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(54) **BINDER-CONTAINING INORGANIC FIBER MOLDED BODY, HOLDING MATERIAL FOR EXHAUST GAS PURIFYING DEVICE, AND METHOD FOR PRODUCING BINDER-CONTAINING INORGANIC FIBER MOLDED BODY**

(57) The object of the present invention is to provide a binder-containing inorganic fiber molded body that can suppress fiber scattering in a case of a large basis weight and a low binder amount. The present invention provides a binder-containing inorganic fiber molded body containing an inorganic fiber in the inorganic fiber molded body. The basis weight of the inorganic fiber molded body is greater than 2600 g/m². The content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body.

When a shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes, a weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test is 1.0% or less.

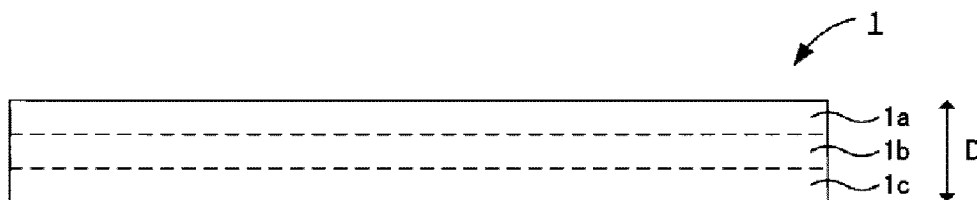


FIG. 1

EP 4 502 257 A1

Description

Technical Field

- 5 **[0001]** The present invention relates to a binder-containing inorganic fiber molded body including a binder in the inorganic fiber molded body, and to a method for producing the same.

Background Art

- 10 **[0002]** Inorganic fiber molded bodies with inorganic fibers such as ceramic fibers molded into a mat shape are widely used in applications that involve exposure to high temperature conditions, such as in industrial heat insulating materials, refractory materials, and packing materials. In addition, inorganic fiber molded bodies are also used as cushioning materials for automobile exhaust gas purification devices, that is, inorganic fiber molded bodies are also used as a holding material for an exhaust gas purification device. The holding material is wound around an exhaust gas treatment body such as a catalyst carrier or a particle filter and disposed between the exhaust gas treatment body and a casing (in the gap therebetween) when the exhaust gas treatment body is housed in a casing made of metal.

[0003] However, inorganic fiber molded bodies may have problems such as shedding and scattering of the inorganic fibers from the surface during processing, assembly, transportation, use, and the like, resulting in deterioration of the working environment.

- 20 **[0004]** Furthermore, ceramic fibers are known to be carcinogenic and may cause health problems, and regulations regarding inorganic fibers are being strengthened. For example, according to the World Health Organization (WHO), a fibrous substance that is inhaled into the human body upon respiration and reaches the lungs is referred to as an "inhalable fiber" and is defined as having a length of greater than 5 μm , a diameter of less than 3 μm , and an aspect ratio (ratio of the length to the diameter) of greater than 3. Therefore, when the inorganic fiber molded body contains such inhalable fibers, the above-described problem of fiber scattering becomes significant.

- 25 **[0005]** In recent years, a trend has emerged in which the exhaust gas purification device is arranged at a high temperature area directly below the engine in order to improve the catalytic efficiency. Therefore, in order to cope with the widening of the gap at higher temperatures and prevent leakage of the exhaust gas and damage to the exhaust gas treatment body, there is a demand for an inorganic fiber molded body having a large basis weight (for example, see Patent Literature 1). However, as the basis weight of the inorganic fiber molded body increases, the scattering amount of the inorganic fibers from the surface increases. Therefore, when the inorganic fiber molded body has a large basis weight, the above-described problem of fiber scattering becomes significant.

[0006] Thus, in order to suppress this fiber scattering, a binder such as an organic binder is generally included in the inorganic fiber molded body (for example, see Patent Literature 2).

- 30 **[0007]** When a binder is included in the inorganic fiber molded body, a method of impregnating the inorganic fiber molded body with a binder solution containing the binder is carried out. When the inorganic fiber molded body has a large basis weight, at least one of the thicknesses and the bulk density is large, and thus the binder solution does not easily permeate the inorganic fiber molded body. Therefore, even if a binder is included in an inorganic fiber molded body having a large basis weight, scattering of the fibers cannot be sufficiently suppressed.

- 35 **[0008]** Patent Literature 2 discloses that when a binder solution is sprayed onto an inorganic fiber molded body and allowed to permeate from the surface of the inorganic fiber molded body, it is possible to adjust the contents of the binder in the upper portion, in the middle portion, and in the lower portion of the inorganic fiber molded body by adjusting the strength at which the binder solution is sprayed. However, in the case of an inorganic fiber molded body having a large basis weight, that is, in the case of an inorganic fiber molded body having a large bulk density or thickness, when the spraying strength of the binder solution is increased to cause the binder solution to permeate into the inorganic fiber molded body, the surface layer structure of the inorganic fiber molded body may be destroyed, and the performance thereof may be reduced.

- 40 **[0009]** In addition, the problems with an inorganic fiber molded body containing an organic binder include generation of a combustion gas of the organic binder when the inorganic fiber molded body is used at a high temperature, and generation of an odor by the organic binder or the combustion gas. Therefore, although the effect of suppressing fiber scattering is enhanced by increasing the amount of the organic binder, with the increased attention to environmental problems in recent years, a significant reduction in the organic binder amount is in demand (for example, see Patent Literature 3).

Citation List

- 55 Patent Literature

[0010]

Patent Literature 1: JP 6870787 B
 Patent Literature 2: JP 4042305 B
 Patent Literature 3: JP 4665618 B

5 Summary of Invention

Technical Problem

10 **[0011]** As described above, it is difficult to achieve both a low binder amount and a low dust generation when an inorganic fiber molded body having a large basis weight is used. Therefore, although there is a need for an inorganic fiber molded body having a large basis weight, it is difficult to solve the problem of fiber scattering and to increase the added value. Hence, such inorganic fiber molded bodies are not used in practical applications. Thus, a binder-containing inorganic fiber molded body that uses an inorganic fiber molded body having a large basis weight, has a reduced amount of the binder, and can suppress fiber scattering does not exist at present.

15 **[0012]** The present invention is developed in view of the above circumstances, and a main object thereof is to provide a binder-containing inorganic fiber molded body that can suppress fiber scattering in a case in which the inorganic fiber molded body has a large basis weight and a low binder amount.

Solution to Problem

20 **[0013]** In order to achieve the above object, an aspect of the present invention provides a binder-containing inorganic fiber molded body including a binder in the inorganic fiber molded body, in which the basis weight of the inorganic fiber molded body is greater than 2600 g/m², a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

25 **[0014]** Further, another aspect of the present invention provides a binder-containing inorganic fiber molded body including a binder in an inorganic fiber molded body,

in which

30 a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and

35 a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

40 **[0015]** Another aspect of the present invention provides a binder-containing inorganic fiber molded body including a binder in an inorganic fiber molded body, in which a basis weight of the inorganic fiber molded body is greater than 2600 g/m², when the binder-containing inorganic fiber molded body is equally divided into three parts in a thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber contained in the corresponding region, and

45 a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

50 **[0016]** Another aspect of the present invention also provides a binder-containing inorganic fiber molded body including a binder in the inorganic fiber molded body, in which a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less,

when the binder-containing inorganic fiber molded body is equally divided into three parts in a thickness direction, and

the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber contained in the corresponding region, and

a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

[0017] In addition, in the aspects of the present invention, when the binder-containing inorganic fiber molded body is equally divided into three parts in the thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is preferably 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber contained in the corresponding region.

