Claims

1. A particle capture filtration film with communication pores formed by anode oxidization of an aluminum material, comprising:

a small pore diameter part having communication pores formed to open to one surface of the filtration film;

an intermediate pore part having communication pores to which the communication pores of the small pore diameter part are connected and have a pore diameter of 10 to 100 nm, and that have a larger diameter than a diameter of the communication pores in the small pore diameter part; and

a large pore diameter part having communication pores to which the communication pores of the intermediate pore part are connected and which have a larger diameter than a diameter of the communication pores in the intermediate pore part and are formed to open to the other surface of the filtration film, wherein

the small pore diameter part is provided with the communication pores formed from the one surface of the filtration film to a position of at least 400 nm, the communication pores having an average pore diameter of 4 to 20 nm,

a total film thickness of the filtration film is equal to or less than 50 μm,

the communication pores of the large pore diameter part have a large pore diameter part narrow portion in the intermediate pore part side, and

an opening rate of the communication pores of the small pore diameter part on the one surface of the particle capture filtration film is 15 to 50%.

2. The particle capture filtration film according to claim 1, wherein

a pore diameter of an opening side of the large pore diameter part is 30 to 300 nm.

3. The particle capture filtration film according to claim 2, wherein

a pore diameter of a large pore diameter part narrow portion of the communication pores of the large pore diameter part is 20 to 200 nm.

4. The particle capture filtration film according to any of claims 1 to 3, wherein

a plurality of the communication pores of the small pore diameter part are connected to the communication pores of the intermediate pore part, and a plurality of the communication pores of the intermediate pore part are connected to the communication pores of the large pore diameter part.

~~5. The particle capture filtration film according to any of claims 1 to 4, wherein~~

~~an opening rate of the communication pores of the small pore diameter part on one surface of the filtration film is 10 to 50%.~~

5~~6~~. The particle capture filtration film according to any of claims 1 to 4~~5~~, wherein

a total film thickness of the whole particle capture filtration film is 15 to 50 μm.

6~~7~~. A manufacturing method of a particle capture filtration film, comprising:

a first anode oxidization process (A) of anodizing an aluminum material to form a progenitor communication pore of a communication pore for a large pore diameter part on the aluminum material and obtain an anode oxidization aluminum material (1A);

pore diameter enlarging treatment of immersing the anode oxidization aluminum material (1A) in any aqueous solution of an oxalic acid aqueous solution, a chromic acid aqueous solution, a phosphoric acid aqueous solution, a sulfuric acid aqueous solution, a mixed acid aqueous solution of them or an alkaline aqueous solution to enlarge a diameter of the progenitor communication pore and form the communication pore for the large pore diameter part;

a second anode oxidization process (A) of anodizing the anode oxidization aluminum material (1A) subjected to pore diameter enlarging treatment to form a large pore diameter part narrow portion smaller in diameter than the communication pore for the large pore diameter part on an end of the communication pore for the large pore diameter part in the anode oxidization aluminum material (1A) subjected to the pore diameter enlarging treatment and obtain an anode oxidization aluminum material (2);

a third anode oxidization process of anodizing the anode oxidization aluminum material (2) to form a communication pore for an intermediate pore part that is connected to the large pore diameter part narrow portion of the communication pore for the large pore diameter part and is smaller in diameter than the large pore diameter part narrow portion of the communication pore for the large pore diameter part on the anode oxidization aluminum material (2) and obtain an anode oxidization aluminum material (3);

a fourth anode oxidization process of anodizing the anode oxidization aluminum material (3) to form a communication pore having a pore diameter of 10 to 100 nm, for a small pore diameter part which is connected to the communication pore for the intermediate pore part and is smaller in diameter than the communication pore for the intermediate pore part, and obtain an anode oxidization aluminum material (4), the communication pores of the

small pore diameter part on one surface of the particle capture filtration film, having an opening rate of 15 to 50%;

a separation and etching process of separating an anodized section from the anode oxidization aluminum material (4) and next, executing etching treatment to the separated section to obtain an anodized section; and

a calcination process of firing the anodized section at a temperature of 800 to 1200℃ to obtain a particle capture filtration film, wherein

in the fourth anode oxidization process, the communication pores having an average pore diameter of 4 to 20 nm are formed in a range of 400 nm or more in a thickness direction, and

from the first anode oxidization process to the fourth anode oxidization process, a total thickness of sections on which the communication pores are formed by the anode oxidization is equal to or less than 50 μm.

