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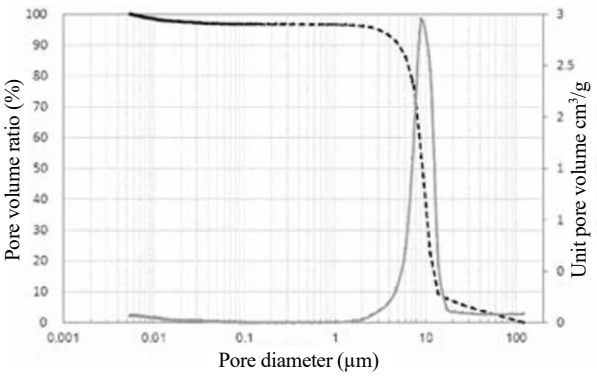
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(54) [Title of Invention] POLYOLEFIN POROUS SINTERED COMPACT

(57) [Abstract]
[Problem] To provide a polyolefin porous sintered compact that can ensure high water absorption performance, has little pressure loss, and has excellent durability.
[Resolution Means] A polyolefin porous sintered compact containing polyolefin particles composed of a polyolefin, having a thickness of 0.05 to 1 mm, and having a median pore diameter distribution in which, when defining a median pore diameter corresponding to 10% cumulative and 90% cumulative from the large diameter side of the cumulative pore distribution as D10 and D90, respectively, a D10/D90 ratio is 10 or less.
[Selected Drawing] FIG. 1



[Scope of Patent Claims]
[Claim 1]
A polyolefin porous sintered compact, comprising polyolefin particles composed of a polyolefin,
having a thickness of 0.05 to 1 mm, and
having a median pore diameter distribution in which, when defining a median pore diameter corresponding to 10% cumulative and 90% cumulative from the large diameter side of the cumulative pore distribution as D10 and D90, respectively, a D10/D90 ratio is 10 or less.
[Claim 2]
The polyolefin porous sintered compact according to claim 1, having a pore volume of 0.1 cm^3/g or more and 2.0 cm^3/g or less, a median pore diameter of 1 μm or more and 15 μm or less, and contiguous pores.
[Claim 3]
The polyolefin porous sintered compact according to claims 1 or 2, having an aluminum content of 1 ppm or more and 30 ppm or less.
[Claim 4]
The polyolefin porous sintered compact according to any of claims 1 to 3, having a chlorine content of 10 ppm or less.
[Claim 5]
The polyolefin porous sintered compact according to any of claims 1 to 4, wherein the thickness is 0.1 to 0.8 mm.
[Claim 6]
The polyolefin porous sintered compact according to any of claims 1 to 5, wherein the polyolefin is a homopolymer of ethylene or a copolymer of ethylene and an olefin having 3 or more carbon atoms
[Claim 7]
The polyolefin porous sintered compact according to any of claims 1 to 6, wherein the polyolefin has a viscosity-average molecular weight of 500,000 to 10,000,000.
[Claim 8]
The polyolefin porous sintered compact according to any of claims 1 to 7, wherein the polyolefin is a polyolefin into which is grafted at least one molecular chain selected from hydrophilic monomers containing an ethylene-based unsaturated group and polymers thereof.
[Claim 9]
A method for producing the polyolefin porous sintered compact according to any of claims 1 to 8, comprising a step for performing sinter molding by filling the polyolefin particles in a mold.
[Claim 10]
A method for producing the polyolefin porous sintered compact according to any of claims 1 to 8, comprising a step for performing sinter molding by depositing the polyolefin particles.
[Claim 11]
A laminate comprising the polyolefin porous sintered compact according to any of claims 1 to 8 and a base material on which the polyolefin porous sintered compact is laminated.
[Claim 12]
An adsorptive immobilization transport sheet, comprising the polyolefin porous sintered compact according to any one of claims 1 to 8 or the laminate according to claim 11.
[Claim 13]
A carrier sheet of a rapid test kit using an immunochromatographic method, comprising the polyolefin porous sintered compact according to any one of claims 1 to 8 or the laminate according to claim 11.

[Detailed Description of Invention]
[Technical Field]
[0001]
The present invention relates to a polyolefin porous sintered compact.
[Background Art]
[0002]
One means for fixing or transporting a membrane, plate, or film object such as a glass plate for liquid crystal or a green sheet for a multilayer ceramic capacitor is a method for fixing or adsorbing and transporting the thin film or the like onto an adsorption stage by vacuum suction. A porous resin body permeable by air acting as an adsorption cushioning material is mounted on an adsorption surface of the adsorption stage. Thus, scratches or contact marks can be prevented from occurring on the member to be adsorbed. From the perspective of rigidity, cushioning properties, and the like, a sintered compact obtained by sintering and molding a polyethylene powder is sometimes used as this type of porous resin sintered compact.
[0003]
In recent years, liquid crystal and multilayer ceramic capacitors are rapidly becoming smaller and higher performance, and glass plates and ceramic green sheets, which are raw materials thereof, are becoming thinner. Therefore, there is a need to perform extremely precise adsorption immobilization or adsorption transport. Accordingly, even an adsorption cushioning material that is mounted to an adsorption stage under vacuum suction must have a surface that contacts the member to be adsorbed that has uniform height, hardness, and suction-applied pressure. Furthermore, from an economic point of view, there is a desire for a durable material that has low pressure loss even when suctioning dust and the like.
[0004]
In response to such demand, for example, patent document 1 proposes a filter for an air cleaner made of ultrahigh molecular weight polyethylene as a porous sheet with small pressure loss. Furthermore, for example, patent document 2 proposes an adsorption fixing sheet with a small surface roughness that is obtained by a method of cutting a block-shaped porous sintered compact obtained by sintering and molding fine ultrahigh molecular weight polyethylene particles.
[0005]
Conversely, as a hydrophilic porous sintered compact whose main component is a hydrophilized polyolefin, a water absorbing function thereof is useful in applications such as water absorption, diffusion, dispersion, permeation, induction, and the like, and in patent document 3, for example, applications such as a condensed water absorbing material such as a vegetable compartment or a chilled compartment of a refrigerator, an in-compartment humidifier, a humidifying element such as an air conditioner, an ink absorbing body of a printer, and the like are proposed.
[0006]
Furthermore, in recent years, porous sintered compacts have been used in fields such as electronics and medical fields, and there is demand for porous sintered compacts that are more precisely controlled. In the electronics field, for example, patent document 4 proposes a clean, thin uniaxially stretched ultrahigh molecular weight polyethylene with specified porosity and average pore diameter. Furthermore, in the medical field, for example, patent document 5 propose, an ultra high molecular weight polyethylene porous sintered compact having a pore diameter suitable for filtering a collected sample.
[Prior Art Documents]
[Patent Documents]
[0007]
[Patent Document 1] JP 2006-257888 A
[Patent Document 2] JP 2006-26981 A
[Patent Document 3] JP 1739911 Specification
[Patent Document 4] JP 2000-317280 A
[Patent Document 5] JP 2015-14618 A
[Summary of Invention]
[Problem to Be Solved by Invention]

[0008]

However, although it is possible to make a porous sheet thin with the art disclosed in patent documents 1 to 3, there is a tendency for mechanical strength and durability to become low when making a membrane. Furthermore, the suppression effect of the amount of air flow and pressure loss is insufficient. Furthermore, although the art disclosed in patent documents 4 and 5 describes filtration of a solution using a porous sintered compact to which hydrophilicity has been imparted, there is a variation in performance within the sheet, and therefore improvements in ventilation performance and water absorbing function are sought.

[0009]

The present invention has been configured in view of the problems of the conventional art described above, and an object is to provide a polyolefin porous sintered compact that can ensure high water absorption performance, has little pressure loss, and has excellent durability.

[Means for Solving Problem]

[0010]

As a result of diligent research to solve the problems described above, the present inventors discovered that by controlling pore size distribution, it is possible to obtain a polyolefin porous sintered compact that can ensure high air permeability and water absorption performance even with a thin film, has little pressure loss, and has excellent mechanical strength and durability, thereby arriving at the present invention.

[0011]

That is, the present invention is as described below.

[1]

A polyolefin porous sintered compact containing polyolefin particles composed of a polyolefin,

having a thickness of 0.05 to 1 mm, and

having a median pore diameter distribution in which, when defining a median pore diameter corresponding to 10% cumulative and 90% cumulative from the large diameter side of the cumulative pore distribution as D10 and D90, respectively, a D10/D90 ratio is 10 or less.

[2]

The polyolefin porous sintered compact according to [1], having a pore volume of 0.1 cm^3/g or more and 2.0 cm^3/g or less, a median pore diameter of 1 μm or more and 15 μm or less, and contiguous pores.

[3]

The polyolefin porous sintered compact according to [1] or [2], having an aluminum content of 1 ppm or more and 30 ppm or less.

[4]

The polyolefin porous sintered compact according to any of [1] to [3], having a chlorine content of 10 ppm or less.

[5]

The polyolefin porous sintered compact according to any of [1] to [4], wherein the thickness is 0.1 to 0.8 mm.

[6]

The polyolefin porous sintered compact according to any of [1] to [5], wherein the polyolefin is a homopolymer of ethylene or a copolymer of ethylene and an olefin having 3 or more carbon atoms

[7]

The polyolefin porous sintered compact according to any of [1] to [6], wherein the polyolefin has a viscosity average molecular weight of 500,000 to 10,000,000.

[8]

The polyolefin porous sintered compact according to any of [1] to [7], wherein the polyolefin is a polyolefin into which is grafted at least one molecular chain selected from hydrophilic monomers containing an ethylene-based unsaturated group and polymers thereof.

[9]

A method for producing the polyolefin porous sintered compact according to any of [1] to [8], having a step for performing sinter molding by filling the polyolefin particles in a mold.

[10]

A method for producing the polyolefin porous sintered compact according to any of [1] to [8], having a step for performing sinter molding by depositing the polyolefin particles.

[11]

A laminate provided with the polyolefin porous sintered compact according to any of [1] to [8] and a base material on which the polyolefin porous sintered compact is laminated.