[0018] In this case, a difference between the content of the binder in the binder-containing inorganic fiber molded body and the maximum content among the contents of the binder in the first region, the second region, and the third region is preferably 0.75 parts by mass or less.

[0019] Furthermore, in the aspects of the present invention, the binder is preferably an organic binder.

[0020] Moreover, in the aspects of the present invention, the inorganic fiber molded body preferably contains alumina fibers.

[0021] Further, in the aspects of the present invention, the inorganic fiber molded body is preferably a needle blanket.

[0022] Another aspect of the present invention provides a holding material for an exhaust gas purification device, the holding material including the above-described binder-containing inorganic fiber molded body.

[0023] Another aspect of the present invention provides a method for producing a binder-containing inorganic fiber molded body of a first embodiment of the present invention including impregnating an inorganic fiber molded body with a binder solution containing a binder, in which the basis weight of the inorganic fiber molded body is greater than 2600 g/m², the content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a supply amount of the binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

[0024] Another aspect of the present invention provides a method for producing a binder-containing inorganic fiber molded body, the method including impregnating an inorganic fiber molded body with a binder solution containing a binder, wherein

a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a supply amount of the binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

[0025] Moreover, in the aspects of the present invention, the impregnation of the inorganic fiber molded body with the binder solution is performed by applying the binder solution to the inorganic fiber molded body, and performed by a process other than immersion, or performed by immersing a portion of the inorganic fiber molded body in the binder solution, or performed by injecting the binder solution into the inorganic fiber molded body.

Advantageous Effects of Invention

[0026] In the binder-containing inorganic fiber molded body of the present invention, an effect of suppressing fiber scattering is exhibited in the case in which the inorganic fiber molded body has a large basis weight and a low binder amount.

Brief Description of Drawings

[0027] FIG. 1 is a schematic cross-sectional view illustrating an example of a binder-containing inorganic fiber molded body of the present invention.

Description of Embodiments

[0028] Hereinafter, a binder-containing inorganic fiber molded body, a holding material for an exhaust gas purification device, and a method for producing a binder-containing inorganic fiber molded body according to the present invention will be described.

A. Binder-Containing Inorganic Fiber Molded Body

[0029] The binder-containing inorganic fiber molded body of the present invention has four embodiments. Hereinafter, each embodiment will be described.

I. First Embodiment of Binder-Containing Inorganic Fiber Molded Body

[0030] A binder-containing inorganic fiber molded body of a first embodiment includes a binder in the inorganic fiber molded body, in which the basis weight of the inorganic fiber molded body is greater than 2600 g/m^2 , a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

[0031] In the present embodiment, an inorganic fiber molded body having a large basis weight is used, and the content of the binder is low. Even in such a case, since the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the above-described shaking test is a predetermined value or less, fiber scattering can be suppressed, and the amount of dust that is generated can be reduced. Therefore, a binder-containing inorganic fiber molded body that can ensure an appropriate working environment and is environmentally safe can be provided.

[0032] Hereinafter, each constitution of the binder-containing inorganic fiber molded body of the present embodiment will be described.

1. Inorganic Fiber Molded Body

[0033] The inorganic fiber molded body in the present embodiment is an aggregate of inorganic fibers and is referred to as, for example, a mat, a blanket, or a block.

[0034] The basis weight of the inorganic fiber molded body is greater than 2600 g/m^2 , preferably 2800 g/m^2 or greater, and more preferably 3000 g/m^2 or greater. In the present embodiment, even when the basis weight of the inorganic fiber molded body is large, as within the above range, the amount of dust that is generated from the binder-containing inorganic fiber molded body can be reduced. On the other hand, the upper limit of the basis weight of the inorganic fiber molded body is not particularly limited, but is, for example, preferably 10000 g/m^2 or less, more preferably 7000 g/m^2 or less, and still more preferably 5000 g/m^2 or less. When the basis weight of the inorganic fiber molded body is too large, the inorganic fiber molded body becomes thick, which may make it difficult to assemble the binder-containing inorganic fiber molded body or may increase the cost.

[0035] The basis weight of the inorganic fiber molded body can be controlled by adjusting the bulk density and thickness of the inorganic fiber molded body in a free state.

[0036] The bulk density of the inorganic fiber molded body in a free state is, for example, preferably 0.10 g/cm^3 or greater and 0.20 g/cm^3 or less, more preferably 0.13 g/cm^3 or greater and 0.20 g/cm^3 or less, and even more preferably 0.15 g/cm^3 or greater and 0.20 g/cm^3 or less. In the present embodiment, even when the bulk density of the inorganic fiber molded body in a free state is large, as within the above range, the amount of dust that is generated from the binder-containing inorganic fiber molded body can be reduced. On the other hand, when the bulk density of the inorganic fiber molded body in a free state is too large, the inorganic fiber molded body becomes hard, and thus the moldability may be reduced. If the bulk density of the inorganic fiber molded body in a free state is too small, the mechanical strength of the molded body may be reduced. The bulk density of the inorganic fiber molded body in a free state refers to the bulk density of the inorganic fiber molded body in a free state before the binder is included.

[0037] The thickness of the inorganic fiber molded body is preferably a thickness at which the above-described basis weight and bulk density can be satisfied, and the thickness can be appropriately set according to the above-described basis weight and bulk density, the intended use, and the like.

[0038] The inorganic fibers constituting the inorganic fiber molded body are not particularly limited, and for example, ceramic fibers, biosoluble fibers (alkaline earth silicate fibers), rock wool, basalt fibers, potassium titanate fibers, calcium silicate fibers, and glass fibers can be used. Moreover, examples of the ceramic fibers include single fibers or composite

fibers of silica, alumina, alumina/silica, zirconia containing these, spinel, titania, and calcia. Among these, the inorganic fibers are preferably alumina/silica fibers, and are particularly preferably crystalline aluminasilica fibers. The aluminasilica fibers are ceramic fibers containing alumina and silica as main components, and are simply referred to as "alumina fibers". When the inorganic fibers are aluminasilica fibers (alumina fibers), the composition ratio (mass ratio) of the alumina/silica is, for example, preferably in a range from 60/40 to 98/2, more preferably in a range from 65/35 to 95/5, and preferably in a range from 70/30 to 80/20.

[0039] The inorganic fibers are preferably short fibers. This is because the toughness can be increased without impairing the thickness of the inorganic fiber molded body when the inorganic fibers are short. The inorganic fibers being short fibers means, for example, that the average fiber length of the inorganic fibers is 1000 mm or less. When the inorganic fibers are short fibers, the average fiber length of the inorganic fibers may be, for example, in a range of 210 μm or greater and 1000 μm or less.

[0040] The average fiber diameter of the inorganic fibers is not particularly limited, but is, for example, preferably 3 μm or greater and 15 μm or less, more preferably 4 μm or greater and 13 μm or less, still more preferably 5 μm or greater and 10 μm or less, and particularly preferably 5 μm or greater and 8 μm or less. This is because the repulsive force and toughness of the inorganic fibers are improved, and the strength of the fibers can be increased. Note that if the average fiber diameter of the inorganic fibers is too large, the cold compression cycle characteristics (cold compression) of the inorganic fiber molded body may be lost. On the other hand, if the average fiber diameter of the inorganic fibers is too small, the amount of dust that is generated and floating in the air may increase, or the amount of fibrous substances reaching the lungs upon inhalation may increase.

[0041] The inorganic fiber molded body is preferably a needle blanket. The needle blanket is an inorganic fiber molded body that has been subjected to a needling treatment. Through the needling treatment, not only can a strong inorganic fiber molded body in which the inorganic fibers are entangled with each other be formed, but also the thickness of the inorganic fiber molded body can be adjusted.

