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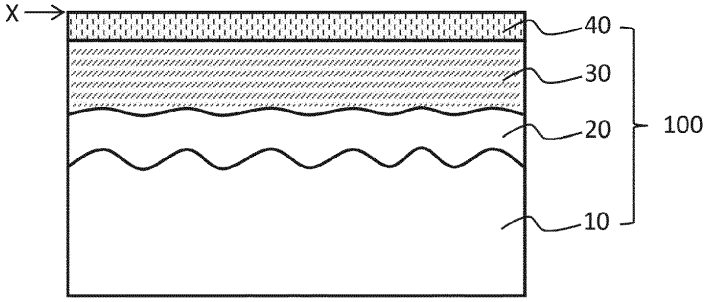
# (54) BARRIER PAPER, CONTAINER AND LID MEMBER CONTAINING SAID BARRIER PAPER, AND METHOD FOR PRODUCING BARRIER PAPER

(57) Provided is barrier paper excellent in gas barrier properties, with respect to barrier paper including a paper substrate layer.

Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer. In the barrier paper, when the arithmetic average roughness of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, and the standard deviation of the Ra1 is defined as σRa1, σRa1 is preferably 0.030 μm or less.

Fig. 1

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## Description

Technical Field

**[0001]** The present invention relates to barrier paper, a container and a lid including the barrier paper, and a method for producing barrier paper.

Background Art

**[0002]** Environmental issues caused by microplastics and the like have been greatly dealt with in recent years. Also in products using paper, improvement in recyclability by constituting such products only with paper as much as possible and improvement in biodegradability have been begun to be required in order to reduce environmental burden.

**[0003]** As a packaging method for inhibiting degradation in the quality of contents such as foods, medicines, chemical products, cosmetics, and the like due to moisture or oxygen, there have been conventionally conducted techniques for using a packaging material having high gas barrier properties, for subjecting the portion for receiving contents to gas replacement with an inert gas such as nitrogen gas, for enclosing an oxygen scavenger including reduced iron powder packaged, and the like. However, problems of the techniques mentioned above such as insufficient performance, increase in the packaging costs, increase in litter, exertion of the performance only under environments having moisture, and accidental ingestion have been posed.

**[0004]** Packaging materials including paper material have begun to attract attention for reducing environmental burdens during recycling and incineration disposal. However, a paper material singly has insufficient gas barrier properties. As a technique for enhancing the gas barrier properties of a paper material, a technique for coating surface of a paper material with a resin and a technique for laminating a resin film having metal foil or an inorganic vapor-deposited layer on a paper material are contemplated. However, the techniques mentioned above have problems such as decrease in recyclability and biodegradability, damage to incinerators due to resin components during incineration, and generation of a large amount of incineration residues resulted from metal foil.

**[0005]** Patent Literature 1 discloses a laminate in which a gas barrier thin film layer obtained by plasma polymerization is laminated on a substrate comprised of paper or a pulp mold having a sealing layer comprised of a polycondensate of a polysaccharide and a silica compound on the surface thereof.

**[0006]** In the laminate of Patent Literature 1, however, the sealing layer is required to have a thickness of about several tens of micrometers, and thus the coating formation method for the sealing layer is limited.

**[0007]** Further, for the laminate of Patent Literature 1, a substrate comprised of paper or a pulp mold is required to be placed in a plasma polymerization apparatus for forming a gas barrier thin film layer. Thus, as for the laminate of Patent Literature 1, depressurization to a pressure suitable for plasma polymerization inside the plasma polymerization apparatus is likely to be hindered due to paper powder or pulp powder generated from the substrate, and formation of a stable gas barrier thin film layer has been difficult. Moreover, in the laminate of Patent Literature 1, it has been difficult to achieve gas barrier properties at a high level.

Citation List

Patent Literature

**[0008]** PTL 1: JP 4622201

Summary of Invention

Technical Problem

**[0009]** An object of the present invention is to provide barrier paper excellent in gas barrier properties, with respect to barrier paper including a paper substrate layer.

Solution to Problem

**[0010]** The present invention provides the following [1] to [15].

[1] Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

[2] The barrier paper according to [1], wherein, when the arithmetic average roughness of the surface of the inorganic

vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, and the standard deviation of the Ra1 is defined as oRal, σRa1 is 0.030 μm or less.

[3] The barrier paper according to [1] or [2], wherein, when the arithmetic average roughness of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, the Ra1 is 0.100 μm or less.

[4] The barrier paper according to any of [1] to [3], wherein, when the kurtosis of the roughness curve of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Rku1, Rku1 is more than 3.0.

[5] The barrier paper according to any of [1] to [4], comprising a sealing layer between the paper substrate layer and the adhesive layer.