[12]

An adsorption immobilization transport sheet, containing the polyolefin porous sintered compact according to any one of [1] to [8] or the laminate according to claim 11.

[13]

A carrier sheet of a rapid test kit using an immunochromatographic method, containing the polyolefin porous sintered compact according to any one of [1] to [8] or the laminate according to claim 11.

[Effect of Invention]

[0012]

According to the present invention, it is possible to realize a polyolefin porous sintered compact that can ensure high water absorption performance, has little pressure loss, and has excellent durability.

[Brief Description of Drawings]

[0013]

FIG. 1 shows a chart of median pore diameter distribution and cumulative median pore diameter of the polyolefin porous sintered compact of example 1 obtained by mercury porosity measurement.

[Embodiments of Invention]

[0014]

An embodiment of the present invention (hereinafter simply referred to as "the present embodiment") will be described in detail below. The following embodiments are examples for describing the present invention, and are not intended to limit the present invention to the following contents. The present invention can be implemented with various modifications within the scope of the essence.

[0015]

The polyolefin porous sintered compact according to the present invention is a polyolefin porous sintered compact containing polyolefin particles composed of a polyolefin, having a thickness of 0.05 to 1 mm, and having a median pore diameter distribution in which, when defining a median pore diameter corresponding to 10% cumulative and 90% cumulative from the large diameter side of the cumulative pore distribution as D10 and D90, respectively, a D10/D90 ratio is 10 or less. Due to being configured as such, the polyolefin porous sintered compact of the present embodiment can ensure high air permeability and water absorption performance, has little pressure loss, and has excellent mechanical strength and durability.

[0016]

Generally, "porous sintered compacts" include porous sintered compacts obtained by heating a powder of a metal, ceramic, plastic or the like under pressure or no pressure and fusing near the surface layer of the powder while leaving contiguous pores therein.

[0017]

The polyolefin porous sintered compact of the present embodiment may have contiguous pores. In the present embodiment, the contiguous pores mean pores that are contiguous from one surface to another surface of the sintered body. These holes may be linear or curved. Furthermore, the overall dimensions may be uniform, or for example, the dimensions of the pores may be different between the surface layer and the interior or between one surface layer and the other surface layer. The polyolefin porous sintered compact of the present embodiment can be confirmed to have the contiguous pores by, for example, observing a cross-section with a scanning electron microscope or the like.

[0018]

The thickness of the polyolefin porous sintered compact is 0.05 mm or more and 1 mm or less. The thickness may be appropriately set depending on the application, but is preferably 0.07 mm or more and 0.9 mm or less, and more preferably 0.1 mm or more and 0.8 mm or less. When the thickness is 0.05 mm or more, mechanical strength is improved, and breakage less readily occurs during use. Furthermore, due to the thickness being 1 mm or less, not only can the air permeability in the thickness direction be improved, but the polyolefin porous sintered compact can

be wound in a roll shape and is thus extremely effective industrially. Note that the thickness of the polyolefin porous sintered compact can be measured by cutting the porous sintered compact in the thickness direction and observing the cut surface using an optical microscope (Microscope VH-Z100UR made by Keens Co., Ltd.).

[0019]

The polyolefin porous sintered compact of the present embodiment has a narrow median pore distribution diameter range, and when the pore diameters corresponding to the cumulative 10% diameter and the cumulative 90% diameter from the large diameter side of the cumulative pore distribution are defined as D10 and D90, respectively, the D10/D90 ratio is 10 or less, preferably 8 or less, and more preferably 6 or less. Note that, theoretically, the value of the D10/D90 ratio cannot be smaller than 1. The D10/D90 ratio being 10 or less enables the pressure applied to the polyolefin porous sintered compact to be uniformly dispersed when a gas or the like passes through the polyolefin porous sintered compact, and thus not only is deformation or breakage suppressed but also durability can be improved. Even when the polyolefin porous sintered compact is thin, effects such as improvement of mechanical strength and reduction of pressure loss when the pores are blocked can be obtained. Furthermore, filtration performance is improved and there is an effect of uniformizing the water absorption rate, so the inspection accuracy in a rapid test kit by an immunochromatographic method can be improved. Immunochromatography is an immunoassay method that applies the property of a porous membrane where a subject slowly flows while dissolving a reagent (capillary phenomenon). This is a method in which an antigen in a specimen is passed through a porous membrane while forming an immune complex with an antibody (labeled antibody) prepared in advance on the bottom of a specimen drop, the immune complex is trapped and colored on a capture antibody prepared in advance on the porous membrane, and this is visually assessed, which is applied to pregnancy diagnosis, influenza diagnosis, and the like. The porous membrane is used for passing a developing solution containing a specimen by capillary phenomenon, but by using the polyolefin porous sintered compact of the present embodiment having a D10/D90 ratio of 10 or less as the porous membrane, unnecessary substances can be strictly removed, a necessary immune complex can be developed at a high probability, and color can be developed even by a small amount of antigen, and therefore, inspection accuracy can be improved. Furthermore, due to the water absorption rate becoming uniform, the amount of the immune complex trapped on the capture antibody is the same in the width direction, and the degree of coloration is uniform, and thus human assessment errors can be prevented.

[0020]

The D10/D90 ratio of the polyolefin porous sintered compact may be controlled within the above range by, for example, in a sintering method that will be described later, controlling the average particle diameter, tap density, and the like of the polyolefin particles that are the raw material within the preferable range that will be described later and adjusting the firing temperature/time, cooling temperature/time, and the like during the production of the polyolefin porous sintered compact. In particular, the cooling temperature/time is preferably suitably adjusted from the perspective of suppressing deformation due to shrinkage of the polyolefin porous sintered compact. As a specific example thereof, it is preferable to sinter at a melting point of the polyolefin or higher, then leave at 95°C to 115°C at the melting point or lower for 3 hours or longer, and then cool to room temperature. By adopting this type of cooling temperature/time, there is a tendency for rapid shrinkage to be further suppressed. By such a method or the like, fluctuation due to the pore volume or the contraction of the median pore diameter can be reduced and equalized, and as a result, there is a tendency for the D10/D90 ratio to be controlled to a desired value. Furthermore, the difference in characteristics of the polyolefin porous sintered compact (sheet) can be reduced for each site, and not only can warping due to sheet strain be suppressed, but also production can be stabilized. Note that the D10/D90 ratio can be measured by, for example, mercury porosimetry described in an embodiment that will be described later.

[0021]

The median pore diameter of the polyolefin porous sintered compact of the present embodiment is preferably 1 μm or more and 15 μm or less, more preferably 2 μm or more and 14 μm or less, and more preferably 3 μm or more and 13 μm or less. A median pore diameter of 1 μm or more is preferable from the perspective of being able to prevent porosity and being able to secure a sufficient amount of air or water absorption for each pore. Conversely, a median pore diameter of 15 μm or less is preferable from the perspective that it is possible to increase the number of contiguous pores per unit volume, it is possible to reduce pressure loss even when some of the pores are closed, it is possible to secure a sufficient flow rate over a long period of time, and mechanical strength is also improved. Furthermore, there is a tendency for the water absorption function due to the capillary phenomenon to be

sufficiently exhibited and for the water absorption rate to be further improved. The median pore diameter of the polyolefin porous sintered compact can be controlled by the average particle diameter, tap density, and firing temperature/time and compression temperature/pressure/time during production of the polyolefin particles, which are raw materials described later. Note that the median pore diameter can be measured by, for example, the mercury porosimetry method described in an embodiment that will be described later.

[0022]

The pore volume of the polyolefin porous sintered compact in the present embodiment is preferably 0.1 cm^3/g or higher and 2.0 cm^3/g or lower, more preferably 0.2 cm^3/g or higher and 1.8 cm^3/g or lower, and more preferably 0.3 cm^3/g or higher and 1.6 cm^3/g or lower. A pore volume of 0.1 cm^3/g or more is preferable from the perspective of being able to ensure a space in the polyolefin porous sintered compact necessary for gas and liquid to pass through and hold. Conversely, a pore volume of 2.0 cm/g^3 or less is preferable from the perspective of increasing the strength of the polyolefin porous sintered compact. The pore volume of the polyolefin porous sintered compact can be controlled by the average particle diameter, tap density, and firing temperature/time and compression temperature/pressure/time during production of the polyolefin particles, which are raw materials described later. Note that the pore volume can be measured by, for example, the mercury porosity method described in an embodiment that will be described later.

[0023]

As described above, from the perspective of balancing molding strength and flow path maintenance, it is particularly preferable that the polyolefin porous sintered compact in the present embodiment has a pore volume of 0.1 cm^3/g or more and 2.0 cm^3/g or less, a median pore diameter of 1 μm or more and 15 μm or less, and contiguous pores.

[0024]

The aluminum content of the polyolefin porous sintered compact in the present embodiment is preferably 1 ppm or more and 30 ppm or less, more preferably 1.5 ppm or more and 25 ppm or less, and more preferably 2 ppm or more and 20 ppm or less. An aluminum content of 30 ppm or less in the polyolefin porous sintered compact is preferable from the perspective of having a tendency to generate fewer low molecular weight components due to thermal degradation of the polyolefin and to have fewer discoloration in the polyolefin porous sintered compact. Note that aluminum is known form aluminum hydroxide particles with higher hardness and higher heat resistance than polyolefin particles, and because it is difficult to fuse with adjacent particles during the molding process, it is preferable to adjust the above ranges to avoid problems such as falling off, clogging of fine pores, and increasing surface roughness. Conversely, an aluminum content of 1 ppm or more is preferable from the perspective of suppressing growth of live bacteria in the polyolefin porous sintered compact and being able to inactivate components interfering with color. The aluminum content of the polyolefin porous sintered compact can be controlled by, for example, the productivity of the ethylene polymer per unit catalyst. The productivity of the ethylene polymer can be controlled, for example, by the polymerization temperature, polymerization pressure, or slurry concentration of the reactor during production. That is, to increase the productivity of the ethylene polymer according to the present embodiment, examples include raising the polymerization temperature, raising the polymerization pressure, and/or raising the slurry concentration. As another method, it is possible to control the aluminum content by, for example, selecting a type of co-catalyst component when polymerizing the ethylene polymer, lowering the concentration of the co-catalyst component, or cleaning the ethylene polymer with an acid or an alkali. Note that the measurement of the amount of aluminum derived from the catalyst can be performed by, for example, a method described in an embodiment described later.