7~~8~~. A manufacturing method of a particle capture filtration film, comprising:

a first anode oxidization process (B) of anodizing an aluminum material to form a communication pore for a large pore diameter part on the aluminum material and obtain an anode oxidization aluminum material (1B);

a second anode oxidization process (B) of anodizing the anode oxidization aluminum material (1B) to form a

large pore diameter part narrow portion smaller in diameter than the communication pore for the large pore diameter part on an end of the communication pore for the large pore diameter part in the anode oxidization aluminum material (1B) and obtain an anode oxidization aluminum material (2);

a third anode oxidization process of anodizing the anode oxidization aluminum material (2) to form a communication pore for an intermediate pore part that is connected to the large pore diameter part narrow portion of the communication pore for the large pore diameter part and is smaller in diameter than the large pore diameter part narrow portion of the communication pore for the large pore diameter part on the anode oxidization aluminum material (2) and obtain an anode oxidization aluminum material (3);

a fourth anode oxidization process of anodizing the anode oxidization aluminum material (3) to form a communication pore having a pore diameter of 10 to 100 nm, for a small pore diameter part that is connected to the communication pore for the intermediate pore part and is smaller in diameter than the communication pore for the intermediate pore part and obtain an anode oxidization aluminum material (4), the communication pores of the small pore diameter part on one surface of the particle capture filtration film, having an opening rate of 15 to 50%;

a separation and etching process of separating an anodized section from the anode oxidization aluminum material (4) and next, executing etching treatment to the separated section to obtain an anodized section; and

a calcination process of firing the anodized section at a temperature of 800 to 1200℃ to obtain a particle capture filtration film, wherein

in the fourth anode oxidization process, the communication pores having an average pore diameter of 4 to 20 nm are formed in a range of 400 nm or more in a thickness direction, and

from the first anode oxidization process to the fourth anode oxidization process, a total thickness of sections on which the communication pores are formed by the anode oxidization is equal to or less than 50 μm.

8~~9~~. A porous film with communication pores formed by anode oxidization of an aluminum material, comprising:

a small pore diameter part having communication pores formed to open to one surface of the porous film;

an intermediate pore part having communication pores to which the communication pores of the small pore diameter part are connected and which is larger in diameter than the communication pores in the small pore diameter part; and

a large pore diameter part having communication pores to which the communication pores of the

intermediate pore part are connected and which are larger in diameter than the communication pores in the intermediate pore part and are formed to open to the other surface of the porous film, wherein

the small pore diameter part is provided with the communication pores formed from the one surface of the porous film to a position of at least 400 nm, the communication pores having an average pore diameter of 4 to 20 nm, and the communication pores of the small pore diameter part on the one surface of the particle capture filtration film, having an opening rate of 15 to 50%,

a total film thickness of the porous film is equal to or less than 50 μm, and

the communication pores of the large pore diameter part have a large pore diameter part narrow portion in the intermediate pore part side.