[6] The barrier paper according to any of [1] to [5], comprising one or more layers selected from a release layer, a protective layer, a heat seal layer, and a sealant layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

[7] The barrier paper according to any of [1] to [6], comprising a printing layer on the side of the paper substrate layer opposite to the adhesive layer.

[8] The barrier paper according to any of [1] to [7], wherein the thickness of the adhesive layer is 1 μm or more and 20 μm or less.

[9] The barrier paper according to any of [1] to [8], wherein the standard deviation of the thickness of the adhesive layer is 0.80 μm or less.

[10] The barrier paper according to any of [1] to [9], wherein the coefficient of variance of the thickness of the adhesive layer is 0.17 or less.

[11] The barrier paper according to any of [1] to [10], wherein the thickness proportion of the paper substrate layer in the barrier paper is 60% or more and less than 100%.

[12] The barrier paper according to any of [1] to [11], wherein the interlayer adhesion strength between the adhesive layer and the inorganic vapor-deposited layer corresponds to any of the classes 0, 1, and 2 in a crosscut test according to JIS K5600-5-6.

[13] A container comprising the barrier paper according to any of [1] to [12].

[14] A lid comprising the barrier paper according to any of [1] to [12].

[15] A method for producing barrier paper comprising steps 1 to 2 below:

Step 1: a step of bonding an inorganic vapor-deposited layer donor comprising an inorganic vapor-deposited layer on a support having mold-releasability to a paper substrate layer with an adhesive layer interposed therebetween to prepare a barrier paper intermediate, wherein in step 1, the inorganic vapor-deposited layer donor is disposed such that the surface on the side having the inorganic vapor-deposited layer faces toward the paper substrate layer side with reference to the support having mold-releasability; and

Step 2: a step of releasing the support having mold-releasability from the barrier paper intermediate obtained in step 1 to obtain barrier paper described below:

(Barrier Paper)

**[0011]** Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

## Advantageous Effects of Invention

**[0012]** Barrier paper of the present invention enables barrier paper including a paper substrate layer to have favorable gas barrier properties. A container or lid of the present invention enables gas barrier properties to be favorable. A method for producing barrier paper of the present invention enables barrier paper having excellent gas barrier properties to be easily produced.

## Brief Description of Drawings

**[0013]**

[Fig. 1] Fig. 1 is a schematic cross-sectional view illustrating one embodiment of barrier paper of the present invention.

[Fig. 2] Fig. 2 is a schematic cross-sectional view illustrating one embodiment of barrier paper of the present invention.

[Fig. 3] Fig. 3 is a schematic cross-sectional view illustrating one embodiment of barrier paper of the present invention.

[Fig. 4] Fig. 4 is a schematic cross-sectional view illustrating one embodiment of conventional barrier paper.

[Fig. 5] Fig. 5 illustrates one example of measurement points for the surface profile.

Description of Embodiments

[Barrier Paper]

**[0014]** The barrier paper of the present embodiment has a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

**[0015]** The numerical range of "AA to BB" herein means a numerical range of "AA or more and equal to or less than BB".

**[0016]** Fig. 1 to Fig. 3 are schematic cross-sectional views each illustrating one embodiment of barrier paper 100 of the present invention. The barrier paper 100 in each of Fig. 1 to Fig. 3 has a paper substrate layer 10, an adhesive layer 30, and an inorganic vapor-deposited layer 40 in this order, the adhesive layer 30 being in contact with the inorganic vapor-deposited layer 40. The barrier paper 100 in each of Fig. 1 to Fig. 3 has a sealing layer 20 between the paper substrate layer 10 and the adhesive layer 30. The barrier paper 100 in Fig. 2 has a release layer 50 on the side of the inorganic vapor-deposited layer 40 opposite to the adhesive layer 30. The barrier paper 100 in Fig. 3 has a release layer 50 and a heat seal layer 60 on the side of inorganic vapor-deposited layer 40 opposite to the adhesive layer 30.

**[0017]** In the barrier paper 100 in each of Fig. 1 to Fig. 4, the "surface of the inorganic vapor-deposited layer 40 on the side opposite to the paper substrate layer 10" refers to "X" in the figure. That is, in the barrier paper 100 in each of Fig. 1 to Fig. 4, Ra1, oRal, and Rku1 means Ra1, oRal, and Rku1 of the surface X.

**[0018]** Exemplary laminate structures of the barrier paper of the present embodiment are shown in the following (1) to (8). In the following (1) to (8), the adhesive layer and the inorganic vapor-deposited layer are laminated in contact with each other.