[0042] When the inorganic fiber molded body is a needle blanket, the inorganic fiber molded body has a plurality of needle marks, that is, a plurality of recesses. The needle mark may be a through hole penetrating in the thickness direction of the inorganic fiber molded body, or may be a non-through hole that does not penetrate the inorganic fiber molded body.

[0043] The number of needle marks per unit area of the inorganic fiber molded body (hereinafter, referred to as a needle mark density) is not particularly limited, but as the needle mark density increases, the shearing force increases, but the surface pressure decreases, and as the needle mark density decreases, the surface pressure increases, but the shearing force decreases. Therefore, the needle mark density is preferably a density at which a good balance is achieved between the shearing force and the surface pressure. The needle mark density can be, for example, 1.0 marks/cm² or greater and 50.0 marks/cm² or less.

[0044] Here, when one surface of the inorganic fiber molded body is irradiated with visible light, the amount of transmitted light at a needle mark is greater than the amount of transmitted light at a region other than the needle mark, and as a result, the transmitted light is observed as a light spot on the other surface of the inorganic fiber molded body. Therefore, the number of needle marks can be determined by irradiating one surface of the inorganic fiber molded body with visible light, and counting the light spots due to the transmission of light to the other surface of the inorganic fiber molded body. Note that the light spot can be confirmed regardless of whether the needle mark is a through hole or a non-through hole.

[0045] The needle marks may be provided at equal intervals in a plan view, or may be randomly provided. The average distance between two adjacent needle marks may be, for example, 0.1 cm or greater and 4 cm or less.

[0046] The inorganic fiber molded body may have a long shape or a sheet-like shape.

2. Binder

[0047] The binder in the present embodiment is included in the inorganic fiber molded body and binds the inorganic fibers and inorganic fiber bundles. As the binder, either an organic binder or an inorganic binder can be used.

[0048] Examples of the organic binder include various rubbers, water-soluble polymer compounds, thermoplastic resins, and thermosetting resins. Specific examples thereof include synthetic rubbers such as acrylic rubber and nitrile rubber; water-soluble polymer compounds such as carboxymethyl cellulose and polyvinyl alcohol; and acrylic resins. A single type of organic binder may be used alone, or two or more types may be mixed and used. Among these, acrylic rubber, nitrile rubber, carboxymethyl cellulose, polyvinyl alcohol, and an acrylic resin not included in acrylic rubber are preferable. This is because with these organic binders, an organic binder solution can be easily prepared, and the below-described effects of the organic binder are easily exhibited.

[0049] On the other hand, examples of the inorganic binder include inorganic oxides. Specific examples thereof include alumina, spinel, zirconia, magnesia, titania, calcia, and materials having the same composition as that of the inorganic fibers. A single type of inorganic binder may be used alone, or two or more types may be mixed and used. The average particle diameter of the inorganic oxide is not particularly limited, but may be, for example, 1 μm or less.

[0050] The binder preferably includes an organic binder. In this case, the binder may be only an organic binder or may include both an organic binder and an inorganic binder. Among these options, the binder is preferably an organic binder. This is because an organic binder is more easily impregnated into the inorganic fiber molded body than an inorganic binder. In addition, an organic binder can be easily thermally decomposed or burned off under the usage temperature condition of the binder-containing inorganic fiber molded body. Therefore, the repulsive force of the inorganic fiber molded body can be restored, and the binder-containing inorganic fiber molded body can be suitably used as, for example, a holding material for an exhaust gas purification device.

[0051] In the present embodiment, the content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less, and more preferably 0.10 parts by mass or greater and 1.50 parts by mass or less, per 100 parts by mass of the inorganic fiber molded body. In the present embodiment, in a case in which an inorganic fiber molded body having a large basis weight is used, the amount of dust that is generated from the binder-containing inorganic fiber molded body can be reduced even when the binder content is low as within the above range.

[0052] In the present embodiment, for example, as illustrated in FIG. 1, when a binder-containing inorganic fiber molded body 1 is equally divided into three parts in a thickness direction D, and the three parts are defined as a first region 1a, a second region 1b, and a third region 1c from one surface side of the binder-containing inorganic fiber molded body 1, among the contents of the binder in the first region, the second region, and the third region, the maximum content is preferably 0.01 parts by mass or greater and 2.24 parts by mass or less, and more preferably 0.10 parts by mass or greater and 1.50 parts by mass or less per 100 parts by mass of the inorganic fiber included in the corresponding region.

[0053] In this case, the difference between the content of the binder in the binder-containing inorganic fiber molded body and the maximum content among the contents of the binder in the first region, the second region, and the third region is preferably 0.75 parts by mass or less, more preferably 0.70 parts by mass or less, and still more preferably 0.60 parts by mass or less. When the difference between the content of the binder and the maximum content is within the above range, it can be considered that the binder is included in all of the first to third regions without being unevenly distributed. Therefore, the portion in which the inorganic fibers or the inorganic fiber bundles are bound by the binder can be increased, and the amount of dust generated from the binder-containing inorganic fiber molded body can be further reduced.

[0054] In addition, the binder is preferably included in all of the first to third regions. As described above, the portion in which the inorganic fibers or the inorganic fiber bundles are bound by the binder can be increased, and the amount of dust generated from the binder-containing inorganic fiber molded body can be further reduced.

[0055] In this case, the content of the binder in each of the first region, the second region, and the third region is, for example, 0.01 parts by mass or greater and 2.24 parts by mass or less, and more preferably 0.10 parts by mass or greater and 1.50 parts by mass or less per 100 parts by mass of the inorganic fibers included in the corresponding region of the first region, the second region, and the third region. When the content of the binder in each of the first region, the second region, and the third region is within the above range, the inorganic fibers or the inorganic fiber bundles can be bound by the binder in all of the first to third regions, and the amount of dust generated from the binder-containing inorganic fiber molded body can be further reduced.

[0056] Further, the content of the binder in each of the first region, the second region, and the third region may be the same or different.

[0057] Note that in the binder-containing inorganic fiber molded body, the content of the binder refers to the percentage (%) of the mass of the binder to the mass of the inorganic fiber molded body. Moreover, the content of the binder in each of the first region, the second region, and the third region refers to the percentage (%) of the mass of the binder included in each of the first region, the second region, and the third region to the mass of the inorganic fiber included in the corresponding region of the first region, the second region, and the third region.

[0058] Here, the method for determining the content of the binder in the binder-containing inorganic fiber molded body is not particularly limited, but for example, when the binder is an organic binder, the content can be calculated by the following method. That is, first, a 50 mm-square sample is cut out from the binder-containing inorganic fiber molded body. Next, a binder bum-off treatment is carried out in which the sample of the binder-containing inorganic fiber molded body is heated at 800°C for 1 hour, and thereby the organic binder is burned off. In addition, the mass before and after the binder bum-off treatment is measured. The mass after the binder burn-off treatment corresponds to the mass of the inorganic fiber molded body included in the binder-containing inorganic fiber molded body. The difference in mass between before and after the binder burn-off treatment corresponds to the mass of the organic binder included in the binder-containing inorganic fiber molded body. Moreover, the content of the binder in the binder-containing inorganic fiber molded body is calculated by the following equation (1).

$$\text{Binder content (\%)} = [(\text{mass before binder bum-off treatment}) - (\text{mass after binder burn-off})] \times 100 / (\text{mass before binder bum-off treatment}) \quad (1)$$

[0059] In addition, the method for determining the binder content in each of the first to third regions is not particularly limited, and for example, when the binder is an organic binder, the binder content can be calculated by the following

method. That is, first, the binder-containing inorganic fiber molded body is equally divided into three parts in the thickness direction to obtain a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body. Next, a 50 mm-square sample is cut out from each of the regions. The samples of each region are then subjected to a binder burn-off treatment by heating at 800°C for 1 hour, and thereby the organic binder is burned off. In addition, the mass before and after the binder burn-off treatment is measured. Note that the mass after the binder burn-off treatment corresponds to the mass of the inorganic fibers included in the respective region. The difference in mass between before and after the binder burn-off treatment corresponds to the mass of the organic binder included in the respective region. The content of the binder in each region is then calculated by the above equation (1).