[0025]

The chlorine content of the polyolefin porous sintered compact in the present embodiment is preferably 10 ppm or less, more preferably 8 ppm or less, more preferably 5 ppm or less, and the smaller the amount, the more preferable the amount. The chlorine content of the polyolefin porous sintered compact is preferably 10 ppm or less from the perspective of suppressing corrosion of a suction fixing plate, ceramic green sheet, or the like that is easily affected by chlorine and hydrochloric acid when used as a suction transport sheet. Furthermore, when used in medical and pharmaceutical applications such as a support for a rapid test kit using immunochromatography, a filter for apheresis treatment, a filter for dialysis and the like, a pre-filter for various implants, bioanalysis kits and the like, it is extremely important to reduce the content of chlorine that generates acid. The chlorine content of the polyolefin

porous sintered compact can be controlled by appropriately adjusting polymerization conditions and the like using a catalyst described later. Furthermore, the chlorine content of the polyolefin porous sintered compact can be measured by, for example, a method described in an embodiment described later.

[0026]

Examples of the polyolefin used as the material of the polyolefin porous sintered compact include, but are not limited to, homopolymers of ethylene, propylene, 1-butene, 4-methyl-pentene-1, and the like, copolymers of ethylene, propylene, and other α-olefins, copolymers of ethylene and vinyl acetate, copolymers of ethylene and acrylic acid, methacrylic acid, and esters thereof, and the like. Among these polyolefins, for reason such as that the powder suitable for sintering molding can be easily obtained, sintering molding can be easily performed, chemical resistance is excellent, and there are comparatively soft and appropriate rigidity and the like, ethylene homopolymers, ethylene copolymers that are copolymers of ethylene and other α-olefins, propylene homopolymers, and propylene copolymers that are copolymers of propylene and other α-olefins such as ethylene and the like can be suitably applied. In the above, example of other α-olefins include, but are not limited to, α-olefins with 4 to 20 carbon atoms, and specific examples include 1-butene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 1-tridecene, 1-tetradecene, and the like. In the present embodiment, from the perspective of rigidity and ease of sintering and molding, it is particularly preferable that the polyolefin be a homopolymer of ethylene or a copolymer of ethylene and an olefin with three or more carbon atoms.

[0027]

The density of the polyolefin in the present embodiment is preferably 890 kg/m^3 or more and 970 kg/m^3 or less. From the perspective of providing sufficient rigidity to the polyolefin porous sintered compact, the lower limit of density is preferably 890 kg/m^3, more preferably 900 kg/m^3, and more preferably 910 kg/m^3. Furthermore, from the perspective of ease of handling, the upper limit of density is preferably 970 kg/m^3, and 960 kg/m^3 is more preferable. Here, the density of the polyethylene can be obtained by, for example, measuring in accordance with JISK7112:1999 by a density slope piping method (23°C).

[0028]

The viscosity average molecular weight (Mv) of the polyolefin in the present embodiment is preferably 500,000 or more and 10,000,000 or less, more preferably 750,000 or more and 9,000,000 or less, and even more preferably 1,000,000 or more and 8,000,000 or less. Since the viscosity average molecular weight (Mv) is 500,000 or more, the flow of the resin, which is a factor in inhibiting the formation of voids during sintering molding, is further reduced, and the control of the porosity and the like becomes easier. Conversely, when the viscosity average molecular weight (Mv) is 10,000,000 or less, adjacent particles have excellent fusibility with each other, the strength of the polyolefin porous sintered compact is increased, and workability is also increased. The viscosity average molecular weight (Mv) of the polyolefin can be adjusted by suitably adjusting polymerization conditions and the like using, for example, a catalyst that will be described later. Specifically, the viscosity average molecular weight (Mv) can be adjusted by causing hydrogen to exist in the polymerization system as a chain transfer agent, or by changing the polymerization temperature.

[0029]

The viscosity average molecular weight (Mv) of the polyolefin of the present embodiment prepares a solution where the polyolefin is dissolved in decalin at different concentrations, and measures the solution viscosity at 135°C of the solution. The reducing viscosity calculated from the solution viscosity measured in this manner is extrapolated to a concentration of 0, the limiting viscosity is found, and calculation can be performed by the following formula (A) from the found limiting viscosity [η] (dL/g). More specifically, measurement can be performed by the method described in the example, for example.

$$Mv = (5.34\times10^{4)} \times [\eta]^{1.49} \quad \text{... (A)}$$

[0030]

The average particle diameter of the polyolefin particles in the present embodiment is preferably 20 μm or more and 100 μm or less, more preferably 25 μm or more and 90 μm or less, and more preferably 30 μm or more and 80 μm or less. Because the average particle diameter of the polyolefin particles is 20 μm or more, the formation of pores in the polyolefin porous sintered compact becomes easy, and there is a tendency that it becomes easier to secure a sufficient amount of air and water absorption. Meanwhile, the average particle diameter is 100 μm or less, and therefore the surface roughness (Ra) and the surface pore diameter become small, and there is a tendency to be

able to suppress bending of a breathable sheet that is attracted inside the polyolefin porous sintered compact. The average particle size of the polyolefin particles can be adjusted by suitably adjusting the polymerization conditions and the like using, for example, a catalyst that will be described later. Specifically, the average particle diameter can be adjusted by producing polyolefin particles using a catalyst having a size that falls within the above range after polymerization or by controlling the amount of polyolefin particles produced under the polymerization conditions. In addition, polyolefin particles that fall within the above range may be selected by classification and the like. Note that the average particle size of the polyolefin is a particle size where the cumulative weight is 50%, and for example, methanol can be measured using a laser diffraction type particle size distribution measurement device (SALD-2100 made by Shimadzu Corporation) as a dispersion medium.

[0031]

The ratio of particles of 106 μm or more (hereinafter also referred to as "coarse particles") in the polyolefin particles in the present embodiment is preferably 1.0% or less, more preferably 0.8% or less, and even more preferably 0.5% or less. Because the ratio of particles with a polyolefin particle diameter of 106 μm or more is 1.0% or less, the surface opening diameter, median pore diameter, and the like of the polyolefin porous sintered compact become more uniform, and there is a tendency that deformation of a suctioned adsorbate due to local ventilation pressure is less likely to occur when used as a suction transport sheet. Furthermore, when used as a chromatograph, there is a tendency for the water passage speed to be uniform and separation to be more accurate. The method for making the ratio of particles with a particle diameter of 106 μm or more 1.0% or less is not particularly limited, and may be obtained directly by polymerization or the powder obtained by polymerization may be in the above range by classification. Furthermore, an object once shaped into a shape other than a powder may be subjected to mechanical pulverization at room temperature or at a low temperature to obtain objects in the above range, or objects that have been mechanically pulverized may be classified and obtained. Furthermore, after dissolving in a solvent, a poor solvent may be added to precipitate, and a powdered product may also be used. Note that the ratio of particles with a particle diameter of 106 μm or more can be calculated by, for example, the ratio of the total particle mass before classification of the particle mass on the sieve when passing using the 106 μm sieve according to JIS Z8801.

[0032]

The tap density of the polyolefin particles in the present embodiment is preferably 0.30 g/cm^3 or more and 0.55 g/cm^3 or less, more preferably 0.32 g/cm^3 or more and 0.50 g/cm^3 or less, and more preferably 0.35 g/cm^3 or more and 0.45 g/cm^3 or less. The tap density has a tendency to increase as the amount of agglomerates and particles with irregular shapes is small, and the tap density is similar to a spherical shape and has a regular surface configuration. Due to having a tap density of 0.30 g/cm^3 or more, the fluidity of the particles increases and there is a tendency for easier filling into a mold or the like for sintering molding. Conversely, due to having a tap density of 0.55 g/cm^3 or less, particles are prevented from being excessively filled densely, and an appropriate pore volume and median pore diameter tend to be maintained. As a result, there is a tendency to secure a sufficient amount of air and water absorption as the polyolefin porous sintered compact.

[0033]

The tap density of the polyolefin particles in the present embodiment can be controlled by, for example, introducing a slurry after polymerization into a flash tank where the internal temperature is adjusted to 30°C or higher and 40°C or lower, and blowing the humidified inert gas into the liquid. Examples of the inert gas include nitrogen, helium, neon, argon, and the like, but not limited to below. Furthermore, the amount of water contained in the inert gas is preferably 1 vol% to 10 vol%, more preferably 2 vol% to 8 vol%, and even more preferably 3 vol% to 5 vol%. Furthermore, the residence time of slurry when blowing the humidified inert gas is preferably 0.1 to 2 hours, more preferably 0.3 to 1.5 hours, and more preferably 0.5 to 1.0 hours. Furthermore, the tap density can be controlled by suppressing the amount of heat generated by the rapid polymerization reaction that occurs when producing the polyolefin particles. Specifically, there is a tendency for rapid polymerization reactions and deposits on the reaction tank wall to decrease and for aggregates of polyolefin particles and different shaped polyolefin particles to decrease by, for example, continuously supplying ethylene gas, a solvent, a catalyst, and the like into the polymerization system and continuously discharging the same with the generated ethylene polymer, positioning the catalyst introduction line outlet at a distance within a possible range from the outlet of the ethylene introduction line, reducing the concentration of the catalyst feed, and the like. Note that the tap density of the polyolefin particles can be measured by, for example, a method described in an embodiment described later.

[0034]

In the present embodiment, examples of the polymerization method in the method for manufacturing the polyethylene particle include, but are not limited to, methods that (co)polymerize ethylene or a monomer containing ethylene by a slurry polymerization method, a gas phase polymerization method, or a solution polymerization method. Of these, a slurry polymerization method that can efficiently remove the heat of polymerization is preferable. In the slurry polymerization method, an inert hydrocarbon medium can be used as the medium, and furthermore, the olefin itself can be used as the medium.