(1) A laminate structure having a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order.
(2) A laminate structure having a paper substrate layer, an adhesive layer, an inorganic vapor-deposited layer, and a release layer in this order.
(3) A laminate structure having a paper substrate layer, an adhesive layer, an inorganic vapor-deposited layer, and a protective layer in this order.
(4) A laminate structure having a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order and further having a heat seal layer or a sealant layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.
(5) A laminate structure having a paper substrate layer, an adhesive layer, an inorganic vapor-deposited layer, and a release layer in this order and further having a heat seal layer or a sealant layer on the side of the release layer opposite to the inorganic vapor-deposited layer.
(6) A laminate structure having a paper substrate layer, an adhesive layer, an inorganic vapor-deposited layer, and a protective layer in this order and further having a heat seal layer or a sealant layer on the side of the protective layer opposite to the inorganic vapor-deposited layer.
(7) A laminate structure having a paper substrate layer, an adhesive layer, an inorganic vapor-deposited layer, a protective layer, and a release layer in this order and further having a heat seal layer or a sealant layer on the side of the release layer opposite to the inorganic vapor-deposited layer.
(8) A laminate structure having a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order and further having a heat seal layer or a sealant layer on the side of paper substrate layer opposite to the adhesive layer and on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0019]** The barrier paper of the present embodiment is not limited to the laminate structures in Fig. 1 to Fig. 3 and the laminate structures of (1) to (8) described above. The barrier paper of the present embodiment may have other layers such as a printing layer, a functional layer, a reinforcing layer, and a second adhesive layer as long as the effects of the present invention are not impaired. Examples of the place in which other layers are disposed include "between the paper substrate layer and the adhesive layer", "on the side of the paper substrate layer opposite to the adhesive layer", and "on the side of the inorganic vapor-deposited layer opposite to the adhesive layer".

**[0020]** The orientation of the barrier paper in use of the barrier paper of the present embodiment is not particularly limited. Also when the barrier paper of the present embodiment is used as a packaging material, the orientation of the barrier paper is not limited, and the barrier paper is preferably used such that the inorganic vapor-deposited layer side thereof becomes the inner layer side with reference to the adhesive layer. The inner side in a packaging material means the contents side.

<Paper Substrate Layer>

**[0021]** As the paper substrate constituting the paper substrate layer, general-purpose paper substrates can be used.

**[0022]** Example of paper substrates include bleached or unbleached paper substrates having strong sizing properties, or pure white roll paper, kraft paper, paperboards, coated paper, cast coated paper, milk base paper, processed base paper, wood free paper, lightweight coated printing sheets, coated printing sheets, resin coated paper, release base paper, and two-sided coated release base paper.

**[0023]** The paper substrate layer may be composed of a single layer or may be composed of multiple layers including two or more identical or different paper substrates. Two or more paper substrates can be laminated by use of a general-purpose lamination means such as an adhesive therebetween.

**[0024]** The basis weight and thickness of the paper substrate layer are not particularly limited. For the purpose of imparting appropriate strength and stiffness to barrier paper, the basis weight of the paper substrate layer is preferably 30 $g/m^2$ or more and 600 $g/m^2$ or less, and more preferably 50 $g/m^2$ or more and 450 $g/m^2$ or less. For the purpose of imparting appropriate strength and stiffness to barrier paper, the thickness of the paper substrate layer is preferably 5 $\mu m$ or more and 200 $\mu m$ or less, more preferably 30 $\mu m$ or more and 100 $\mu m$ or less, and further preferably 40 $\mu m$ or more and 80 $\mu m$ or less.

**[0025]** As a raw material pulp for the paper substrate layer, a mixture of softwood pulp (N material) and hardwood pulp (L material) is preferable from the viewpoint of smoothness. The mixing ratio of hardwood pulp (L material) is preferably 50% by mass or more and 90% by mass or less from the viewpoint of further improved smoothness.

**[0026]** The paper substrate is preferably neutral paper so as to have sufficient heat resistance, and more preferably neutral paper sized with an alkyl ketene dimer as a sizing agent.

**[0027]** The paper substrate layer may contain additives such as a lubricant, a crosslinking agent, an antioxidant, an ultraviolet absorber, a light stabilizer, a filler, a reinforcing agent, an antistatic agent, and a pigment, as required.

**[0028]** The paper substrate layer also can be preliminarily subjected to a physical surface treatment such as corona discharge treatment, ozone treatment, plasma treatment, glow discharge treatment, or sandblasting treatment or a chemical surface treatment such as oxidization treatment by use of a chemical in order to make the adhesiveness thereof to a layer to be in contact with the paper substrate layer favorable.

**[0029]** The proportion of the thickness of the paper substrate layer with respect to the total thickness of the barrier paper is preferably 60% or more and less than 100%, more preferably 63% or more and 90% or less, and more preferably 65% or more and 80% or less.