[0060] In addition, the method for confirming that the binder is included in each of the first to third regions is not particularly limited. However, for example, when the binder is an organic binder, the presence or absence of the organic binder can be confirmed by the following method. That is, first, the binder-containing inorganic fiber molded body is equally divided into three parts in the thickness direction to obtain a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body. Next, a 50 mm-square sample is cut out from each of the regions. The samples of each region are then subjected to a binder burn-off treatment by heating at 800°C for 1 hour, and thereby the organic binder is burned off. In addition, the mass before and after the binder burn-off treatment is measured. The difference in mass between before and after the binder burn-off treatment corresponds to the mass of the organic binder included in the respective region. Therefore, when the mass after the binder burn-off treatment is less than the mass before the binder burn-off treatment, it is determined that the organic binder was included.

3. Weight Reduction Ratio of Binder-Containing Inorganic Fiber Molded Body Before and After Shaking Test

[0061] In the present embodiment, when a shaking test is carried out in which the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes, the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test is 1.0% or less, preferably 0.9% or less, and more preferably 0.8% or less. When the weight reduction ratio is within the above range, fiber scattering can be suppressed, and the amount of dust that is generated can be reduced. The weight reduction ratio is preferably as small as possible, and thus the lower limit of the weight reduction ratio is not particularly limited.

[0062] The shaking test is carried out by the following method. First, a 50 mm-square sample is cut out from the binder-containing inorganic fiber molded body. Next, the sample of the binder-containing inorganic fiber molded body is placed in a sieve. As the sieve, a sieve having a diameter of 200 mm and a mesh size of 4 mm is used. The sieve is then mounted on a shaker. As the shaker, for example, the "Analysette 3" available from Fritsch GmbH can be used. Next, the shaking test is performed using the shaker, in which the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes. Moreover, the weight of the binder-containing inorganic fiber molded body is measured before and after the shaking test. In addition, the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test is calculated by the following equation (2).

Weight reduction ratio (%) = [(weight of binder-containing inorganic fiber molded body before shaking test) - (weight of binder-containing inorganic fiber molded body after shaking test)] / (weight of binder-containing inorganic fiber molded body before shaking test) × 100 (2)

[0063] In addition, three 50 mm-square samples are randomly cut from the binder-containing inorganic fiber molded body, each sample is subjected to the above-described shaking test, the above-described weight reduction ratio is calculated for each sample, and the average value is determined. This average value is adopted as the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test. Note that the three samples taken from the same binder-containing inorganic fiber molded body may be subjected to the shaking test at the same time if the weights thereof are measured individually.

4. Other

[0064] The average thickness of the binder-containing inorganic fiber molded body of the present embodiment is not particularly limited, and can be appropriately set according to the application or the like. The average thickness may be, for example, in an approximate range of 2 mm or greater and 50 mm or less.

5. Applications

[0065] Examples of applications of the binder-containing inorganic fiber molded body of the present embodiment include thermal insulation applications, fireproofing applications, construction applications, and in-vehicle applications. Specifically, the binder-containing inorganic fiber molded body of the present embodiment can be applied in, for example, a heat insulating material, a refractory material, a cushioning material (holding material), a sealing material, and a packing material. Among these applications, the binder-containing inorganic fiber molded body of the present embodiment has a large basis weight and a low binder amount, and thus is suitable as a holding material for an exhaust gas purification device.

II. Second Embodiment of Binder-Containing Inorganic Fiber Molded Body

[0066] A binder-containing inorganic fiber molded body of a second embodiment includes a binder in the inorganic fiber molded body, in which the bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, the content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

[0067] In the present embodiment, an inorganic fiber molded body having a large bulk density and a large basis weight is used, and the content of the binder is low. Even in such a case, since the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the above-described shaking test is a predetermined value or less, fiber scattering can be suppressed, and the amount of dust that is generated can be reduced. Therefore, a binder-containing inorganic fiber molded body that can ensure an appropriate working environment and is environmentally safe can be provided.

[0068] The configuration of the binder-containing inorganic fiber molded body of the present embodiment can be the same as that of the binder-containing inorganic fiber molded body of the first embodiment described above, and thus the description thereof is omitted here.

III. Third Embodiment of Binder-Containing Inorganic Fiber Molded Body

[0069] A binder-containing inorganic fiber molded body of a third embodiment includes a binder in the inorganic fiber molded body, in which the basis weight of the inorganic fiber molded body is greater than 2600 g/m², when the binder-containing inorganic fiber molded body is equally divided into three parts in a thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among the contents of the binder in the first region, the second region, and the third region, the maximum content is 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber included in the corresponding region, and a weight reduction rate of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

[0070] In the present embodiment, among the binder contents of the three regions obtained by equally dividing the binder-containing inorganic fiber molded body into three parts in the thickness direction, the maximum content is within the prescribed range and is small. Therefore, it can be considered that the binder content of the binder-containing inorganic fiber molded body is also small. Moreover, in the present embodiment, an inorganic fiber molded body having a large basis weight is used, and the content of the binder is low. Even in such a case, since the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the above-described shaking test is a predetermined value or less, fiber scattering can be suppressed, and the amount of dust that is generated can be reduced. Therefore, a binder-containing inorganic fiber molded body that can ensure an appropriate working environment and is environmentally safe can be provided.

[0071] In the present embodiment, the difference between the content of the binder in the binder-containing inorganic fiber molded body and the maximum content among the contents of the binder in the first region, the second region, and the third region is preferably 0.75 parts by mass or less. When the difference in the binder content is within the above range, it can be considered that the binder is included in all of the first to third regions without being unevenly distributed. Therefore, the portion in which the inorganic fibers or the inorganic fiber bundles are bound by the binder can be increased, and the amount of dust generated from the binder-containing inorganic fiber molded body can be further reduced.

[0072] The configuration of the binder-containing inorganic fiber molded body of the present embodiment can be the same as that of the binder-containing inorganic fiber molded body of the first embodiment described above, and thus the description thereof is omitted here.

5 IV. Fourth Embodiment of Binder-Containing Inorganic Fiber Molded Body

[0073] A binder-containing inorganic fiber molded body of a fourth embodiment includes a binder in the inorganic fiber molded body, in which the bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, when the binder-containing inorganic fiber molded body is equally divided into three parts in the thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among the contents of the binder in the first region, the second region, and the third region, a maximum content is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber included in the corresponding region, and a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

[0074] In the present embodiment, among the binder contents of the three regions obtained by equally dividing the binder-containing inorganic fiber molded body into three parts in the thickness direction, the maximum content is within the prescribed range and is small. Therefore, it can be considered that the binder content of the binder-containing inorganic fiber molded body is also small. Moreover, in the present embodiment, an inorganic fiber molded body having a large bulk density and a large basis weight is used, and the content of the binder is low. Even in such a case, since the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the above-described shaking test is a predetermined value or less, fiber scattering can be suppressed, and the amount of dust that is generated can be reduced. Therefore, a binder-containing inorganic fiber molded body that can ensure an appropriate working environment and is environmentally safe can be provided.