[0035]

The above inert hydrocarbon medium is not particularly limited, but specific examples include aliphatic hydrocarbons such as propane, butane, isobutane, pentane, isopentane, hexane, heptane, octane, decane, dodecane, kerosene, and the like; alicyclic hydrocarbons such as cyclopentane, cyclohexane, methylcyclopentane, and the like; aromatic hydrocarbons such as benzene, toluene, xylene, and the like; halogenated hydrocarbons such as ethyl chloride, chlorobenzene, dichloromethane, and the like; and mixtures thereof.

[0036]

In the present embodiment, it is preferable to use a hydrocarbon medium having 6 to 10 carbon atoms. When the number of carbon atoms is 6 or greater, a side reaction at the time of polyolefin polymerization and low molecular weight components caused by polyolefin degradation are relatively likely to dissolve, and are easily removed by a step for separating the polyolefin and the polymerization medium. By reducing the low molecular weight components in the polyolefin particles, the flow of the resin due to heating during molding of the polyolefin porous sintered compact can be suppressed, and therefore there is a tendency for the pore volume, median pore diameter, and D10/D90 ratio of the polyolefin porous sintered compact to be easily controlled. Conversely, when the number of carbon atoms is 10 or less, the low molecular weight component (medium) remaining in the polyolefin will be reduced, adhesion of polyethylene particles to the reaction tank and the like will be suppressed, and there is a tendency that stable industrial operation will be possible.

[0037]

The polymerization temperature in the method for producing a polyolefin according to the present embodiment is typically 30°C or higher and 100°C or lower, more preferably 35°C or higher and 95°C or lower, and even more preferably 40°C or higher and 90°C or lower. When the polymerization temperature is 30°C or higher, there is a tendency that efficient manufacturing will be possible industrially. Conversely, when the polymerization temperature is 100°C or less, there is a tendency that contiguous and stable operation can be performed.

[0038]

In the present embodiment, the polymerization pressure in the method for producing a polyolefin is normally normal pressure or higher and 2 MPa or less, more preferably 0.1 MPa or more and 1.5 MPa or less, and more preferably 0.1 MPa or more and 1.0 MPa or less.

[0039]

The polymerization reaction can be performed by any of a batch method, a semi-continuous method, and a continuous method, but polymerization is preferably performed by the continuous method. By continuously supplying ethylene gas, a solvent, a catalyst, and the like into the polymerization system and continuously discharging the same with the generated polyolefin, it becomes possible to suppress a partial high-temperature state due to a rapid ethylene reaction, and there is a tendency for the polymerization system to become more stable. When ethylene reacts with the system in a uniform state, there is a tendency to suppress the generation of branches, double bonds, and the like in the polymer chain. Thus, it is possible to easily obtain a polyolefin having a low molecular weight component and a tap density in the range of the present embodiment. Therefore, a contiguous type that makes the interior of the polymerization system more uniform is preferable. In the method for producing polyolefin particles in the present embodiment, polymerization is preferably performed in two or more stages with different reaction conditions.

[0040]

The molecular weight adjustment of the polyolefin particles can be adjusted by, for example, making hydrogen exist in the polymerization system or changing the polymerization temperature as described in the specification of West Germany Patent Application Publication No. 3127133. By adding hydrogen as a chain transfer agent into the polymerization system, it becomes easier to control the molecular weight in an appropriate range.

When the polymerization-based internal hydrogen is added, the molar fraction of the hydrogen is preferably 0 mol% or more and 30 mol% or less, more preferably 0 mol% or more and 25 mol% or less, and more preferably 0 mol% or more and 20 mol% or less.

[0041]

The solvent separation method in the polyolefin particle manufacturing method can be performed by, for example, a decantation method, a centrifugal separation method, a filter filtration method, or the like, and a centrifugal separation method with favorable separation efficiency between polyethylene and the solvent is more preferable. The amount of solvent included in the polyolefin after the solvent separation is not particularly limited, but is preferably 70 mass% or less, more preferably 60 mass% or less, and even more preferably 50 mass% or less, based on the mass of the polyolefin. When a solvent contained in a polyolefin is removed by drying in a small amount, there is a tendency that metal components such as aluminum and chlorine contained in the solvent are less likely to remain in the polyolefin. By not having these components remaining, there is a tendency for aluminum denatured material to fall off, for fine pores to clog, for surface roughness to be increased, and for corrosion and the like of suction fixing plates, ceramic green sheets, and the like to be suppressed.

[0042]

In the present embodiment, the catalyst component used in the production of the polyolefin particles is not particularly limited, and it is possible to produce using, for example, a Ziegler-Natta catalyst, a metallocene catalyst, a Phillips catalyst, or the like. The Ziegler-Natta catalyst described in the Specification of JP 5767202 can be suitably used, and a metallocene catalyst not limited to the following can be suitably used, for example, the catalyst described in JP 2006-273977 A.

[0043]

In the present embodiment, the average particle size of the catalyst is preferably in the range of 0.1 to 10 μm, more preferably in the range of 0.2 to 9 μm, and even more preferably in the range of 0.5 to 8 μm. When the average particle diameter is 0.1 μm or more, there is a tendency that problems such as scattering and adhesion of the obtained polyolefin particles can be prevented. Furthermore, when 10 μm or less, the polyolefin particles become too large and tend to be able to prevent problems such as settling in the polymerization system, blockage of the line in the post-treatment process of the polyolefin particles, and the like. The particle diameter distribution of the catalyst is preferably as narrow as possible, and the fine powder particles and the coarse powder particles can be removed by means of a sieve, centrifugal separation, or cyclone.

[0044]

The method for deactivating the catalyst used to synthesize the polyolefin particles is not particularly limited, but is preferably performed after the polyolefin and the solvent are separated. By introducing a chemical agent for inactivating the catalyst after separation from the solvent, precipitation of the catalyst component and the like dissolved in the solvent can be suppressed, and aluminum and chlorine derived from the catalyst component can be reduced. Examples of the agent that deactivates the catalytic system include, but are not limited to, oxygen, water, alcohols, glycols, phenols, carbon monoxide, carbon dioxide, ethers, carbonyl compounds, alkynes, and the like.

[0045]

The drying temperature in the method for producing the polyolefin particles is typically 50°C or higher and 150°C or lower, more preferably 50°C or higher and 140°C or lower, and more preferably 50°C or higher and 130°C or lower. When the drying temperature is 50°C or higher, efficient drying is possible. Conversely, when the drying temperature is 150°C or below, drying can be performed while suppressing the aggregation and thermal deterioration of the polyolefin particles. In the present embodiment, other commonly known components that are useful in the manufacture of polyethylene can also be included in addition to the components described above.

[0046]

In order to obtain a polyolefin porous sintered compact using the polyolefin particles, a method for sintering molding is suitably used. Sintering molding can also be obtained, for example, by uniformly spraying the polyolefin particles on a flat plate of a material such as metal and then heating and cooling, or a method can also be used in which the polyolefin particles are uniformly sprayed on the flat plate of a material such as metal and then heated, and during heating or after heating, the flat plate of a material such as metal and then further overlaid and cooled to transfer the surface of the flat plate of a material such as metal and the like. Or, for example, there is a method in which the particles are uniformly sprayed on a contiguous belt made of a material such as metal and then sandwiched

and cooled by a roll or belt made of a material such as metal during or after heating. Furthermore, the particles may be filled into a mold having a desired space and heated together with the mold, or heated by passing a hot air or a heating medium that does not impede the fusion bonding of the particles into the mold having the desired space into which the particles have been inserted. Further, a method of slicing or skiving a polyolefin porous sintered compact formed by the above forming method or the like is suitably used.

[0047]

In skive processing, a cutting sheet of a polyolefin porous sintered compact can be obtained by stripping (cutting) a molded body formed into a desired shape such as a cylindrical shape or a cylindrical shape into a film shape toward the core in a spiral shape in the circumferential direction of the sintered compact as when peeling a radish in a spiral; however, with a thick molded body such as a cylindrical shape or a cylindrical shape, median pore diameter, D10/D90 ratio, and the like tend to change depending on the location, and in the present embodiment, among these molding methods, a mold method that fills polyolefin particles into a mold and heats and cools these particles, and a continuous sintering method (deposition method) that uniformly sprays the polyolefin particles on a belt and continuously heats and cools these particles are particularly preferable.

[0048]

As described above, the method for manufacturing a polyolefin porous sintered compact according to the present embodiment has a step (mold method) for performing sintered compact by filling polyolefin particles into a mold. Furthermore, another method for manufacturing a polyolefin porous sintered compact according to the present embodiment has a step (deposition method) for performing sintered compact by depositing polyolefin particles.

[0049]

When sintering molding is performed using a mold, a method that heats the entire mold is suitably used in consideration of post-processing and the like after molding. As a method for heating the entire mold, the mold may be inserted into a furnace provided with a hot blast furnace or a heater, or a heating medium may be passed through by providing a flow path in the mold.

[0050]

The continuous sintering method can be implemented using a device made from, for example, a rotary steel belt, a powder supply hopper with a low-speed rotation roller, a leveling part, a heating part, and a rolling roller. That is, the obtained polyethylene particles are continuously deposited from the hopper on the mobile steel belt, and passing through the scraping part with the clearance from the belt (deposited part is on the steel belt), and thus uniformly deposited in an arbitrary thickness. Next, a polyolefin porous sintered compact can be obtained in which the pore volume, median pore diameter, and pore distribution are controlled at any thickness at any given thickness by continuously charging into a heating furnace, passing through a rolling roller heated to 100°C or more where a clearance of any given thickness is provided from the belt, and then cooling at room temperature.

[0051]

In either case, it is preferable that the surface temperature of the material to be heated, such as a mold or a belt, be held in a range of (the melting point of the polyolefin used + 20°C) to (the melting point of the polyethylene used + 100°C). When the surface temperature of a material such as a mold or a belt is (the melting point of polyethylene used + 20°C) or more, the material is firmly fused, the strength is improved, and the surface roughness of the polyolefin porous sintered compact tends to be lower. Furthermore, by setting the surface temperature of a material such as a mold or belt to (the melting point of polyethylene used + 100°C) or below, deterioration of polyethylene due to overheating can be prevented, and intense flow is suppressed, and as a result, there is a tendency to be able to secure an appropriate pore volume, median pore diameter, and pore distribution.