**[0030]** When the proportion is set to 60% or more, decrease in the recyclability and the biodegradability can be easily inhibited. When the proportion is set to less than 100%, the barrier properties can be easily maintained.

<Adhesive Layer>

**[0031]** The barrier paper of the present embodiment has an adhesive layer between the paper substrate layer and the inorganic vapor-deposited layer. The adhesive layer is required to be laminated in contact with the inorganic vapor-deposited layer.

**[0032]** When the adhesive layer is laminated in contact with the inorganic vapor-deposited layer, in the case of occurrence of cracking in the adhesive layer side of the inorganic vapor-deposited layer, the adhesive layer repairs the cracking, and thus the barrier properties of the barrier paper can be easily maintained. When an adhesive layer is included between the paper substrate layer and the inorganic vapor-deposited layer, the surface profile including Ra1, $\sigma$Ra1, and Rku1 can be allowed to easily fall within the ranges described below.

**[0033]** The adhesive layer is preferably included on the substantially entire surface on one side of the paper substrate layer. The phrase "substantially entire surface" means 95% or more, preferably 97% or more, more preferably 99% or more, and most preferably 100% of the area of the one side of the paper substrate layer.

**[0034]** Example of an adhesive constituting the adhesive layer include moisture-curable adhesives, anaerobic-curable adhesives, dry-curable adhesives, UV-curable adhesives, heat-sensitive adhesives (e.g., hot melt-type adhesives), and pressure-sensitive adhesives (so-called tacking agents).

**[0035]** The adhesives described above may be general-purpose adhesives or may be specific adhesives.

**[0036]** Examples of general-purpose adhesives include two-liquid-curable urethane-based adhesives, polyester-based polyurethane adhesives, polyether-based polyurethane adhesives, acrylic adhesives, polyester-based adhesives, polyamide-based adhesives, polyvinyl acetate-based adhesives, epoxy-based adhesives, and rubber-based adhesives. Examples of general-purpose adhesives additionally include resins such as polyolefin-based resins, acid-modified polyolefin-based resins, polyvinyl acetate-based resins, poly(meth)acrylic resins, and polyvinyl chloride-based resins. These adhesives may be used singly or in combination of two or more.

**[0037]** Specific adhesives are preferably adhesives that protect the inorganic vapor-deposited layer.

**[0038]** Adhesives that protect the inorganic vapor-deposited layer are adhesives that allow the gas barrier properties of the barrier paper to be easily maintained by protecting the inorganic vapor-deposited layer that exerts gas barrier properties. An example thereof is an adhesive that reduces occurrence of cracking in the inorganic vapor-deposited layer in the case where a bending load is applied on the barrier paper and can exert action of reducing degradation in

the gas barrier properties even in the case where minute cracking begins to be generated in the inorganic vapor-deposited layer after the bending load.

**[0039]** A more detailed embodiment of an adhesive that protects the inorganic vapor-deposited layer will be mentioned below.

**[0040]** The glass transition temperature of the adhesive layer is preferably -30°C or more and 80°C or less, more preferably 0°C or more and 70°C or less, and further preferably 25°C or more and 70°C or less. When the glass transition temperature is set to -30°C or more, the cohesive force of the adhesive layer does not become insufficient, and thus the adhesive force between the adhesive layer and a layer in contact with the adhesive layer can be easily maintained. When the glass transition temperature is set to 80°C or less, the adhesive force between the adhesive layer and a layer in contact with the adhesive layer can be easily rendered favorable around room temperature.

**[0041]** The amount of the remaining solvent in the adhesive layer is preferably small. The amount of the remaining solvent in the adhesive layer is preferably 6 $mg/m^2$ or less. The amount of the remaining solvent is most preferably 0 $mg/m^2$, and is practically preferably 6 $mg/m^2$ or less.

**[0042]** When the amount of the remaining solvent in the adhesive layer is set to 6 $mg/m^2$ or less, there can be expected "inhibition of decrease in the adhesive force due to the remaining solvent", "inhibition of degradation in the gas barrier properties, as a result of occurrence of deformation and minute delamination defects on the surface of the inorganic vapor-deposited layer on the adhesive layer side due to the volume shrinkage of the adhesive layer on drying", and "inhibition of generation of a solvent odor from the barrier paper". In order to lower the amount of the remaining solvent in the adhesive layer, preferable is use of a highly volatile solvent, formation of the adhesive layer using a solventless-type or aqueous adhesive, or the like.

**[0043]** In the case where the barrier paper includes no layer containing a solvent other than the adhesive layer, the solvent content of the entire barrier paper can be measured, and the content measured can be detected as the solvent content of the adhesive layer.

**[0044]** The thickness of the adhesive layer is preferably 1 μm or more and 20 μm or less and more preferably 2 μm or more and 10 μm or less.

