wherein the porous polymer film is contained within the casing with:

(i) the two or more independent porous polymer films being aggregated;

(ii) the porous polymer film being folded up;

(iii) the porous polymer film being wound into a roll-like shape; and/or

(iv) the porous polymer film being tied together into a rope-like shape.

[23] The cell culture module according to [22], wherein a diameter of the medium flow inlet is larger than a diameter of a cell, and smaller than a diameter at which the porous polymer films flow out.

[24] The cell culture module according to [22] or [23], wherein the casing has a mesh-like structure.

[25] The cell culture module according to any one of [22] to [24], wherein the casing consists of an inflexible material.

[26] The cell culture module according to any one of [22] to [25], wherein the porous polymer film has a plurality of pores having an average pore diameter of 0.01 to 100 μm.

[27] The cell culture module according to any one of [22] to [26], wherein an average pore diameter of the surface layer A is 0.01 to 50 μm.

[28] The cell culture module according to any one of [22] to [27], wherein an average pore diameter of the surface layer B is 20 to 100 μm.

[29] The cell culture module according to any one of [22] to [28], wherein a total film thickness of the porous polymer film is 5 to 500 μm.

[30] The cell culture module according to any one of [22] to [29], wherein the porous polymer film is a porous polyimide film.

[31] The cell culture module according to [30], wherein the porous polyimide film is a porous polyimide film comprising a polyimide derived from tetracarboxylic dianhydride and diamine.

[32] The cell culture module according to [30] or [31], wherein the porous polyimide film is a colored porous polyimide film that is obtained by molding a polyamic acid solution composition comprising a polyamic acid solution derived from tetracarboxylic dianhydride and diamine, and a coloring precursor, and subsequently heat-treating the resultant composition at 250°C or higher.

[33] The cell culture module according to any one of [22] to [29], wherein the porous polymer film is a porous polyethersulfone film.

[0012a]

A method for culturing a cell, the method comprising the steps of:

(1) applying a cell culture module to a first medium containing a cell;

(2) maintaining a temperature at which the cell can be cultured, and adsorbing the cell to the cell culture module, and

(3) culturing the cell culture module having the cell adsorbed, in a second medium in a

culture vessel which is used for suspension culture;

wherein the cell culture module comprising:

a porous polymer film; and

a casing having two or more medium flow inlets, the casing containing the porous polymer film,

wherein the porous polymer film is a three-layer structure porous polymer film having a surface layer A and a surface layer B, the surface layers having a plurality of pores, and a macrovoid layer sandwiched between the surface layers A and B;

wherein an average pore diameter of the pores present in the surface layer A is smaller than an average pore diameter of the pores present in the surface layer B;

wherein the macrovoid layer has a partition wall bonded to the surface layers A and B, and a plurality of macrovoids surrounded by such a partition wall and the surface layers A and B;

wherein the pores in the surface layers A and B communicate with the macrovoid; and

wherein in the casing,

(i) the two or more independent porous polymer films being aggregated;

(ii) the porous polymer films being folded up;

(iii) the porous polymer films being wound into a roll-like shape; and/or

(iv) the porous polymer films being contained, being tied together into a rope-like shape;

wherein the porous polymer film is contained in the casing so that the porous polymer film is continually prevented from waving by fluid,

wherein no surfactant is contained in the second medium

[0012b]

A method for killing a cell in a cell suspension, the method comprising the steps of:

(1) applying a porous polymer film to a first medium containing the cell;

(2) maintaining a temperature at which the cell can be cultured, and allowing the cell to be adsorbed onto the porous polymer film; and

(3) allowing the porous polymer film having the cell adsorbed therein to be floated in a second medium in a culture vessel which is used for suspension culture, adding air in the culture vessel, and culturing the porous polymer film by continuously changing the morphology thereof;

wherein the porous polymer film is a three-layer structure porous polymer film having a surface layer A and a surface layer B, the surface layers having a plurality of pores, and a macrovoid layer sandwiched between the surface layers A and B;

wherein an average pore diameter of the pores present in the surface layer A is smaller than an average pore diameter of the pores present in the surface layer B;

wherein the macrovoid layer has a partition wall bonded to the surface layers A and B, and a plurality of macrovoids surrounded by such a partition wall and the surface layers A and B;

wherein the pores in the surface layers A and B communicate with the macrovoid; and

wherein no surfactant is contained in the second medium.