[0075] In the present embodiment, the difference between the content of the binder in the binder-containing inorganic fiber molded body and the maximum content among the contents of the binder in the first region, the second region, and the third region is preferably 0.75 parts by mass or less. When the difference in the binder content is within the above range, it can be considered that the binder is included in all of the first to third regions without being unevenly distributed. Therefore, the portion in which the inorganic fibers or the inorganic fiber bundles are bound by the binder can be increased, and the amount of dust generated from the binder-containing inorganic fiber molded body can be further reduced.

[0076] The configuration of the binder-containing inorganic fiber molded body of the present embodiment can be the same as that of the binder-containing inorganic fiber molded body of the first embodiment described above, and thus the description thereof is omitted here.

B. Holding Material for Exhaust Gas Purification Device

[0077] A holding material for an exhaust gas purification device of the present invention includes the above-described binder-containing inorganic fiber molded body. The holding material for an exhaust gas purification device is for an exhaust gas treatment body such as a catalyst carrier or a particle filter, and when the exhaust gas treatment body is to be housed in a casing made of metal, the holding material is wound around the exhaust gas treatment body and interposed between the exhaust gas treatment body and the metal casing. The holding material for an exhaust gas purification device of the present invention is made of the binder-containing inorganic fiber molded body described above. Specifically, the above-described binder-containing inorganic fiber molded body is subjected to shape processing such as cutting to produce the holding material for an exhaust gas purification device.

C. Method for Producing Binder-Containing Inorganic Fiber Molded Body

[0078] The method for producing a binder-containing inorganic fiber molded body of the present invention has two embodiments. Hereinafter, each embodiment will be described.

I. First Embodiment of Method for Producing Binder-Containing Inorganic Fiber Molded Body

[0079] A method for producing a binder-containing inorganic fiber molded body of a first embodiment of the present invention includes impregnating an inorganic fiber molded body with a binder solution containing a binder, in which the basis weight of the inorganic fiber molded body is greater than 2600 g/m², the content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a supply amount of the

binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

[0080] In the present embodiment, an inorganic fiber molded body having a large basis weight is used. Even in such a case, the entire inorganic fiber molded body can be impregnated with the binder solution by relatively increasing the supply amount of the binder solution in the impregnating. Therefore, fiber scattering can be suppressed even when the content of the binder in the binder-containing inorganic fiber molded body is relatively small. Accordingly, when an inorganic fiber molded body having a large basis weight is used, the amount of dust that is generated can be reduced while also reducing the content of the binder. That is, in the case of the inorganic fiber molded body having a large basis weight, both a low binder amount and low amount of dust generation can be achieved.

[0081] Hereinafter, each step in the method for producing a binder-containing inorganic fiber molded body according to the present embodiment will be described.

1. Impregnating

[0082] In the present embodiment, the inorganic fiber molded body is impregnated with a binder solution containing a binder.

[0083] In the present embodiment, the supply amount of the binder solution in the impregnating is 5 vol% or greater, preferably 10 vol% or greater, more preferably 50 vol% or greater, and still more preferably 100 vol% or greater, relative to 100 vol% of the inorganic fiber molded body. When the supply amount of the binder solution is relatively large as in the above range, the entire inorganic fiber molded body can be impregnated with the binder solution. Fiber scattering can thereby be suppressed, and the amount of dust that is generated can be reduced. Meanwhile, the upper limit of the supply amount of the binder solution is not particularly limited, but the effect is saturated if the supply amount is too large. Therefore, from the viewpoint of cost and workability in a step after the impregnating, such as drying, the supply amount of the binder solution is, for example, 1000 vol% or less, and may be 500 vol% or less, or 300 vol% or less.

[0084] The inorganic fiber molded body is the same as the inorganic fiber molded body described in the above section "A. Inorganic Fiber Molded Body, I. First Embodiment", and thus a description thereof is omitted here.

[0085] As a method for producing the inorganic fiber molded body, a known method can be used. For example, the method disclosed in WO 2016/152795 may be used.

[0086] In addition, the binder included in the binder solution is also the same as the binder described in the above section "A. Inorganic Fiber Molded Body, I. First Embodiment", and thus a description thereof is omitted here.

[0087] The solvent and the dispersion medium included in the binder solution are appropriately selected according to the types of the binder and the binder solution, and examples thereof include water and organic solvents. A one type of solvent or dispersion medium may be used alone, or two or more types thereof may be mixed and used.

[0088] When an organic binder is used, an aqueous solution, a water-dispersed emulsion, a latex, or an organic solvent solution containing an organic binder can be used as the binder solution. An emulsion is particularly preferred. The binder solution may be prepared, or a commercially available organic binder solution may be used. A commercially available organic binder solution can be used as is, or may be diluted with water or the like and then used. An inorganic binder may be included in an organic binder solution. Examples of the dispersion medium for the organic binder include anionic surfactants, nonionic surfactants, and cationic surfactants. From the viewpoint of long-term stability of latex, these dispersion media may be appropriately added when preparing the binder solution.

[0089] When an inorganic binder is used, a sol, a colloid, a slurry, or a solution containing the inorganic binder can be used as the binder solution. An organic binder may be included in an inorganic binder solution. A dispersion stabilizer may be added to the inorganic binder solution to enhance the stability of the inorganic binder. Examples of the dispersion stabilizer include acetic acid, lactic acid, hydrochloric acid, and nitric acid.

[0090] The concentration of the binder in the binder solution is appropriately adjusted according to parameters such as the supply amount of the binder solution, the content of the binder in the targeted binder-containing inorganic fiber molded body, the type of the binder, and the method used for impregnating the binder solution. The binder concentration in the binder solution may be, for example, in a range 0.5 mass% or greater and 50 mass% or less. If the binder concentration is too low, the binder may be unevenly distributed in the binder-containing inorganic fiber molded body, and the amount of fiber scattering may not be sufficiently suppressed. On the other hand, if the binder concentration is too high, it may be difficult to impregnate the inorganic fiber molded body with the binder solution.

[0091] The method for impregnating the inorganic fiber molded body with the binder solution is not particularly limited as long as the method can uniformly impregnate the inorganic fiber molded body with the binder solution. Examples of the method thereof include a method of applying the binder solution to the inorganic fiber molded body and a method of injecting the binder solution into the inorganic fiber molded body.

[0092] The method of applying the binder solution to the inorganic fiber molded body is not particularly limited as long as the method can uniformly apply the binder solution to the inorganic fiber molded body, and examples thereof include a spray method, a roll coating method, a curtain coating method, a kiss coating method, a gravure coating method, a die coating method, and an immersion method. In addition, in the case of the immersion method, the entire inorganic fiber

molded body may be immersed in the binder solution, or a portion of the inorganic fiber molded body may be immersed in the binder solution. Note that in a case in which a portion of the inorganic fiber molded body is immersed in the binder solution, for example, a predetermined amount of the binder solution is placed in a container or the like, a portion of the surface or end face of the inorganic fiber molded body is brought into contact with the binder solution, and the entire amount of the binder solution is absorbed by the inorganic fiber molded body, and thereby the supply amount of the binder solution can be increased.

[0093] In addition, with the method of injecting the binder solution into the inorganic fiber molded body, for example, an injector such as a syringe, a pipette, or a dropper can be used. The binder solution may be repeatedly injected a plurality of times.

[0094] Among these methods, the method of impregnating the inorganic fiber molded body with the binder solution is preferably a method of applying the binder solution to the inorganic fiber molded body other than through immersion, or a method of immersing a portion of the inorganic fiber molded body in the binder solution, or a method of injecting the binder solution into the inorganic fiber molded body. When an application method other than immersion, a partial immersion method, or an injection method is used, the supply amount of the binder solution is generally relatively small. When this is the case, it is difficult to impregnate the entire inorganic fiber molded body with the binder solution. However, in the present embodiment, with the application method other than immersion, the partial immersion method, and the injection method, the entire inorganic fiber molded body can be impregnated with the binder solution by increasing the supply amount of the binder solution.