**[0045]** When the thickness of the adhesive layer is set to 1 μm or more, the adhesive force between the adhesive layer and a layer in contact with the adhesive layer can be easily rendered favorable. When the thickness of the adhesive layer is set to be 20 μm or less, the cost efficiency can be rendered appropriate, and further, the adhesive layer can be easily formed.

**[0046]** In the case where the adhesive constituting the adhesive layer is an adhesive that protects the inorganic vapor-deposited layer, the thickness of the adhesive layer is preferably in the range of the larger thicknesses within the range described above. Specifically, in the case where the adhesive constituting the adhesive layer is an adhesive that protects the inorganic vapor-deposited layer, the thickness of the adhesive layer is preferably 1.5 μm or more and 20 μm or less. When the thickness is set to 1.5 μm or more, the inorganic vapor-deposited layer can be easily protected. When the thickness is set to 20 μm or less, it is possible to inhibit decrease in the effect of protecting the inorganic vapor-deposited layer due to excessive increase in the rigidity of the adhesive layer itself.

**[0047]** The thickness of the adhesive layer herein can be calculated by the following techniques: (x1) to (x4), for example. The thickness of layers other than the adhesive layer also can be calculated by a technique similar to the following techniques: (x1) to (x4) (provided that, in the following (x2) to (x4), "the adhesive layer" shall be read as "a layer of which the thickness is to be calculated (e.g., paper substrate layer, sealing layer, or the like)".).

(x1) A sample 1 is prepared by cutting barrier paper in a direction perpendicular to the paper surface.
(x2) A cross-sectional micrograph 1 is taken at any point in the width direction of the sample 1. The thickness of the adhesive layer is measured at 15 points at intervals of 1 μm based on the cross-sectional micrograph 1.
(x3) Cross-sectional micrographs 2 to 5 are taken at different 4 points in the width direction of the sample 1. The thickness of the adhesive layer is measured at 15 points at intervals of 1 μm based on each of the cross-sectional micrographs 2 to 5.
(x4) The average value of the thicknesses at the 75 points in total obtained in the (x2) and (x3) is taken as the thickness of the adhesive layer.

**[0048]** The standard deviation of the thickness of the adhesive layer is preferably 0.80 μm or less, more preferably 0.60 μm or less, and further preferably 0.55 μm or less.

**[0049]** When the standard deviation of the thickness of the adhesive layer is set to 0.80 μm or less, the barrier properties can be easily rendered more favorable.

**[0050]** In the barrier paper of the present embodiment, the adhesive layer is in contact with the inorganic vapor-deposited layer. Thus, when the volume of the adhesive layer varies over time to generate a stress, the stress is transferred directly to the adhesive layer. In the case where the variation in the thickness of the adhesive layer is large, the stress is different from location to location, and thus, local defects may be generated in the inorganic vapor-deposited

layer. Then, as a result of permeation of water vapor or gas through a region locally having weak barrier properties, it is considered that barrier paper having a standard deviation of the thickness of the adhesive layer of more than 0.80 μm is less likely to make the barrier properties favorable. In contrast, when the standard deviation of the thickness of the adhesive layer is set to 0.80 μm or less, it is considered that failures as mentioned above are less likely to occur and the barrier properties can be easily rendered more favorable.

**[0051]** In the barrier paper of the present embodiment, which has a paper substrate layer having high moisture permeability, volume changes in the adhesive layer are likely to occur due to moisture. Thus, in the laminate structures of the barrier paper of the present embodiment, a structure having a standard deviation of the thickness of the adhesive layer of 0.80 μm or less is considered to be an advantageous structure to make the barrier properties favorable.

**[0052]** When the standard deviation of the thickness of the adhesive layer is set to be equal to or greater than a predetermined value, the adhesiveness between the adhesive layer and the paper substrate layer or between the adhesive layer and the sealing layer can be rendered favorable by anchor action, and further, the adhesiveness of the entire barrier paper can be easily rendered favorable. For this reason, the standard deviation of the thickness of the adhesive layer is preferably 0.20 μm or more, more preferably 0.30 μm or more, and further preferably 0.35 μm or more.

**[0053]** The "standard deviation" herein means "standard deviation 1σ", unless otherwise specified.

**[0054]** The lower limit of the standard deviation of the thickness of the adhesive layer is not particularly limited, and is preferably 0.10 μm or more and more preferably 0.20 μm or more.

**[0055]** The standard deviation of the thickness of the adhesive layer means the standard deviation calculated from the thicknesses at the 75 points in (x1) to (x4) described above (standard deviation 1σ).