[0052]

The material of the material used in sintering molding such as a mold or a belt is not particularly limited so long as it can withstand the temperature during heating and the thermal expansion of the polyethylene generated during heating. Normally, a metal mold is suitably used. Among metals, aluminum, brass and the like are suitably used because they are comparatively lightweight and have good thermal conductivity. These metals can be used as is, or the surface can be plated with chrome, nickel, or the like. At this time, it is preferable that at least one surface of a surface of a material such as a mold or a belt, which is in contact with the polyolefin, has a surface roughness finished at a maximum height (Ry) of 10 μm or less, and more preferably 5 μm or less. When the surface roughness of the surface of a material such as a mold or a belt, which is in contact with polyethylene, is set at a maximum height

(Ry) of 10 μm or less, the surface can be prevented from being transferred to polyolefin during sintering and the surface roughness of a polyolefin porous sintered compact tends to be controlled within a desired range. The maximum height (Ry) of the surface roughness referred to here is a value measured according to JIS B0601-1994 by a contact method using a probe with a measurement tip of 0.1 mmR.

[0053]

In the present embodiment, the polyolefin porous sintered compact is preferably hydrophilized. Examples of the hydrophilization treatment method in the present embodiment include, but are not limited to, a method that uses a surfactant and a method that uses a graft polymerization treatment. In this embodiment, the polyolefin is preferably a polyolefin obtained by grafting at least one molecular chain selected from hydrophilic ethylene-based unsaturated group-containing monomers or polymers thereof.

[0054]

Examples of the surfactant include, but are not limited to, a sulfonic acid anionic surfactant (A) and one or more types of a mixture (B) of non-ionic surfactants selected from the group consisting of polyoxyethylene sorbitan fatty acid esters, polyoxyethylene sorbitol fatty acid esters, polyoxyethylene fatty acid esters, polyglycerol fatty acid esters, glycerol fatty acid esters, and sorbitan fatty acid esters. The components (A) and (B) are preferably added and mixed in a range of 0 to 3.0 parts by mass and in a range of $0.05 \leq (A)+(B) \leq 3.0$ parts by mass to 100 parts by mass of the polyolefin particles. When a sulfonic acid type anionic surfactant (A) and a nonionic surfactant (B) are added within the above range, there is a tendency that sufficient strength will be obtained in the polyolefin particle sintered compact.

[0055]

Examples of the sulfonic acid type anionic surfactant (A) include, but are not limited to, alkyl sulfonates, alkyl naphthalenesulfonates, alkyl benzene sulfonates, succinic acid ester sulfonates, alkyl diphenyl ether disulfonates, and the like.

[0056]

Of the nonionic surfactant (B), examples of the polyoxyethylene sorbitan fatty acid ester include, but are not limited to, polyoxyethylene sorbitan monolaurate and the like. Examples of polyoxyethylene sorbitol fatty acid esters include, but are not limited to, polyoxyethylene sorbittetraolate and the like. Examples of the polyoxyethylene fatty acid ester include, but are not limited to, polyethylene glycol monolaurate and the like. Furthermore, examples of the polyglycerin fatty acid ester include, but are not limited to, polyglycerin monoisostearate and the like. Examples of the glycerin fatty acid ester include, but are not limited to, glycerin monostearate, glycerin monooleate, and the like. Examples of the sorbitan fatty acid ester nonionic surfactant include, but are not limited to, sorbitan monolaurate and the like. Only one type of these nonionic surfactants may be used, or two or more types may be used in combination.

[0057]

It is preferable that the surfactant is uniformly dispersed and adhered to the polyolefin particles. The hydrophilicity imparting treatment of the surfactant is preferably dry mixing. For example, using a commonly known blender such as a high-speed mixer or the like, the polyolefin particles described above, a surfactant, and preferably a small amount of water are mixed together. At this time, a predetermined additive such as a heat stabilizer or a release agent may be added. Note that when the hydrophilicity imparting treatment is performed using a surfactant, the treatment may be performed in the state of polyolefin particles as described above, or may be performed after the polyolefin porous sintered compact molding step.

[0058]

As for the method of hydrophilizing the polyolefin particles constituting the polyolefin porous sintered compact, a method using a surfactant as described above and a method of graft polymerization treatment can be used. Note that, when performing a graft polymerization process, after molding the polyolefin porous sintered compact, at least one molecular chain selected from a monomer containing an ethylene-based unsaturated group and a polymer thereof having a predetermined hydrophilicity may be grafted, or alternatively, at least one molecular chain selected from a monomer containing an ethylene-based unsaturated group and a polymer thereof having a predetermined hydrophilicity may be previously grafted to polyolefin particles and then molded. In the present embodiment, when at least one molecular chain selected from a monomer having an ethylene-based unsaturated group with a prescribed hydrophilic property or a polymer thereof is grafted onto polyolefin particles in advance and

then sintering molding is performed, it is preferable to perform sintering molding in a state where polyolefin particles that have not been graft polymerized are also mixed in order to increase the fusing strength.

[0059]

The hydrophilic ethylene-based unsaturated group-containing monomer used for the graft polymerization is an ethylene-based unsaturated group, that is, a monomer having a polymerizable double bond for causing a graft reaction. Furthermore, the compound may be a compound having at least one or more polymerizable double bonds, and may become a macromer by itself being polymerized, or may not form a homopolymer by itself. One type of these ethylene-based unsaturated group-containing monomers may be used alone or two or more types may be used in combination.

[0060]

Since the hydrophilic property of the ethylene-based unsaturated group-containing monomer is derived from a hydrophilic functional group, the ethylene-based unsaturated group-containing monomer preferably has at least one functional group selected from a phosphorylcholine group, a hydroxyl group, a carboxyl group, an amino group, an amide group, an alkoxy group, a sulfo group and a salt thereof.

[0061]

Examples of other hydrophilic ethylene-based unsaturated group-containing monomers include, but are not limited to: monomers having a hydroxyl group such as 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, and 2-hydroxypropyl acrylate; monomers having a carboxyl group such as acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, citraconic acid, and mesaconic acid; monomers having an amino group such as 2-vinylpyridine and 4-vinylpyridine; monomers having an amide group such as acrylamide, methacrylamide, N,N-dimethylacrylamide, and N,N-diethylacrylamide; monomers having an alkoxy group such as methoxymethyl acrylate, methoxyethyl acrylate, and methoxypropyl acrylate; and monomers having a sulfo group or a salt thereof such as vinyl sulfonic acid, styrene sulfonic acid, sodium vinyl sulfonate, sodium styrene sulfonate, lithium styrene sulfonate, and ammonium styrene sulfonate.

[0062]

The method for grafting at least one molecular chain selected from a hydrophilic monomer containing an ethylene-based unsaturated group or a polymer thereof onto a polymer that configures polyolefin particles is not particularly limited as long as it is a method that can introduce a hydrophilic monomer containing an ethylene-based unsaturated group, using a radical generated in the polyolefin as a starting point. Examples include methods using plasma generated by corona discharge or glow discharge, methods using active gas such as ozone, methods using photosensitizers such as benzophenone and acetophenone and active rays such as ultraviolet rays, methods using ionizing radiation, methods using various radical initiators, and the like. A method for generating radicals by irradiating with active light or ionizing radiation is preferable because of excellent uniformity. The ionizing radiation is a radiation that can act on a substance to cause an ionization phenomenon. Examples include γ rays, X rays, β rays, electron beams, α rays, and the like, but γ rays that are suited to industrial production and that can generate radicals uniformly are particularly preferable.

[0063]

The contact between the polyolefin particles or molded body thereof that generated radicals and the ethylene-based unsaturated group-containing monomer that has the above hydrophilicity may be performed in a gas phase or a liquid phase, and while there are no limitations in particular, a method that performs this in a liquid phase that can be grafted more uniformly is preferable. Furthermore, in order to increase the uniformity of graft polymerization, it is preferable to use a hydrophilic monomer containing an ethylene-based unsaturated group after dissolving in a solvent in advance. Furthermore, these liquid phases are preferably liquid phases from which dissolved oxygen has been removed. Removing dissolved oxygen from the liquid phase makes it possible to effectively utilize the polymerization activity of the radical without inadvertently taking it away, and thus there is a tendency for hydrophilicity of a molded body to proceed more uniformly.

[0064]

The hydrophilic polyolefin porous sintered compact produced by the graft treatment in the present embodiment is suitable for use in precision industrial applications, medical applications and the like where cleanliness is required because the hydrophilic functional group is bonded to the polyolefin by a covalent bond and thus the water absorbing function is not lost and compounds that can become impurities such as surfactants are not

eluted.

[0065]

The polyolefin porous sintered compact of the present embodiment can also be used by laminating with another sheet. That is, the laminate of the present embodiment is provided with the polyolefin porous sintered compact of the present embodiment and a base material on which the polyolefin porous sintered compact is laminated. When another sheet is laminated to the polyolefin porous sintered compact, the sheet may be bonded using an adhesive or the like, or may be fused by heat. Examples of the base material in the present embodiment include, but are not limited to, organic sintered bodies such as polyolefin porous sintered bodies and the like, inorganic sintered bodies such as ceramics and the like, metal sintered bodies and the like.

[0066]

It is preferable that the polyolefin porous sintered compact and the sheet are partially bonded and/or fused by heat to ensure air permeability. This type of laminating method is not particularly limited, but can be performed by, for example, a method for forming a point-like or fibrous adhesive surface using a spray adhesive or an adhesive, a method for forming an adhesive surface in a point-like, mesh-like, streak-like shape or the like using a gravure coater, roll coater, screen printing machine or the like, a method for welding by heating under pressure through a thermoplastic resin having a particle shape or net shape, a method for spot welding using an ultrasonic welder machine, an ultrasonic sewing machine or the like, or a method for fusing by slightly melting the surface of a polyolefin porous sintered compact that contacts a sheet, or the like. Among these, it is preferable that a method for forming a dotted, fibrous, or other adhesive surface using a spray adhesive is simple.