[0095] In addition, in the case of the application method, the binder solution may be applied to one surface or both surfaces of the inorganic fiber molded body. In the case of application to both surfaces, the inorganic fiber molded body can be impregnated with the binder solution deeply into the inside of the inorganic fiber molded body by increasing the supply amount of the binder solution. In addition, even in the case of application to one surface, the inorganic fiber molded body can be impregnated with the binder solution deeply into the inside of the inorganic fiber molded body by increasing the supply amount of the binder solution. Furthermore, in the case of application to one surface, for example, in a solution removing described below, the binder solution is suctioned from the surface of the inorganic fiber molded body opposite the surface coated with the binder solution, and thereby to allow migration of the binder solution from the surface of the inorganic fiber molded body coated with the binder solution to the surface opposite thereto, and thus the entire inorganic fiber molded body can be impregnated with the binder solution.

[0096] Moreover, in the case of the application method, the binder solution may be applied not only on the surface of the inorganic fiber molded body but also on the end face of the inorganic fiber molded body. In the binder-containing inorganic fiber molded body, damage due to processing such as cutting is more significant on the end face than the surface, and therefore by applying the binder solution to the end face of the inorganic fiber molded body, fiber scattering can be effectively suppressed, and the amount of dust that is generated can be further reduced.

[0097] In addition, when the injection method is used, for example, the binder solution may be injected from one surface of the inorganic fiber molded body, or the binder solution may be injected from both surfaces of the inorganic fiber molded body. Among these options, injection from both surfaces is preferable. When the binder solution is injected from both surfaces, in comparison with injection from one surface, the injector does not need to be inserted deep into the inorganic fiber molded body, and therefore damage to the inorganic fiber molded body can be reduced. On the other hand, even in the case of injection from one surface, by increasing the supply amount of the binder solution, it is not necessary to insert the injector deep into the inorganic fiber molded body, and thus the inorganic fiber molded body can be impregnated with a predetermined amount of the binder solution.

[0098] In the case of the injection method, the binder solution may be injected not only near the surface or the center of the inorganic fiber molded body but also near the end face of the inorganic fiber molded body. In the binder-containing inorganic fiber molded body, damage due to processing such as cutting is more significant on the end face than the surface, and therefore by injecting the binder solution near the end face of the inorganic fiber molded body, fiber scattering can be effectively suppressed, and the amount of dust that is generated can be further reduced.

[0099] In the present embodiment, when the inorganic fiber molded body is subjected to cutting, the impregnating may be carried out before the cutting or after the cutting.

2. Drying

[0100] In the present embodiment, the inorganic fiber molded body impregnated with the binder solution is usually dried after the impregnating.

[0101] The drying is not particularly limited as long as it is a method by which the solvent and the dispersion medium included in the binder solution can be removed, and examples of such a drying method include natural drying, compression drying, ventilation drying, hot air drying, air blow drying, heat drying, reduced pressure drying, centrifugal drying, and suction drying.

[0102] The drying temperature is appropriately selected according to the drying method, the type of the binder, and the

like. The drying temperature need only be equal to or higher than the boiling point of the solvent or dispersion medium included in the binder solution. In particular, in the case of an organic binder, the drying temperature is preferably equal to or higher than the temperature at which a crosslinking reaction of the organic binder begins and proceeds and equal to or lower than the decomposition temperature of the organic binder. Specifically, the drying temperature is preferably in a range of 80°C or higher and 200°C or lower, and more preferably in a range of 120°C or higher and 160°C or lower. If the drying temperature is too low, sufficient drying may not be achieved or crosslinking of the binder may be insufficient. On the other hand, if the drying temperature is too high, the binder may be altered, or the solvent or dispersion medium of the binder solution may be rapidly evaporated, resulting in migration of the binder.

[0103] Other drying conditions such as the air volume during drying and the drying time are appropriately adjusted such that the solvent and the dispersion medium can be removed from the inorganic fiber molded body impregnated with the binder solution without removing the binder. The drying time may be, for example, from about 10 seconds to several tens of minutes.

[0104] Moreover, when an inorganic binder is used, firing is usually carried out after drying. The firing conditions can be appropriately selected from general firing conditions that are used in a method for producing a binder-containing inorganic fiber molded body that contains an inorganic binder.

3. Solution Removal

[0105] In the present embodiment, the binder solution may be removed from the inorganic fiber molded body impregnated with the binder solution between the impregnating and the drying. The solvent and dispersion medium of the binder solution can be easily removed in the drying described below, and the drying time can be shortened.

[0106] Examples of the solution removal method include solution removal through centrifugation, solution removal through compression, and solution removal through suctioning. In the case of the solution removal through suctioning, the binder solution is preferably suctioned from the surface of the inorganic fiber molded body opposite the surface to which the binder solution is supplied. Thereby, the binder solution can be moved from the surface of the inorganic fiber molded body coated with the binder solution to the surface on the opposite side, and the entire inorganic fiber molded body can be impregnated with the binder solution.

[0107] The solution removal conditions such as the pressure during solution removal and the solution removal time are appropriately adjusted such that the entire amount of the binder in the binder solution is not removed.

II. Second Embodiment of Method for Producing Binder-Containing Inorganic Fiber Molded Body

[0108] A method for producing a binder-containing inorganic fiber molded body of a second embodiment includes impregnating an inorganic fiber molded body with a binder solution containing a binder, in which the bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, the content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and a supply amount of the binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

[0109] In the present embodiment, an inorganic fiber molded body having a large bulk density and a large basis weight is used. Even in such a case, the entire inorganic fiber molded body can be impregnated with the binder solution by relatively increasing the supply amount of the binder solution in the impregnating. Therefore, fiber scattering can be suppressed even when the content of the binder in the binder-containing inorganic fiber molded body is relatively small. Accordingly, when an inorganic fiber molded body having a large bulk density and a large basis weight is used, the amount of dust that is generated can be reduced while also reducing the content of the binder. That is, in the case of the inorganic fiber molded body having a large bulk density and a large basis weight, both a low binder amount and low amount of dust generation can be achieved.

[0110] Each step of the method for producing a binder-containing inorganic fiber molded body of the present embodiment can be the same as those of the method for producing a binder-containing inorganic fiber molded body of the first embodiment, and thus the description thereof is omitted here.

[0111] In addition, the inorganic fiber molded body is the same as the inorganic fiber molded body described in the above section "A. Inorganic Fiber Molded Body, II. Second Embodiment", and thus a description thereof is omitted here.

[0112] Note that the present invention is not limited to the above-described embodiments. The above-described embodiments are examples, and any embodiment having substantially the same configuration as the technical concept set forth in the claims of the present invention and exhibiting the same action and effect is included in the technical scope of the present invention.

Examples

[0113] The present invention will be described in more detail with reference to Examples and Comparative Examples below.

5

Example 1

[0114] An alumina fiber needle blanket having a basis weight of 2800 g/m² was used as an inorganic fiber molded body. In addition, an acrylic binder solution diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 1 part by mass (target value) and having the same volume as that of the needle blanket was applied to the needle blanket by a spray method. Subsequently, dehydration was carried out using a centrifugal dehydrator, and drying was implemented for 20 minutes using a blow dryer at 135°C. A binder-containing inorganic fiber molded body was thereby produced.

10

15 Example 2

[0115] An alumina fiber needle blanket having a basis weight of 2800 g/m² was used as an inorganic fiber molded body. An acrylic binder solution diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 0.3 parts by mass (target value) and having the same volume as that of the needle blanket was placed in a container, the needle blanket was placed on the acrylic binder solution, and a portion of the needle blanket was immersed in the acrylic binder solution. Subsequently, dehydration was carried out using a centrifugal dehydrator, and drying was implemented for 20 minutes using a blow dryer at 135°C. Through this, a binder-containing inorganic fiber molded body was produced.