**[0056]** The coefficient of variance of the thickness of the adhesive layer is preferably 0.17 or less and more preferably 0.15 or less. When the coefficient of variance of the adhesive layer is set within the range, effects caused by the standard deviation of the adhesive layer can be more easily exerted.

**[0057]** The coefficient of variance of the thickness of the adhesive layer is not particularly limited, and is preferably 0.02 or more and more preferably 0.05 or more.

**[0058]** The coefficient of variance is a dimensionless value obtained by dividing the standard deviation by the average value.

**[0059]** In order to easily set the standard deviation and the coefficient of variance of the thickness of the adhesive layer within the ranges above, a sealing layer is preferably included between the paper substrate and the adhesive layer.

**[0060]** The adhesive layer can contain additives such as an antioxidant, an ultraviolet absorber, a light stabilizer, an antistatic agent, an anti-blocking agent, a flame retardant, a crosslinking agent, and a colorant as long as the effects of the present invention are not impaired.

«Adhesive that Protects Inorganic Vapor-deposited Layer»

**[0061]** As an adhesive that protects the inorganic vapor-deposited layer, a urethane-based resin composition is preferable. A urethane-based resin composition preferably contains a specific polyol having two or more hydroxyl groups in one molecule and a specific isocyanate compound having two or more isocyanate groups in one molecule. The adhesive that protects the inorganic vapor-deposited layer may also contain a phosphate compound. The adhesive that protects the inorganic vapor-deposited layer may also contain an inorganic compound.

- Polyol-

**[0062]** The polyol having two or more hydroxyl groups in one molecule is preferably a polyol having two or more hydroxyl groups in one molecule and having one or two or more selected from the group consisting of a polyester structure moiety, a polyester polyurethane structure moiety, a polyether structure moiety, an isocyanuric ring structure moiety, and a polyether polyurethane structure moiety as a main skeleton. The polyol is more preferably a polyol having a polyester structure moiety and/or polyester polyurethane structure moiety as the main skeleton, and further preferably a polyol having a polyester structure moiety and/or polyester polyurethane structure moiety, and an isocyanuric ring structure moiety as the main skeleton.

**[0063]** The hydroxyl groups are preferably alcoholic hydroxyl groups but may include a phenolic hydroxyl group.

**[0064]** The polyester structure moiety can be obtained by subjecting a polycarboxylic acid and a polyhydric alcohol to a polycondensation reaction in accordance with a known conventional method, for example, but the synthesis method is not limited thereto.

**[0065]** As the polyester structure moiety, one including a polyester structure moiety formed of an o-aromatic dicarboxylic acid and an aliphatic diol is most preferable.

**[0066]** 70% by mass or more and 100% by mass or less of the polyvalent carboxylic acid-derived structure moiety in the polyester structure moiety or the polyester polyurethane structure moiety is preferably an o-aromatic dicarboxylic acid-derived structure moiety. Here, o-aromatic dicarboxylic acids refer to o-aromatic dicarboxylic acids and derivatives

thereof, and examples of such derivatives include anhydrides and esters.

**[0067]** Polyvalent carboxylic acids refer to polyvalent carboxylic acids and derivatives such as anhydrides and esters thereof, and examples thereof include aliphatic polyvalent carboxylic acids and aromatic polyvalent carboxylic acids.

**[0068]** Examples of aliphatic polyvalent carboxylic acids include succinic acid, adipic acid, azelaic acid, sebacic acid, dodecane dicarboxylic acid, and 1,4-cyclohexane dicarboxylic acid.

**[0069]** Examples of aromatic polyvalent carboxylic acids include o-phthalic acid, terephthalic acid, isophthalic acid, pyromellitic acid, trimellitic acid, 1,2-naphthalene dicarboxylic acid, 1,8-naphthalene dicarboxylic acid, 2,3-naphthalene dicarboxylic acid, 1,4-naphthalene dicarboxylic acid, 2,5-naphthalene dicarboxylic acid, 2,6-naphthalene dicarboxylic acid, 2,3-anthraquinone dicarboxylic acid, 2,3-anthracene dicarboxylic acid, naphthalic acid, biphenyl dicarboxylic acid, 1,2-bis(phenoxy)ethane-p,p'-dicarboxylic acid, dicarboxylic anhydrides, ester-forming derivatives of dicarboxylic acids, p-hydroxybenzoic acid, p-(2-hydroxyethoxy)benzoic acid, and ester-forming derivatives of dihydroxycarboxylic acids.

**[0070]** Examples of o-aromatic dicarboxylic acids include o-phthalic acid, 1,2-naphthalene dicarboxylic acid, 1,8-naphthalene dicarboxylic acid, 2,3-naphthalene dicarboxylic acid, 2,3-anthraquinone dicarboxylic acid, 2,3-anthracene dicarboxylic acid, dicarboxylic anhydrides, and esters of dicarboxylic acids.