[0067]

Examples of the spray adhesive and adhesive are not particularly limited but include those that are known, such as polyester resins, acrylic resins, polyamide resins, polyimide resins, α-olefin resins, polyolefin resins, urethane resins, ether celluloses, nitrocellulose, polyvinyl acetate resins, polystyrene resins, polyvinyl alcohol resins, polyvinyl butyral resins, polyvinyl butyral resins, polybenzimidazole resins, polymethacrylate resins, melamine resins, urea resins, resorcinol resins, ethylene vinyl acetate resins, vinyl acetate resins, epoxy resins, vinyl chloride resins, chloroprene rubber resins, butadiene rubber resins, nitrile rubber resins, cyanoacrylate resins, aqueous polymers, isocyanate resins, silicone resin, modified silicone resin, modified silicone resin, hot-melt resins, and hot-melt resin, and hot-melt resin, and hot-melt resin, hot-reactive polyamide resins, polyurethane hot melt, and polyolefin hot melt.

[0068]

When laminating the polyolefin porous sintered compact and the base material, a woven fabric with an adhesive may be used. A known method (for example, described in JP 2009-167275 A) may be used to provide the adhesive layer only on the linear portion of the woven fabric.

[0069]

The polyolefin porous sintered compact obtained by the present embodiment can be used as a general industrial member such as an adsorption immobilization transport sheet and the like, and can also be used in the life sciences field such as a support sheet for a rapid test kit by an immunochromatography method, a filter for apheresis treatment, a filter for artificial dialysis and the like, a pre-filter for various implants, a bioanalysis kit and the like, a carrier for a low-rigidity filter and the like, a carrier for an ion exchange resin and the like, and also in the electronics field such as an ink absorber for a printer head, a carrier for a solid electrolyte, a member for a fuel cell, a separator for a lithium ion secondary cell or a lead storage cell and the like. That is, the adsorption immobilization transport sheet according to the present embodiment includes the polyolefin porous sintered compact of the present embodiment or the laminate of the present embodiment. Furthermore, a carrier sheet of a rapid test kit by an immunochromatographic method according to the present embodiment includes the polyolefin porous sintered compact of the present embodiment or the laminate of the present embodiment.

[Examples]

[0070]

The present embodiment will be described below in further detail using examples and comparative examples, but the present embodiment is not intended to be limited in any way by the following examples.

The physical properties were measured as follows.

[0071]

(1) Pore volume, median pore diameter, and D10/D90 ratio

A polyolefin porous sintered compact having a thickness of less than 0.5 mm was cut out to a width of 20 mm × length of 150 mm, and a polyolefin porous sintered compact having a thickness of 0.5 mm or more was cut out to a width of 20 mm × length of 50 mm, respectively, and two sheets are superimposed on each other to form a test piece. Pore volume and median pore diameter were measured for this test piece in accordance with JISR1655 under the following measurement conditions.

<<Measurement Conditions>>

Device used: AutoPore IV9500 (made by Shimadzu Corporation)

Mercury used: recycled mercury

Mercury surface tension: 485 dynes/cm

Mercury contact angle: 130°

Measured maximum pressure: 44,500 psia

[0072]

The calculation method will be described using FIG. 1. FIG. 1 is a chart showing the results of measuring the pore volume of the polyolefin porous sintered compact of example 1, with the median pore diameter indicated on the horizontal axis, the pore volume (unit pore volume) of the diameter of the horizontal axis indicated on the right side of the vertical axis, and the cumulative pore volume ratio from the large diameter side indicated on the left side of the vertical axis.

[0073]

From FIG. 1, when defining the pore diameters corresponding to the cumulative 10% diameter and the cumulative 90% diameter as D10 and D90, respectively, D10 in example 1 was 13.83 μm, and D90 was 5.07 μm. That is, the D10/D90 ratio of example 1 was 2.73.

[0074]

(2) Aluminum content and chlorine content

A sample of a polyolefin porous sintered compact cut into a width of 1 mm × a length of 1 mm was pressure decomposed using a microwave decomposition device (model ETHOS TC, made by Milestone General Co.), and the aluminum element concentration in the polyolefin porous sintered compact was measured using an internal standard method using an inductively coupled plasma mass spectrometer (ICP-MS) (model X series X7, made by Thermofischer Scientific Co.).

Furthermore, with regards to the chlorine content, similarly cut out samples were combusted using an automatic sample combustion device (AQF-100 made by Mitsubishi Chemical Analytec) and then absorbed by an absorbing solution (Na_2CO_3 and $NaHCO_3$ mixed solution), and this absorbing solution was injected into an ion chromatography device (made by Dionex, ICS1500, column (separation column: AS12A, guard column: AG12A) suppressor ASRS300) and the chlorine content was measured.

[0075]

(3) Thickness of the polyolefin porous sintered compact

The thickness of the polyolefin porous sintered compact was determined by cutting the polyolefin porous sintered compact along the thickness direction, observing five locations using an optical microscope (Microscope VH-Z100UR made by Keens Co., Ltd.), and using the average value of the obtained values.

[0076]

(4) Viscosity average molecular weight (Mv)

20 mg of polyolefin was added to 20 mL of decalin (decahydronaphthalene), and the polymer was dissolved by stirring for 2 hours at 150°C. The drop time (ts) between the marked lines was measured using an Ubbelohde viscometer in a 135°C thermostatic bath. Similarly, three solutions were prepared by changing the weight of the polyolefin, and the drop time was measured. The drop time (tb) of only decalin without containing polyolefin as a blank was measured. The reduced viscosity (ηsp/C) of the polymer obtained according to the following formula was plotted respectively to derive a linear equation of the concentration (C) (unit: g/dL) and the reduced viscosity (ηsp/C) of the polymer, and the intrinsic viscosity ([η]) extrapolated to concentration 0 was obtained.

ηsp/C=(ts/tb-1)/C (units: dL/g)

Next, the viscosity average molecular weight (Mv) was calculated using the value of the limiting viscosity ([η]) using formula (A).

$Mv = (5.34\times10^{-4}) \times [\eta]^{1.49}$ ... (A)

[0077]

(5) Average particle diameter

The average particle diameter of the polyolefin particles was measured using SALD-2100 made by Shimadzu Corporation, using methanol as a dispersion medium, and the particle diameter where the cumulative weight was 50% was the average particle diameter. Furthermore, the cumulative weight in the range of 1 to 500 μm was calculated, and it was confirmed that 90 weight % or more of the total measured particles was present.

[0078]

(6) Percentage of particles with a particle diameter of 106 μm or more

For the ratio of particles exceeding 106 μm particle diameter, the mass of the particles remaining in the sieve when 100 g particles were classified was measured using a sieve with 106 μm openings defined in JISZ8801. The ratio of particles with a particle diameter of 106 μm or more was determined by dividing the mass of polyethylene particles remaining in the sieve by the total mass of polyethylene.

[0079]

(7) Tap density

The tap density of the polyolefin particles was measured by placing the polyethylene particles in a glass cylinder at 100 mL, tapping 500 times, and then measuring the volume. The mass of the polyethylene particles divided by volume was used as the tap density.

[0080]

(8) Evaluation of water suction time and uniformity

The water suction time and uniformity were determined by perpendicularly immersing the bottom portion 20 mm of the polyolefin porous sintered compact with a width of 30 mm and a height of 100 mm in water at 25°C under atmospheric pressure and measuring the time difference between the time from the immersion until the first water reaches a height of 70 mm (suction height of 50 mm) and the time from the arrival of the first water at a height of 70 mm until the last water arrives in the width direction.

○: Suction time is 20 seconds or less and time difference is less than 1 second.

Δ: Suction time is 20 seconds or less, and the time difference is 1 second or more and less than 4 seconds, or suction time is 20 seconds to 30 seconds, and the time difference is less than 1 second.

×: Suction time is 30 seconds or more, and the time difference is 4 seconds or more.

[0081]

(9) Evaluation of low pressure loss

The pressure loss was measured using the method described in JIS B 9927 with a wind speed of 5.3 cm/sec, and the difference in pressure loss ΔP before and after the test was compared and evaluated as follows.

○: Pressure loss difference ΔP is less than 0.1 mmH_2O.

×: Pressure loss difference ΔP is 0.1 mmH_2O or more.

[0082]

(10) Variation in pore volume, median pore diameter, and D90/D10 ratio

Ten points were selected at random from the test pieces according to (1) obtained from a plurality of polyolefin porous sintered compact sheets, the pore volume, median pore diameter, and D90/D10 ratio were measured at 10 points using the method of (1), and the following evaluation was made from the variance in these values.

○: Among pore volume, median pore diameter, and D90/D10 ratio, the maximum values or the minimum values from the average value of 10 points are all less than 10%.

×: Among pore volume, median pore diameter, and D90/D10 ratio, one or more of the maximum values or the minimum values from the average value of 10 points is 10% or more.

[0083]

(11) Rust test

Four stainless steel plates (SUS316) with a width of 5 cm, a length of 5 cm, and a thickness of 2 mm were placed on a metal frame with an inner diameter of 20 cm, a length of 20 cm, and a thickness of 5 mm, four polyolefin porous sintered compact sheets of the same size were stacked thereon, pressed for 22 minutes under the conditions of 200°C and 15 MPa, and then cooled for 10 minutes under the conditions of 25°C and 15 MPa. After this sample

was allowed to stand for two hours in a constant temperature and humidity chamber at a temperature of 60°C and humidity of 90%, the polyolefin porous sintered compact sheet was peeled, and rust on the stainless steel plate was evaluated.

◎: Rust was not observed at all.

○: The occurrence of rust is extremely slight and is seen in only a very small portion.

Δ: Although rust generation is small, rust is observed over the entire surface.

×: Entire surface is rusted.