20

25 Example 3

[0116] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body.

30

Example 4

[0117] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 2 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, and a portion of the needle blanket was immersed in 10 vol% of an acrylic binder solution with respect to the needle blanket, the acrylic binder solution being diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 1 part by mass (target value).

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40 Example 5

[0118] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 5600 g/m² was used as the inorganic fiber molded body, and 10 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

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Example 6

[0119] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 6400 g/m² was used as the inorganic fiber molded body, 10 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 0.3 parts by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

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55 Example 7

[0120] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 50 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

55

Example 8

5 [0121] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, and 50 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

Example 9

10 [0122] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 2 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, and a portion of the needle blanket was immersed in 50 vol% of an acrylic binder solution with respect to the needle blanket, the acrylic binder solution being diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 1 part by mass (target value).

15 Example 10

[0123] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 10 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

Example 11

25 [0124] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, and 10 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

Example 12

30 [0125] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 5 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

35 Example 13

[0126] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, 5 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

45 Example 14

[0127] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 300 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

50 Example 15

[0128] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body, and 280 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket.

Comparative Example 1

5 [0129] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 1 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

Comparative Example 2

10 [0130] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 2 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

15 Comparative Example 3

[0131] A binder-containing inorganic fiber molded body was produced in the same manner as in Comparative Example 1 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body.

20 Comparative Example 4

25 [0132] A binder-containing inorganic fiber molded body was produced in the same manner as in Example 1 with the exception that 1 vol% of an acrylic binder solution diluted with water such that the content of the binder relative to the inorganic fiber molded body was 2.5 parts by mass (target value) was applied to the needle blanket, and centrifugal dehydration was not carried out.

Comparative Example 5

30 [0133] A portion of an alumina fiber needle blanket having a basis weight of 2800 g/m² was immersed in water, after which dehydration was carried out using a centrifugal dehydrator, and drying was implemented for 20 minutes with a blow dryer at 135°C.

35 Comparative Example 6

[0134] A portion of an alumina fiber needle blanket having a basis weight of 3200 g/m² was immersed in water, after which dehydration was carried out using a centrifugal dehydrator, and drying was implemented for 20 minutes with a blow dryer at 135°C.

40 Evaluation 1

Weight Reduction Ratio of Binder-Containing Inorganic Fiber Molded Body Before and After Shaking Test

45 [0135] As described in the above section "A. Binder-Containing Inorganic Fiber Molded Body, I. First Embodiment, 3. Shaking Test", a shaking test was carried out, and the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test was calculated.

Binder Content

50 [0136] The binder content (parts by mass) per 100 parts by mass of the inorganic fiber molded body in the binder-containing inorganic fiber molded body was determined as described in the section "A. Binder-Containing Inorganic Fiber Molded Body, I. First Embodiment, 2. Binder".

55

Table 1

	Inorganic fiber molded body			Binder solution		Binder-containing inorganic fiber molded body	Weight reduction ratio (%) before and after shaking test	
	Basis weight (g/m ²)	Thickness (mm)	Bulk density (g/cm ³)	Impregnation method	Supply amount (vol%)	Binder content (parts by mass)		
5								
10	Example 1	2800	15.5	0.18	Spray	100	1.07	0.20
	Example 2	2800	15.5	0.18	Partial immersion	101	0.33	0.30
	Example 3	3200	16.5	0.19	Spray	100	1.09	0.26
15	Example 4	3200	16.5	0.19	Partial immersion	100	1.10	0.27
	Example 5	5600	31.0	0.18	Spray	10	0.75	0.80
	Example 6	6400	33.0	0.19	Spray	10	0.31	0.61
20	Example 7	2800	15.5	0.18	Spray	50	1.21	0.29
	Example 8	3200	16.5	0.19	Spray	50	1.21	0.31
	Example 9	3200	16.5	0.19	Partial immersion	50	1.03	0.35
25	Example 10	2800	15.5	0.18	Spray	10	1.29	0.54
	Example 11	3200	16.5	0.19	Spray	10	1.15	0.53
	Example 12	2800	15.5	0.18	Spray	5	1.09	0.72
30	Example 13	3200	16.5	0.19	Spray	5	0.94	0.65
	Example 14	2800	15.5	0.18	Spray	300	0.88	0.54
	Example 15	3200	16.5	0.19	Spray	280	0.99	0.41
35	Comparative Example 1	2800	15.5	0.18	Spray	1	1.16	1.34
	Comparative Example 2	2800	15.5	0.18	Spray	2	1.64	1.23
40	Comparative Example 3	3200	16.5	0.19	Spray	1	5.60	0.98
	Comparative Example 4	2800	15.5	0.18	Spray	1	2.63	1.05
45	Comparative Example 5	2800	15.5	0.18	Partial immersion	100	0	2.35
	Comparative Example 6	3200	16.5	0.19	Partial immersion	100	0	2.27

50 **[0137]** From Table 1, it was confirmed that in a case where an inorganic fiber molded body having a large basis weight is used, even when the content of the binder in the binder-containing inorganic fiber molded body is low, the weight reduction ratio before and after the shaking test was 1% or less, and fiber scattering can be suppressed. In addition, it was found that with the known binder solution impregnation method as used in Comparative Examples 1 and 2, the weight reduction ratio before and after the shaking test is large, and fiber scattering cannot be suppressed. Moreover, from Comparative
55 Examples 3 and 4, it was found that when an inorganic fiber molded body having a large basis weight is used, in order to suppress fiber scattering when using the known binder solution impregnation method, the content of the binder in the binder-containing inorganic fiber molded body must be increased. Furthermore, from Comparative Examples 5 and 6, it was found that fiber scattering cannot be suppressed by merely washing the inorganic fiber molded body with water to

remove weakly entangled fine fibers that may become dust.

Example 16

5 **[0138]** An alumina fiber needle blanket having a basis weight of 2800 g/m² was used as an inorganic fiber molded body. In addition, an acrylic binder solution diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 1 part by mass (target value) and having the same volume as the needle blanket was applied to the needle blanket by a spray method. Subsequently, dehydration was carried out using a centrifugal dehydrator, and drying was implemented for 20 minutes using a blow dryer at 135°C. Through this, a binder-containing inorganic fiber molded
10 body was produced.

Example 17

15 **[0139]** A binder-containing inorganic fiber molded body was produced in the same manner as in Example 16 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body.

Comparative Example 7

20 **[0140]** A binder-containing inorganic fiber molded body was produced in the same manner as in Example 16 with the exception that 1 vol% of an acrylic binder solution diluted with water such that the content of the binder with respect to the inorganic fiber molded body was 1 part by mass (target value) was applied to the needle blanket, and the centrifugal dehydration was not carried out.

25 Comparative Example 8

[0141] A binder-containing inorganic fiber molded body was produced in the same manner as in Comparative Example 7 with the exception that an alumina fiber needle blanket having a basis weight of 3200 g/m² was used as the inorganic fiber molded body.
30

Evaluation 2

Weight Reduction Ratio of Binder-Containing Inorganic Fiber Molded Body Before and After Shaking Test

35 **[0142]** As described in the above section "A. Binder-Containing Inorganic Fiber Molded Body, I. First Embodiment, 3. Shaking Test", a shaking test was carried out, and the weight reduction ratio of the binder-containing inorganic fiber molded body before and after the shaking test was calculated.

Binder Content

40 **[0143]** The binder content (parts by mass) per 100 parts by mass of the inorganic fiber molded body in the binder-containing inorganic fiber molded body was determined as described in the section "A. Binder-Containing Inorganic Fiber Molded Body, I. First Embodiment, 2. Binder".