9~~10~~. A manufacturing method of a porous film, comprising:

a first anode oxidization process (A) of anodizing an aluminum material to form a progenitor communication pore of a communication pore for a large pore diameter part on the aluminum material and obtain an anode oxidization aluminum material (1A);

pore diameter enlarging treatment of immersing the anode oxidization aluminum material (1A) in any aqueous solution of an oxalic acid aqueous solution, a chromic acid aqueous solution, a phosphoric acid aqueous solution,

a sulfuric acid aqueous solution, a mixed acid aqueous solution of them or an alkaline aqueous solution to enlarge a diameter of the progenitor communication pore and form communication pores for a large pore diameter part;

a second anode oxidization process (A) of anodizing the anode oxidization aluminum material (1A) subjected to pore diameter enlarging treatment to form a large pore diameter part narrow portion smaller in diameter than the communication pore for the large pore diameter part on an end of the communication pore for the large pore diameter part in the anode oxidization aluminum material (1A) subjected to the pore diameter enlarging treatment and obtain an anode oxidization aluminum material (2);

a third anode oxidization process of anodizing the anode oxidization aluminum material (2) to form a communication pore for an intermediate pore part that is connected to the large pore diameter part narrow portion of the communication pore for the large pore diameter part and is smaller in diameter than the large pore diameter part narrow portion of the communication pore for the large pore diameter part on the anode oxidization aluminum material (2) and obtain an anode oxidization aluminum material (3);

a fourth anode oxidization process of anodizing the anode oxidization aluminum material (3) to form a communication pore having a pore diameter of 10 to 100 nm,

for a small pore diameter part that is connected to the communication pore for the intermediate pore part and is smaller in diameter than the communication pore for the intermediate pore part and obtain an anode oxidization aluminum material (4) the communication pores of the small pore diameter part on one surface of the particle capture filtration film, having an opening rate of 15 to 50%;

a separation and etching process of separating an anodized section from the anode oxidization aluminum material (4) and next, executing etching treatment to the separated section to obtain an anodized section; and

a calcination process of firing the anodized section at a temperature of 800 to 1200°C to obtain a particle capture filtration film, wherein

in the fourth anode oxidization process, the communication pores having an average pore diameter of 4 to 20 nm are formed in a range of 400 nm or more in a thickness direction, and

from the first anode oxidization process to the fourth anode oxidization process, a total thickness of sections on which the communication pores are formed by the anode oxidization is equal to or less than 50 μm.

10~~11~~. A manufacturing method of a porous film, comprising:

a first anode oxidization process (B) of anodizing an aluminum material to form a communication pore for a large pore diameter part on the aluminum material and obtain an anode oxidization aluminum material (1B);

a second anode oxidization process (B) of anodizing the anode oxidization aluminum material (1B) to form a large pore diameter part narrow portion smaller in diameter than the communication pore for the large pore diameter part on an end of the communication pore for the large pore diameter part in the anode oxidization aluminum material (1B) and obtain an anode oxidization aluminum material (2);

a third anode oxidization process of anodizing the anode oxidization aluminum material (2) to form a communication pore for an intermediate pore part that is connected to the large pore diameter part narrow portion of the communication pore for the large pore diameter part and is smaller in diameter than the large pore diameter part narrow portion of the communication pore for the large pore diameter part on the anode oxidization aluminum material (2) and obtain an anode oxidization aluminum material (3);

a fourth anode oxidization process of anodizing the anode oxidization aluminum material (3) to form a communication pore for a small pore diameter part having a pore diameter of 10 to 100 nm, that is connected to the communication pore for the intermediate pore part and is

smaller in diameter than the communication pore for the intermediate pore part and obtain an anode oxidization aluminum material (4) the communication pores of the small pore diameter part on one surface of the particle capture filtration film, having an opening rate of 15 to 50%;

a separation and etching process of separating an anodized section from the anode oxidization aluminum material (4) and next, executing etching treatment to the separated section to obtain an anodized section; and

a calcination process of firing the anodized section at a temperature of 800 to 1200℃ to obtain a particle capture filtration film, wherein

in the fourth anode oxidization process, the communication pores having an average pore diameter of 4 to 20 nm are formed in a range of 400 nm or more in a thickness direction, and

from the first anode oxidization process to the fourth anode oxidization process, a total thickness of sections on which the communication pores are formed by the anode oxidization is equal to or less than 50 μm.