[0084]

[Reference Examples] Catalyst Synthesis

[Reference Example 1: Preparation of Ziegler-Natta Catalyst Component [A]]

In this method, 2,000 mL of hexane was added to an 8 L stainless steel autoclave in which air was sufficiently replaced with nitrogen. 800 mL of a 1 mol/L titanium tetrachloride hexane solution and 800 mL of a hexane solution of a 1 mol/L organomagnesium compound represented by the composition formula $AlMg_5(C_4H_9)_{11}(OSiH)_2$ were simultaneously added in the same amount over six hours while stirring two paddle blades at 0°C at 400 rpm. After adding, the temperature was increased to 10°C, and the reaction was continued for 3 hours. After the reaction was completed, stirring was stopped and the solution was left to stand, and then 2,000 mL of the supernatant solution was removed and washed five times using 1,600 mL of hexane to prepare the solid catalyst component [A]. The amount of titanium contained in 1 g of the solid catalyst component [A] was 3.05 mmol.

[0085]

[Reference Example 2: Preparation of Ziegler-Natta Catalyst Component [B]]

(1) Synthesis of (B-1) carrier

1000 mL of a 2 mol/L hexane solution of hydroxytrichlorosilane was placed in an 8 L stainless steel autoclave in which air had been sufficiently replaced with nitrogen, and while stirring at 65°C, 2550 mL of a hexane solution of an organomagnesium compound represented by the compositional formula $AlMg_5(C_4H_9)_{11}(OC_4H_9)_2$ (equivalent to 2.68 mol of magnesium) was added dropwise for four hours, and the reaction was continued while stirring at 65°C for one hour. After the reaction was completed, the supernatant solution was removed and washed four times with 1800 mL of hexane. As a result of analyzing this solid ((B-1) carrier), the magnesium contained per 1 g of the solid was 8.31 mmol.

[0086]

(2) Preparation of Solid Catalyst Component [B]

110 mL of a 1 mol/L titanium tetrachloride hexane solution and 110 mL of a 1 mol/L hexane solution of an organomagnesium compound represented by the compositional formula $AlMg_5(C_4H_9)11(OSiH)_2$ were simultaneously added for one hour while stirring at 10°C to 1970 mL of a hexane slurry containing 110 g of the (B-1) carrier. After addition, the reaction was continued for 1 hour at 10°C. After the reaction was completed, the supernatant solution was removed 1100 mL, and the solid catalyst component [B] was prepared by washing twice with 1100 mL of hexane. The amount of titanium contained in 1 g of the solid catalyst component [B] was 0.75 mmol.

[0087]

[Reference Example 3: Preparation of Supported Metallocene Catalyst Component [C]]

Spherical silica having an average particle diameter of 1 μm, a surface area of 900 m^2/g, and a pore volume within particles of 2.2 mL/g was fired and dehydrated at 500°C for five hours in a nitrogen atmosphere. The amount of surface hydroxyl groups in the dehydrated silica was 1.85 mmol/g per 1 g of SiO_2. 40 g of dehydrated silica was dispersed in 800 mL of hexane in an autoclave with a capacity of 1.8 L in a nitrogen atmosphere, and a slurry was obtained. A hexane solution (concentration: 1 mol/L) of triethyl aluminum was added to 80 mL while the obtained slurry was being kept at 50°C while being stirred, and then stirred for 2 hours, causing triethyl aluminum and the surface hydroxyl groups of the silica to react, and component [a] containing silica treated with triethyl aluminum and a supernatant solution, where the surface hydroxyl groups of the silica treated with triethyl aluminum were capped with triethyl aluminum was obtained. Afterward, unreacted triethyl aluminum was removed from the supernatant liquid by removing the supernatant liquid in the obtained reaction mixture by decantation. Thereafter, an appropriate amount of hexane was added to obtain 880 mL of hexane slurry of silica treated with triethyl aluminum.

Meanwhile, 200 mmol of [(N-t-butylamide)(tetramethyl-η5-cyclopentadienyl)dimethylsilane]titanium-1,3-

pentadiene (hereinafter referred to as "titanium complex") was dissolved in 1,000 mL of Isopar E [product name of the hydrocarbon mixture made by ExxonMobil Chemical Company (US)], and 20 mL of a 1 mol/L hexane solution of formula $AlMg_6(C_2H_5)_3(n\text{-}C_4H_9)_y$ synthesized in advance from triethyl aluminum and dibutyl magnesium was added, and then a hexanethium complex concentration was added to prepare 0.1 mol/L component [b].

Furthermore, 5.7 g of bis(tallow alkyl hydride)methylammonium tris(pentafluorophenyl)(4-hydroxyphenyl)borate (hereinafter referred to as "borate") was added to 50 mL of toluene and dissolved, and a 100 mmol/L toluene solution of borate was obtained. 5 mL of a 1 mol/L hexane solution of ethoxy diethyl aluminum was added to the toluene solution of borate at room temperature, and then hexane was added so that the borate concentration in the solution was 70 mmol/L. Then, the mixture was stirred for 1 hour at room temperature to obtain a reaction mixture containing borate.

46 mL of this reaction mixture containing borate was added to 800 mL of the slurry of component [a] obtained above while stirring at 15 to 20°C, and borate was carried on silica. Thus, a slurry of silica carrying borate was obtained. Furthermore, 32 mL of the component [b] obtained above was added and stirred for 3 hours, and a titanium complex and borate were caused to react. In this manner, a supported metallocene catalyst [C] containing silica and a supernatant solution and having a catalytically active species formed on the silica was obtained.

Afterward, unreacted triethyl aluminum was removed from the supernatant liquid by removing the supernatant liquid in the obtained reaction mixture by decantation.

[0088]

[Example 1]

(Polyolefin polymerization process)

Hexane, ethylene, hydrogen, and a catalyst were continuously supplied to a Bessel type 300 L polymerization reactor equipped with a stirrer. The polymerization pressure was 0.5 MPa. The polymerization temperature was maintained at 85°C by jacket cooling. Hexane was supplied from the bottom of the polymerizer at 40L/hr. The solid catalyst component [A] and triisobutyl aluminum are used as a cocatalyst. The solid catalyst component [A] was added at a rate of 0.2 g/hr from between the liquid surface and the bottom part of the polymerizer, and triisobutyl aluminum was added at a rate of 10 mmol/hr from between the liquid surface and the bottom part of the polymerizer. The ethylene polymer was produced at a rate of 10 kg/hr. Hydrogen was continuously supplied by a pump so that the hydrogen concentration in relation to the gaseous ethylene was 14 mol%. Note that hydrogen was supplied in advance from the catalyst introduction line in order to make contact with the catalyst, and ethylene was supplied from the bottom of the polymerizer. The catalytic activity was 80,000 g-PE/g-solid catalytic component [A]. The polymerization slurry was continuously discharged to a flash drum at a pressure of 0.05 Mpa and a temperature of 70°C so that the level of the polymerization reactor was kept constant, and unreacted ethylene and hydrogen were separated.

Next, the polymerization slurry was continuously sent to a centrifugal separator so that the level of the polymerization reactor was maintained constant, and the polymer and other solvents and the like were separated. The amount of solvent and the like in relation to the polymer at that time was 40%.

The separated polyethylene particles were dried while nitrogen was blown at 85°C. Note that in the drying step, steam was sprayed onto the polyethylene particles after polymerization to carry out the deactivation of the catalyst and co-catalyst. 0.3 parts by weight of polyoxysorbitan monolaurate was added to the obtained polyethylene particles and uniformly mixed using a Henschel mixer.

Using a sieve having a mesh size of 106 μm, polyethylene particles were obtained by removing those that did not pass through a sieve. The measurement results of the obtained polyethylene particles (PE1) are shown in Table 1.

[0089]

(Continuous sintering method)

As a method for manufacturing a polyolefin porous sintered compact, a continuous sintering apparatus composed of a rotary steel belt, a powder supply hopper with a low-speed rotary roller, a leveling part, a heating part, and a rolling roller was used. The obtained polyethylene particles are continuously deposited from a hopper on a mobile steel belt with a thickness of 0.15 mm or more, and passed through a scraping part provided with a clearance of 0.15 mm from the belt (deposited part has a flat plate shape), thereby uniformly deposited with a thickness of 0.15 mm. Next, a polyolefin porous sintered compact having a thickness of 0.15 mm was obtained by continuously

charging into a heating furnace set at 180°C, heating for 10 minutes, passing through a rolling roller with a temperature of 115°C that provides a clearance of 0.15 mm from the top of the belt, allowing to stand for 3 hours at 105°C, and then cooling at room temperature. The characteristics of the sintered body are shown in Table 1.

[0090]

[Example 2]

The polyethylene particles of example 2 were obtained by the same operations as example 1 except for the polymerization temperature being 78°C and the hydrogen concentration being 6 mol% in the polymerization step.

As the method for manufacturing the polyolefin porous sintered compact, the polyolefin porous sintered compact of example 2 was obtained by the same operations as example 1 other than depositing at least 0.5 mm and setting the clearance between the slide-off portion and the rolling roller to 0.5 mm. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0091]

[Example 3]

The polyolefin porous sintered compact was molded using the polyethylene particles obtained in example 2.

A mold process was used as the method for producing the polyolefin porous sintered compact. Using an aluminum plate having a thickness of 4.52 mm, a die with outer dimensions of a thickness of 4.52 mm, a width of 112 mm, a height of 108 mm and inner dimensions of a thickness of 0.52 mm, a width of 100 mm, and height of 100 mm was produced. An aluminum plate serving as a top cover of the mold was removed, and polyethylene particles were filled while vibrating using a vibrator for 30 seconds. A sintered body 0.5 mm thick was obtained by returning the top cover to the original position, heating in an oven at 150°C for 25 minutes, allowing to stand for 3 hours at 105°C, and then cooling at room temperature. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0092]

[Example 4]

The polyethylene particles of example 4 were obtained by the same operations as example 2 except that the polymerization temperature was 58°C and hydrogenation was not added in the polymerization step.