**[0071]** The polyvalent carboxylic acids described above may be used singly or in combinations of two or more.

**[0072]** Examples of polyhydric alcohols include aliphatic polyhydric alcohols and aromatic polyhydric phenols.

**[0073]** Examples of aliphatic polyhydric alcohols include diols such as ethylene glycol, propylene glycol, butylene glycol, neopentyl glycol, cyclohexanedimethanol, 1,5-pentanediol, 3-methyl-1,5-pentanediol, 1,6-hexanediol, methylpentanediol, dimethylbutanediol, butylethylpropandiol, diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, and tripropylene glycol; triols such as glycerol and 1,2,4-butanetriol; and tetraols such as erythritol, pentaerythritol, and dipentaerythritol.

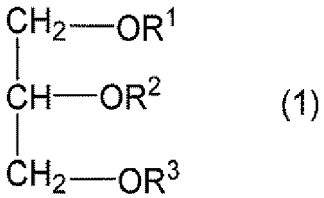
**[0074]** Examples of aromatic polyhydric phenols include hydroquinone, resorcinol, catechol, naphthalene diol, biphenol, bisphenol A, bisphenol F and tetramethyl biphenol and further include ethylene oxide extended products thereof and hydrogenated alicyclics thereof.

**[0075]** The polyhydric alcohols described above may be used singly or in combinations of two or more.

**[0076]** When 5% by mass or more of a triol-derived structure moiety as a polyhydric alcohol is contained in the adhesive that protects the inorganic vapor-deposited layer, the adhesive is polyfunctionalized to thereby enable adhesive force and strength to be improved.

**[0077]** For example, in the case where glycerol of triols is used as the polyhydric alcohol, polyols having a polyester structure moiety in the main skeleton are represented by the following formulas (1) and (2).

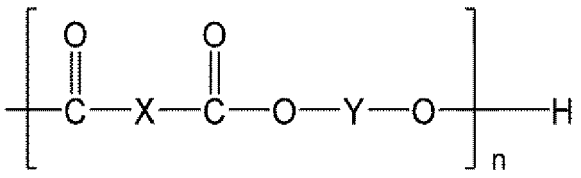
[Formula 1]



(1)

**[0078]** Wherein $R^1$, $R^2$, and $R^3$ each independently represent a hydrogen atom or a group represented by the general formula (2), and at least one of $R^1$, $R^2$, and $R^3$ represents a group represented by the general formula (2).

[Formula 2]



(2)

**[0079]** The formula represents the average composition, wherein n represents a number of from 1 to 5, X is one or two or more selected from the group consisting of a substituted and/or unsubstituted 1,2-phenylene group, 1,2-naphthylene group, 2,3-naphthylene group, 2,3-anthraquinone-diyl group, and 2,3-anthracenediyl group, and Y represents an alkylene group having 2 to 6 carbon atoms.

-Isocyanate Compound-

**[0080]** The isocyanate compound having two or more isocyanate groups in one molecule may be either aromatic or aliphatic as long as having two or more isocyanate groups in the molecule, and may be either a low molecular compound or a high molecular compound. For example, a known compound can be used such as a diisocyanate compound having two isocyanate groups or a polyisocyanate compound having three or more isocyanate groups. Alternatively, also can be used a blocked isocyanate compound obtained by an addition reaction in accordance with a general-purpose method using an isocyanate blocking agent.

**[0081]** Among those described above, a preferable isocyanate compound is one having an aromatic ring structure moiety and/or a polyurethane structure moiety including an aromatic ring in the main skeleton.

**[0082]** From the viewpoint of adhesive properties, a polyisocyanate compound is preferable, and from the viewpoint of gas barrier properties, one having an aromatic ring is preferable. An isocyanate compound including a m-xylene skeleton is particularly preferable because the gas barrier properties are expected to be improved not only by the hydrogen bond of the urethane group but also by $\pi$-$\pi$ stacking of the aromatic rings.

**[0083]** Specific examples of the isocyanate compound having two or more isocyanate groups in one molecule include tetramethylene diisocyanate, hexamethylene diisocyanate, toluene diisocyanate, diphenylmethane diisocyanate, hydrogenated diphenylmethane diisocyanate, m-xylylene diisocyanate, hydrogenated xylylene diisocyanate, and isophoron diisocyanate; trimers of the isocyanate compounds mentioned above; and adduct products, biuret products, and allophanate products obtained by allowing an excess amount of the isocyanate compound mentioned above to react with the following (a) to (c) or the like:

(a) a low molecular active hydrogen compound such as ethylene glycol, propylene glycol, m-xylylene alcohol, 1,3-bishydroxyethylbenzene, 1,4-bishydroxyethylbenzene, trimethylolpropane, glycerol, pentaerythritol, erythritol, sorbitol, ethylenediamine, monoethanolamine, diethanolamine, triethanolamine, and m-xylylenediamine;
(b) an alkylene oxide adduct of the low molecular active hydrogen compounds; and
(c) a high molecular active hydrogen compound such as polyester resins, polyetherpolyols, and polyamides.

