Disclosed herein is a method for producing a complex of a mesh and a porous ultra-thin polymer film, comprising a step of picking up a free-standing porous ultra-thin polymer film produced by the above method with the mesh to produce a complex of the porous ultra-thin polymer film and the mesh.

Disclosed herein is a method for producing a complex of a mesh and a porous ultra-thin polymer film, comprising a step of picking up a free-standing porous ultra-thin polymer film produced by the above method with the mesh to produce a complex of the porous ultra-thin polymer film and the mesh.

Disclosed herein is a complex of a porous ultra-thin polymer film and a nonporous ultra-thin polymer film, comprising one or more of the above porous ultra-thin polymer films and one or more nonporous ultra-thin polymer films.

Disclosed herein is a complex of a porous ultra-thin polymer film and a nonporous ultra-thin polymer film, comprising one or more of the above porous ultra-thin polymer films and one or more nonporous ultra-thin polymer films.

In addition, embodiments of the present invention provide the following ultra-thin polymer film that has been phase-separated into a sea-island structure.

According to an aspect of the present invention, there is provided a complex comprising a phase-separated with a sea-island structure , on a water-soluble sacrificial film over a substrate, obtained by: dissolving two types of mutually-immiscible polymers, namely, a first polymer which forms island parts and a second polymer which forms parts other than the island parts, in a solvent in an arbitrary proportion to obtain a solution; applying the resulting solution onto the sacrificial film over the substrate; and then removing the solvent from the solution applied onto the sacrificial film over the substrate to form the ultra-thin polymer film, wherein the island parts of the sea-island structure have a size in a range that is larger than 1 μm and smaller or equal to 25 μm, and are present on the surface at a density of 5×10^{-3} islands/μm^2-50 islands/μm^2, wherein the film thickness of the ultra-thin polymer film is 10 nm-1000 nm, and wherein the ratio (w/w) of polymer 1:polymer 2 is 1:9-3:7 or the ratio (w/w) of polymer 2:polymer 1 is 1:9-3:7.

Here, the "first polymer" refers to a polymer that forms the island parts upon phase separation into the sea-island structure while the "second polymer" refers to a polymer that forms parts other than the island parts (sea parts).

According to another aspect, there is provided a complex comprising a phase-separated with a sea-island structure, between a water-soluble support film and a substrate, obtained by: dissolving two types of mutually-

immiscible polymers, namely, a first polymer which forms island parts and a second polymer which forms parts other than the island parts, in a solvent in an arbitrary proportion to obtain a solution; applying the resulting solution onto the substrate; removing the solvent from the solution applied onto the substrate to form the ultra-thin polymer film; and then providing the water soluble support film over the ultra-thin polymer film, wherein the island parts of the sea-island structure have a size in a range that is larger than 1 μm and smaller or equal to 25 μm, and are present on the surface at a density of 5 x 10^{-3} islands/μm^2-50 islands/μm^2, wherein the film thickness of the ultra-thin polymer film is 10 nm-1000 nm, and wherein the ratio (w/w) of polymer 1:polymer 2 is 1:9-3:7 or the ratio (w/w) of polymer 2:polymer 1 is 1:9-3:7.

CLAIMS

1. A complex comprising a phase-separated layer with a sea-island structure, on a water-soluble sacrificial film over a substrate, obtained by:

dissolving two types of mutually-immiscible polymers, namely, a first polymer which forms island parts and a second polymer which forms parts other than the island parts, in a solvent in an arbitrary proportion to obtain a solution;

applying the resulting solution onto the sacrificial film over the substrate; and

then removing the solvent from the solution applied onto the sacrificial film over the substrate to form the ultra-thin polymer film,

wherein the island parts of the sea-island structure have a size in a range that is larger than 1 μm and smaller or equal to 25 μm, and are present on the surface at a density of 5×10^{-3} islands/μm^2-50 islands/μm^2,

wherein the film thickness of the ultra-thin polymer film is 10 nm-1000 nm, and

wherein the ratio (w/w) of polymer 1:polymer 2 is 1:9-3:7 or the ratio (w/w) of polymer 2:polymer 1 is 1:9-3:7.

2. The ultra-thin polymer film according to Claim 2, wherein the size of the island parts of the sea-island structure is in a range that is smaller or equal to 15 μm.

3. The ultra-thin polymer film according to Claim 1 or 2, wherein the combination of the first and second polymers is selected from the group below:

(i) first polymer: polystyrene, and second polymer: polymethyl methacrylate;

(ii) first polymer: polystyrene, and second polymer: poly-D/L-lactic acid;

(iii) first polymer: polymethyl methacrylate, and second polymer: polystyrene;

(iv) first polymer: polyethylene glycol, and second polymer: polystyrene;

(v) first polymer: polyvinylpyrrolidone, and second polymer: polystyrene; and

(vi) first polymer: poly-D/L-lactic acid, and second polymer: polystyrene.

4. A complex comprising a phase-separated sea-island structure, between a water-soluble support film and a substrate, obtained by:

dissolving two types of mutually-immiscible polymers, namely, a first polymer which forms island parts and a second polymer which forms parts other than the island parts, in a solvent in an arbitrary proportion to obtain a solution;

applying the resulting solution onto the substrate;

removing the solvent from the solution applied onto the substrate to form the ultra-thin polymer film; and then

providing the water soluble support film over the ultra-thin polymer film,

wherein the island parts of the sea-island structure have a size in a range that is larger than 1 μm and smaller or equal to 25 μm, and are present on the surface at a density of 5×10^{-3} islands/μm^2-50 islands/μm^2,

wherein the film thickness of the ultra-thin polymer film is 10 nm-1000 nm, and

wherein the ratio (w/w) of polymer 1:polymer 2 is 1:9-3:7 or the ratio (w/w) of polymer 2:polymer 1 is 1:9-3:7.

5. The ultra-thin polymer film according to Claim 4, wherein the size of the island parts of the sea-island structure is in a range that is smaller or equal to 15 μm.

6. The ultra-thin polymer film according to Claim 4 or 5, wherein the combination of the first and second polymers is selected from the group below:

(i) first polymer: polystyrene, and second polymer: polymethyl methacrylate;

(ii) first polymer: polystyrene, and second polymer: poly-D/L-lactic acid;

(iii) first polymer: polymethyl methacrylate, and second polymer: polystyrene;

(iv) first polymer: polyethylene glycol, and second polymer: polystyrene;

(v) first polymer: polyvinylpyrrolidone, and second polymer: polystyrene; and

(vi) first polymer: poly-D/L-lactic acid, and second polymer: polystyrene.