As a method for manufacturing the polyolefin porous sintered compact, a polyolefin porous sintered compact was obtained by the same operations as example 2. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0093]

[Example 5]

Using the polyethylene particles obtained in example 4, the polyolefin porous sintered compact was molded by the same method as in the example 3. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0094]

[Example 6]

In the polymerization step, the polyethylene particles of example 6 were obtained by the same operations as example 1, except that the polymerization temperature was 80°C, the polymerization pressure was 0.3 MPa, and the solid catalyst component was 1.2 g of the solid catalyst component [B] per hour.

As the method for manufacturing the polyolefin porous sintered compact, the polyolefin porous sintered compact of example 6 was obtained by the same operations as example 1 other than depositing at least 0.15 mm and setting the clearance between the slide-off portion and the rolling roller to 0.15 mm. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0095]

[Example 7]

The polyethylene particles of example 7 were obtained by the same operations as example 6 except that the polymerization temperature was 78°C and the polymerization pressure was 0.2 MPa.

As the method for manufacturing the polyolefin porous sintered compact, the polyolefin porous sintered compact of example 7 was obtained by the same operations as example 1 other than depositing at least 0.85 mm, setting the clearance between the slide-off portion and the rolling roller to 0.85 mm, and setting the heating time to

15 minutes. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0096]

[Example 8]

The polyolefin porous sintered compact of example 1 was placed in a polyethylene bag with aluminum vapor deposition, sealed with nitrogen gas, and then irradiated with γ rays of 200 kGy while cooling to -60°C using dry ice. A 25 volume% aqueous solution of tert-butanol (made by Genuine Chemical Co., Ltd., reagent grade) and hydroxypropyl acrylate (made by Tokyo Chemical Co., Ltd., reagent grade) were mixed to prepare a 14 volume % monomer solution, and then dissolved oxygen was removed by bubbling with nitrogen for 30 minutes at 40°C. The sintered body after γ-ray irradiation was placed in a reaction vessel and allowed to stand for 15 minutes under reduced pressure of 13.4 MPa or less, and then 1200 cm^3 of the above monomer solution was introduced and reacted at 40°C for 20 minutes. Next, this was immersed in 1200 cm^3 of a 50 vol% aqueous solution of 2-propanol (made by Wako Pure Chemical Industries, Ltd., reagent grade) at 25°C for 20 minutes, washed, this washing operation was repeated a total of three times, and then dried, and thus a hydrophilic polyolefin porous sintered compact was obtained. The characteristics of the obtained polyolefin porous sintered compact are shown in Table 1.

The obtained polyethylene polyolefin porous sintered compacts of example 1 and example 8 were immersed for seven hours in a warm water circulating tank set at 60°C. Then, the moisture remaining in the pores of the polyolefin porous sintered compact was removed and dried. After removing the 60°C hot water soluble component by repeating this operation a total of three times, water absorption evaluation was performed for water, and in example 1, the water absorption rate was extremely slow, but in example 8, the water absorption rate did not change even after hot water soluble components were removed.

[0097]

[Comparative Example 1]

The polyethylene particles of comparative example 1 were obtained by the same operations as example 1 except for the hydrogen concentration being 20 mol% in the polymerization step.

As the method for manufacturing the polyolefin porous sintered compact, the same operations as example 1 were performed, but some of the melted polyethylene particles fused to the steel belt, so the heating temperature was changed to 160°C, and the polyolefin porous sintered compact of comparative example 1 was obtained. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0098]

[Comparative Example 2]

In the polymerization process, polyethylene particles of Comparative Example 2 were obtained by the same operation as example 1 except for the polymerization temperature was 78°C, the polymerization pressure was 0.3 MPa, and the solid catalyst component was 1.2 g of Ziegler-Natta catalyst component [B] per hour.

As a method for manufacturing the polyolefin porous sintered compact, a polyolefin porous sintered compact was formed by the same method as example 2. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0099]

[Comparative Example 3]

The polyethylene particles of comparative example 3 were obtained by the same operations as example 2 except that classification was not performed using a sieve having 106 μm openings.

As a method for manufacturing the polyolefin porous sintered compact, a polyolefin porous sintered compact was formed by the same method as example 2. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0100]

[Comparative Example 4]

The polyolefin porous sintered compact was molded using the polyethylene particles obtained in example 2.

A mold process was used as the method for producing the polyolefin porous sintered compact. Using an aluminum plate having a thickness of 7.15 mm, a die with outer dimensions of a thickness of 9.15 mm , a width of 112 mm, a height of 108 mm and inner dimensions of a thickness of 5.15 mm, a width of 100 mm, and height of 100

mm was produced. An aluminum plate serving as a top cover of the mold was removed, and polyethylene particles were filled while vibrating using a vibrator for 30 seconds. A sintered body 5 mm thick was obtained by returning the top cover to the original position, heating in an oven at 150°C for 25 minutes, allowing to stand for 3 hours at 105°C, and then cooling at room temperature. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0101]

[Comparative Example 5]

10 kg of the polyolefin porous sintered compact of example 2 was filled into a mesh-shaped cylindrical mold (inner diameter 250 mm, height 500 mm), and polyethylene particles were filled while vibrating by a vibrator for 30 seconds. This was placed in a pressure resistant container, water vapor (160°C, 8 atm) was introduced, heated and sintered for 10 hours, and then allowed to stand at room temperature of 25°C and cooled. By cutting the obtained cylindrical polyolefin porous sintered compact, a sheet-shaped polyolefin porous sintered compact having a thickness of 500 μm was obtained. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0102]

[Comparative Example 6]

The polyethylene particles of comparative example 6 were obtained by the same operations as example 2 except that the polymerization temperature was 35°C and hydrogenation was not added in the polymerization step.

As a method for manufacturing the polyolefin porous sintered compact, a polyolefin porous sintered compact was obtained by the same operations as example 2. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0103]

[Comparative Example 7]

The polyolefin porous sintered compact was molded using the polyethylene particles obtained in example 1.

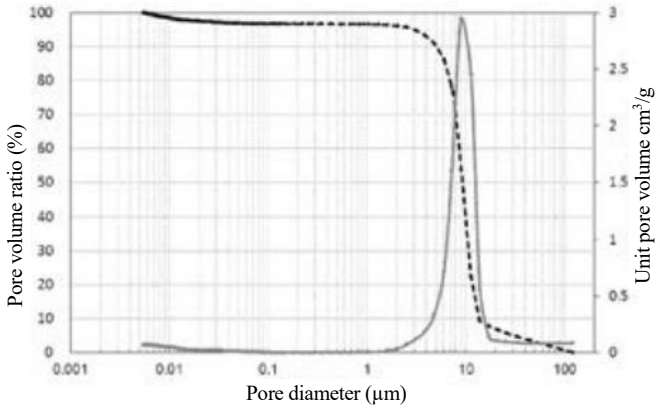
In the manufacturing method of the polyolefin porous sintered compact, the polyolefin porous sintered compact was obtained by the same method as example 1 other than allowing to stand for three hours at 105°C after passing through a rolling roller and then cooling at room temperature. The characteristics of the polyethylene particles and the polyolefin porous sintered compact are shown in Table 1.

[0104]

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Viscosity average molecular weight (Mv)	g/mol	1 million	3 million	3 million	7.5 million	7.5 million	600,000	9.5 million	1 million	100,000	3 million	3 million	3 million	3 million	12 million	1 million
Tap density	g/cc	0.33	0.40	0.40	0.47	0.47	0.54	0.49	0.33	0.31	0.58	0.40	0.40	0.40	0.56	0.33
Average particle diameter	μm	30	56	56	70	70	40	44	30	31	125	56	56	56	30	30
Ratio of particles 106 μm or more	%	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less	63	1.8	0.1 or less	0.1 or less	0.1 or less	0.1 or less
Forming method	-	Deposit	Deposit	Mold	Deposit	Mold	Deposit	Deposit	Deposit	Deposit	Deposit	Deposit	Mold	Skive	Deposit	Deposit
Thickness	mm	0.15	0.5	0.5	0.5	0.5	0.15	0.85	0.15	0.13	0.5	0.5	5	0.5	0.5	0.13
Pore volume	cm^3/g	0.98	0.35	0.29	0.53	0.51	1.23	1.78	0.73	0.55	2.13	0.39	0.15	0.09	3.62	0.87
Median pore diameter	μm	9.3	4.5	3.6	7.3	7.1	10.9	14.6	8.3	0.9	18.8	4.6	2.3	1.9	18.8	8.5
D10/D90	-	2.7	4.9	2.5	3.9	4.3	2.9	8.5	4.9	132	19.1	11.3	280	23.0	18.3	10.2
Aluminum alloy content	ppm	15	18	18	20	20	4	8	15	15	31	18	18	18	39	15
Chlorine content	ppm	2	3	3	5	5	1 or less	1 or less	1 or less	2	11	3	3	3	25	2
Water suction time and uniformity	-	○	○	○	○	○	○	○	○	×	×	△	×	×	△	△
Low pressure loss	-	○	○	○	○	○	○	○	○	×	×	×	×	×	×	×
Characteristic variation	-	○	○	○	○	○	○	○	○	×	○	○	×	×	○	×
Rust test	-	○	○	○	○	○	◎	◎	◎	○	×	○	○	○	×	○

[FIG. 1]


Pore volume ratio (%)
Unit pore volume cm³/g
Pore diameter (μm)
100
90
80
70
60
50
40
30
20
10
0
3
2.5
2
1.5
1
0.5
0
0.001
0.01
0.1
1
10
100

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DECLARATION OF TRANSLATOR

I, Eric Vance, hereby declare as follows:

1. I personally performed the attached translation from Japanese into English of the patent that is entitled “ポリオレフィン多孔質焼結成形体” in Japanese and “POLYOLEFIN POROUS SINTERED COMPACT” in English (also attached).

2. The attached translation is, to the best of my knowledge, a true, full and accurate translation of the attached Japanese document.

3. I am competent to perform this translation, because I have JLPT N1 certification, a baccalaureate degree in Japanese, and 7 years of experience as a professional patent translator.

4. I declare under the penalty of perjury under the laws of the United States that the foregoing is true and correct; and further declare that I am aware that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 1001 of Title 18 of the United States Code.

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