45 Binder Contents of First Region, Second Region, and Third Region

[0144] As described in the above section "A. Binder-Containing Inorganic Fiber Molded Body, I. First Embodiment, 2. Binder", when the binder-containing inorganic fiber molded body was equally divided into three parts in the thickness direction, and the three parts were defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, the content (parts by mass) of the binder per 100 parts by mass of the inorganic fibers was determined for each region. The table below shows the binder content in the region having the maximum content among the three regions.
50

55

Table 2

	Inorganic fiber molded body			Binder solution		Binder content (parts by mass)			Weight reduction ratio (%) before and after shaking test
	Basis weight (g/m ²)	Thickness (mm)	Bulk density (g/cm ³)	Impregnation method	Supply amount (vol%)	Binder-containing inorganic fiber molded body (A)	Maximum binder content (B) among the three equally divided regions	Difference between A and B	
Example 16	2800	15.5	0.18	Spray	99.7	1.21	1.76	0.55	0.19
Example 17	3200	16.6	0.19	Spray	99.7	1.20	1.72	0.52	0.21
Comparative Example 7	2800	15.5	0.18	Spray	1.0	1.52	2.31	0.79	1.43
Comparative Example 8	3200	16.5	0.19	Spray	1.0	1.05	2.55	1.50	1.25

[0145] In Comparative Examples 7 and 8, the maximum content among the binder contents of the three regions was twice or more the target value of 1 part by mass of the binder content, and thus it was found that the binder was unevenly distributed. In addition, in the case in which the inorganic fiber molded body having a large basis weight was used, when the binder was unevenly distributed, the weight reduction ratio before and after the shaking test was large, and this result suggests that fiber scattering could not be suppressed. On the other hand, in Examples 16 and 17, as compared with Comparative Examples 7 and 8, the difference between the binder content of the binder-containing inorganic fiber molded body and the maximum content among the binder contents of the three regions was small, and uneven distribution of the binder was reduced. This suggests that in a case in which an inorganic fiber molded body having a large basis weight is used, the generation of dust can be reduced by reducing the uneven distribution of the binder.

Reference Signs List

[0146] 1: Binder-containing inorganic fiber molded body

Claims

1. A binder-containing inorganic fiber molded body comprising a binder in an inorganic fiber molded body, wherein

a basis weight of the inorganic fiber molded body is greater than 2600 g/m²,
 a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and
 a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

2. A binder-containing inorganic fiber molded body comprising a binder in an inorganic fiber molded body, wherein

a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and
 a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

3. A binder-containing inorganic fiber molded body comprising a binder in an inorganic fiber molded body, wherein

a basis weight of the inorganic fiber molded body is greater than 2600 g/m²,
 when the binder-containing inorganic fiber molded body is equally divided into three parts in a thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber included in the corresponding region, and
 a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

4. A binder-containing inorganic fiber molded body comprising a binder in an inorganic fiber molded body, wherein

a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, when the binder-containing inorganic fiber molded body is equally divided into three parts in a thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber included in the corresponding region, and a weight reduction ratio of the binder-containing inorganic fiber molded body before and after a shaking test is 1.0% or less, when the shaking test is carried out in such a manner that the binder-containing inorganic fiber molded body measuring 50 mm square is placed in a sieve having a mesh size of 4 mm, and the sieve is shaken in a vertical reciprocal shaking method under conditions including a shaking amplitude of 2 mm, a shaking speed of 3000 reciprocations/min, and a vibration time of 10 minutes.

5. The binder-containing inorganic fiber molded body according to claim 1 or 2, wherein when the binder-containing inorganic fiber molded body is equally divided into three parts in the thickness direction, and the three parts are defined as a first region, a second region, and a third region from one surface side of the binder-containing inorganic fiber molded body, among contents of the binder in the first region, the second region, and the third region, a maximum content is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of an inorganic fiber included in the corresponding region.

6. The binder-containing inorganic fiber molded body according to any one of claims 3 to 5, wherein a difference between the content of the binder in the binder-containing inorganic fiber molded body and the maximum content among the contents of the binder in the first region, the second region, and the third region is 0.75 parts by mass or less.

7. The binder-containing inorganic fiber molded body according to any one of claims 1 to 6, wherein the binder is an organic binder.

8. The binder-containing inorganic fiber molded body according to any one of claims 1 to 7, wherein the inorganic fiber molded body contains alumina fibers.

9. The binder-containing inorganic fiber molded body according to any one of claims 1 to 8, wherein the inorganic fiber molded body is a needle blanket.

10. A holding material for an exhaust gas purification device, the holding material comprising the binder-containing inorganic fiber molded body described in any one of claims 1 to 9.

11. A method for producing a binder-containing inorganic fiber molded body, the method comprising impregnating an inorganic fiber molded body with a binder solution containing a binder, wherein

a basis weight of the inorganic fiber molded body is greater than 2600 g/m²,
a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and
a supply amount of the binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

12. A method for producing a binder-containing inorganic fiber molded body, the method comprising impregnating an inorganic fiber molded body with a binder solution containing a binder, wherein

a bulk density of the inorganic fiber molded body in a free state is 0.10 g/cm³ or greater and 0.20 g/cm³ or less, a content of the binder is 0.01 parts by mass or greater and 2.24 parts by mass or less per 100 parts by mass of the inorganic fiber molded body, and
a supply amount of the binder solution in the impregnating is 5 vol% or greater per 100 vol% of the inorganic fiber molded body.

13. The method for producing a binder-containing inorganic fiber molded body according to claim 11 or 12, wherein the impregnation of the inorganic fiber molded body with the binder solution is performed by applying the binder solution to the inorganic fiber molded body, and performed by a process other than immersion, or performed by immersing a portion of the inorganic fiber molded body in the binder solution, or performed by injecting the binder solution into the inorganic fiber molded body.

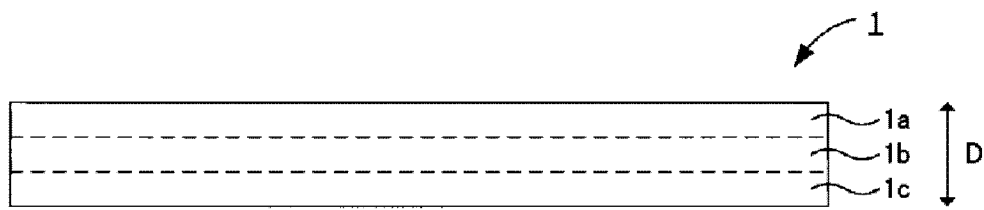


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/012501

5	A. CLASSIFICATION OF SUBJECT MATTER	
	<i>D04H 1/4209</i> (2012.01)i; <i>D04H 1/488</i> (2012.01)i; <i>F01N 3/28</i> (2006.01)i FI: D04H1/4209; D04H1/488; F01N3/28 311P	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) D04H1/00-18/04; F01N1/00-99/00	
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2023 Registered utility model specifications of Japan 1996-2023 Published registered utility model applications of Japan 1994-2023	
20	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	X	WO 2014/168089 A1 (IBIDEN CO., LTD.) 16 October 2014 (2014-10-16) claims, example 1, paragraph [0065]
	X	JP 2013-213463 A (IBIDEN CO., LTD.) 17 October 2013 (2013-10-17) claims, example 2
	A	
30	A	JP 2009-85091 A (IBIDEN CO., LTD.) 23 April 2009 (2009-04-23) claims, example 4
35		
40	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
50	Date of the actual completion of the international search 01 June 2023	Date of mailing of the international search report 13 June 2023
55	Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No. PCT/JP2023/012501

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