT IS CLAIMED IS:

1. A coating compound of highly functional materials on plants by ecological engineering technology at least comprising:

a covering with a functional material, the covering being used to cover a surface of a plant organ of a plant, wherein the covering comprises a stomata expansion material used to promote expansion of a plurality of stomata on the surface of the plant organ, so that the functional material is absorbed into the plant through the stomata of the plant organ, wherein the covering is a water-based material with a variable surface charge and with an adhesiveness of a biogel or a biodegradable gel; and

a protector with a polymeric stabilizing material, the protector being used to cover a surface of the covering, wherein the protector is another water-based material with the biogel or the biodegradable gel, and the polymeric stabilizing material is used to stabilize and polymerize the biogel or the biodegradable gel of the protector and/or the covering, so as to increase a quantity and a density of the functional material absorbed by the plant organ.

2. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the plant organ is a leaf, a metamorphic leaf, a stem, an aerial root and/or a flower.
3. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the covering is sprayed, smeared or covered on the plant organ, and the protector is sprayed, smeared or covered on the covering.
4. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the stomata expansion material is fusicoccin, and the fusicoccin has a function of promoting expansion of the stomata of the surface of the plant organ.
5. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein a content of the stomata expansion material in the covering is less than or equal to 70 μM .
6. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein a particle size of the functional material is 2 μm ~ 5 nm.
7. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the functional material is a nanoscale material, a sub-

nanoscale material or a micro-nanoscale material.

8. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein a zeta potential formed by a surface charge of the functional material is $+0 \sim +60$ meV or $-0 \sim -60$ meV.
9. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the polymeric stabilizing material of the protector is alum ion that stabilizes the biogel or the biodegradable gel by polymerization.
10. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein a weight percentage of the polymeric stabilizing material in the protector is less than or equal to 10%.
11. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the biogel is a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue, and the biodegradable gel is polyamide, polyvinylpyrrolidone and/or polyvinyl acetate.
12. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the water-based material of the covering is an acidic water-based substance, wherein the acidic water-based substance is a water-based solvent containing citric acid, succinic acid, tannic acid, salicylic acid, malic acid, ascorbic acid, gallic acid, hydrochloric acid, nitric acid and/or acetic acid.
13. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the water-based material of the covering is an alkaline water-based substance, wherein the alkaline water-based substance is a water-based solvent containing sodium bicarbonate, sodium carbonate, sodium hydroxide, potassium bicarbonate, potassium carbonate and/or potassium hydroxide.
14. The coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 1, wherein the functional material is needle-shaped or sea urchin-shaped gold nanoparticles.
15. A manufacturing method for a coating compound of highly functional materials on plants by ecological engineering technology comprising following steps of:
 - mixing a functional material suspension solvent containing a functional material into a water-based solvent using a biogel or a biodegradable gel to form a viscous functional material suspension solvent;
 - mixing the viscous functional material suspension solvent into an acidic or alkaline water-

based solvent to form an adhesive functional material suspension with a variable surface charge to be used as a covering with the functional material, the covering being used to cover a surface of a plant organ of a plant, wherein the functional material suspension solvent containing the functional material further comprises a stomata expansion material used to promote expansion of a plurality of stomata on the surface of the plant organ; and

mixing a polymeric stabilizing material into another water-based solvent using a biogel or a biodegradable gel to form a protector, the protector being used to cover a surface of the covering, wherein the polymeric stabilizing material is used to stabilize and polymerize the biogel or the biodegradable gel of the protector and/or the covering, so as to increase a quantity and a density of the functional material absorbed by the plant organ.

16. The manufacturing method for the coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 15, wherein the biogel of the protector and/or the covering is a soft deer glue, a hard deer glue, an isinglass, a cow glue, a rabbit glue, a granular glue and/or a sanzenbon glue, and the biodegradable gel is polyamide, polyvinylpyrrolidone and/or polyvinyl acetate.
17. The manufacturing method for the coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 15, wherein the stomata expansion material is fusicoccin, and the polymeric stabilizing material is alum ion.
18. The manufacturing method for the coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 15, wherein the covering is sprayed, smeared or covered on the plant organ, and the protector is sprayed, smeared or covered on the covering.
19. The manufacturing method for the coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 15, wherein a particle size of the functional material is $2\text{ }\mu\text{m} \sim 5\text{ nm}$.
20. The manufacturing method for the coating compound of highly functional materials on plants by ecological engineering technology as claimed in claim 15, wherein a zeta potential formed by a surface charge of the functional material is $+0 \sim +60\text{ meV}$ or $-0 \sim -60\text{ meV}$.