[ADVANTAGEOUS EFFECTS OF INVENTION]

[0013]

According to the present invention, the suspended cells can be efficiently adsorbed, and can be stably cultured using a conventional suspension culture vessel. In addition, the present

Claims

[Claim 1]

A method for culturing a cell, the method comprising the steps of:

(1) applying a cell culture module to a first medium containing a cell;

(2) maintaining a temperature at which the cell can be cultured, and adsorbing the cell to the cell culture module, and

(3) culturing the cell culture module having the cell adsorbed, in a second medium in a culture vessel which is used for suspension culture;

wherein the cell culture module comprising:

a porous polymer film; and

a casing having two or more medium flow inlets, the casing containing the porous polymer film,

wherein the porous polymer film is a three-layer structure porous polymer film having a surface layer A and a surface layer B, the surface layers having a plurality of pores, and a macrovoid layer sandwiched between the surface layers A and B;

wherein an average pore diameter of the pores present in the surface layer A is smaller than an average pore diameter of the pores present in the surface layer B;

wherein the macrovoid layer has a partition wall bonded to the surface layers A and B, and a plurality of macrovoids surrounded by such a partition wall and the surface layers A and B;

wherein the pores in the surface layers A and B communicate with the macrovoid; and

wherein in the casing,

(i) the two or more independent porous polymer films being aggregated;

(ii) the porous polymer films being folded up;

(iii) the porous polymer films being wound into a roll-like shape; and/or

(iv) the porous polymer films being contained, being tied

together into a rope-like shape;

wherein the porous polymer film is contained in the casing so that the porous polymer film is continually prevented from waving by fluid,

wherein no surfactant is contained in the second medium.

[Claim 2]

The method according to claim 1, wherein the diameter of the medium flow inlet is larger than the diameter of the cell, and smaller than the diameter at which the porous polymer films flow out.

[Claim 3]

The method according to claim 1 or 2, wherein the casing has a mesh-like structure.

[Claim 4]

The method according to any one of claims 1 to 3, wherein the casing consists of an inflexible material.

[Claim 5]

The method according to any one of claims 1 to 4, wherein the step (2) is a step, wherein the cell is adsorbed to the porous polymer film while standing, shaking and/or stirring.

[Claim 6]

The method according to any one of claims 1 to 5, wherein the step (3) is carried out in a system in which the second medium is continuously or intermittently supplied into the culture vessel.

[Claim 7]

The method according to any one of claims 1 to 6, wherein in the culture in the step (3), a part of the porous polymer film is not in contact with the liquid phase of the second medium.

[Claim 8]

The method according to any one of claims 1 to 7, wherein in the culture in the step (3), the culture vessel is a flexible bag type culture vessel.

[Claim 9]

The method according to any one of claims 1 to 7, wherein in the culture in the step (3), the culture vessel is an agitating culture vessel.

[Claim 10]

The method according to any one of claims 1 to 9, wherein the porous polymer film has a plurality of pores having an average pore diameter of 0.01 to 100 μm.

[Claim 11]

The method according to any one of claims 1 to 10, wherein an average pore diameter of the surface layer A is 0.01 to 50 μm.

[Claim 12]

The method according to any one of claims 1 to 11, wherein an average pore diameter of the surface layer B is 20 to 100 μm.

[Claim 13]

The method according to any one of claims 1 to 12, wherein a total film thickness of the porous polymer film is 5 to 500 μm.

[Claim 14]

The method according to any one of claims 1 to 13, wherein the porous polymer film is a porous polyimide film.

[Claim 15]

The method according to claim 14, wherein the porous polyimide film is a porous polyimide film comprising a polyimide derived from tetracarboxylic dianhydride and diamine.

[Claim 16]

The method according to claim 14 or 15, wherein the porous polyimide film is a colored porous polyimide film that is obtained by molding a polyamic acid solution composition comprising a polyamic acid solution derived from tetracarboxylic dianhydride and diamine, and a coloring precursor, and subsequently heat-treating the resultant composition at 250°C or higher.

[Claim 17]

The method according to any one of claims 1 to 13, wherein the porous polymer film is a porous polyethersulfone film.

[Claim 18]

The method according to any one of claims 1 to 17, wherein the cell is an adherent cell.

[Claim 19]

The method according to any one of claims 1 to 18, wherein the cell is selected from the group consisting of CHO cells, Vero cells, MDCK cells, and fibroblasts.

[Claim 20]

A method for killing a cell in a cell suspension, the method comprising the steps of:

(1) applying a porous polymer film to a first medium containing the cell;

(2) maintaining a temperature at which the cell can be cultured, and allowing the cell to be adsorbed onto the porous polymer film; and

(3) allowing the porous polymer film having the cell adsorbed therein to be floated in a second medium in a culture vessel which is used for suspension culture, adding air in the culture vessel, and culturing the porous polymer film by continuously changing the morphology thereof;

wherein the porous polymer film is a three-layer structure porous polymer film having a surface layer A and a surface layer B, the surface layers having a plurality of pores, and a macrovoid layer sandwiched between the surface layers A and B;

wherein an average pore diameter of the pores present in the surface layer A is smaller than an average pore diameter of the pores present in the surface layer B;

wherein the macrovoid layer has a partition wall bonded to the surface layers A and B, and a plurality of macrovoids surrounded by such a partition wall and the surface layers A and B;

wherein the pores in the surface layers A and B communicate with the macrovoid; and

wherein no surfactant is contained in the second medium.