**[0084]** Among these, as the isocyanate compound, a reaction product of m-xylene diisocyanate or m-xylene diisocyanate and an alcohol having two or more hydroxyl groups is preferable.

-Phosphate Compound-

**[0085]** As the phosphate compound, phosphoric acids and/or organic phosphoric esters can be used, and the phosphate compound may be monomeric or polymeric. The phosphate compound preferably has a hydroxyl group connected to the phosphorus atom. The phosphate compound enables the adhesiveness of the adhesive that protects the inorganic vapor-deposited layer to be enhanced.

**[0086]** Phosphoric acids refer to phosphoric acid or multimers of phosphoric acid such as pyrophosphoric acid or polyphosphoric acid.

**[0087]** The organic group of an organic phosphoric ester is preferably one or two or more selected from the group consisting of an alkyl group, a polyalkylene ether group, a (meth)acryloyl group, and a substituted or unsubstituted phenyl group.

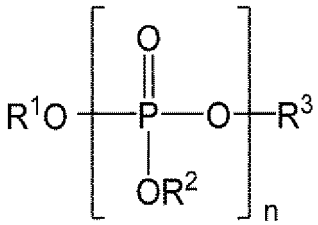
**[0088]** The content of the phosphate compound in the adhesive that protects the inorganic vapor-deposited layer is preferably 0.005% by mass or more and 10% by mass or less and more preferably 0.01% by mass or more and 1% by mass or less.

**[0089]** When the content is lower than the range described above, it may be difficult to obtain an effect resulted from incorporation of the phosphate compound. Even when the content is higher than the range, the effect resulted from the incorporation is not much improved, and a deleterious effect due to decrease in the content of the other components might be likely to be generated.

**[0090]** Examples of the phosphate compound include compounds represented by the following formula (3) or (4).

**[0091]** Specific examples of the phosphate compound include phosphoric acid, pyrophosphoric acid, triphosphoric acid, methyl acid phosphate, ethyl acid phosphate, butyl acid phosphate, dibutyl phosphate, 2-ethylhexyl acid phosphate, bis(2-ethylhexyl)phosphate, isododecyl acid phosphate, butoxyethyl acid phosphate, oleyl acid phosphate, tetracosyl acid phosphate, 2-hydroxyethyl methacrylate acid phosphate, and polyoxyethylene alkyl ether phosphoric acid.

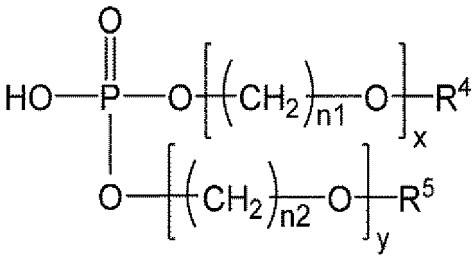
[Formula 3]



(3)

**[0092]** The formula represents the average chemical structure, wherein $R^1$, $R^2$, and $R^3$ are one or two or more selected from the group consisting of a hydrogen atom, an alkyl group having 1 to 30 carbon atoms, a (meth)acryloyl group, a substituted or unsubstituted phenyl group, and an alkyl group having 1 to 4 carbon atoms and having a (meth)acryloyloxy group, at least one of $R^1$, $R^2$, and $R^3$ is a hydrogen atom, and n represents a number of from 1 to 4.

[Formula 4]



(4)

**[0093]** The formula represents the average chemical structure, wherein R4 and R5 are one or two or more selected from the group consisting of a hydrogen atom, an alkyl group having 1 to 30 carbon atoms, a (meth)acryloyl group, a substituted or unsubstituted phenyl group, and an alkyl group having 1 to 4 carbon atoms and having a (meth)acryloyloxy group, n1 and n2 each represent a number of from 1 to 4, x represents a number of from 0 to 30, y represents a number of from 0 to 30, and x + y > 0.

-Inorganic Compound-

**[0094]** The adhesive that protects the inorganic vapor-deposited layer may contain an inorganic compound. Containing an inorganic compound enables the oxygen barrier properties to be improved.

**[0095]** The content of the inorganic compound in the adhesive that protects the inorganic vapor-deposited layer is preferably 5% by mass or more and 50% by mass or less. When the content of the inorganic compound is set to 5% by mass or more, the plate-like inorganic compound mentioned above can be made to easily exert an effect. When the content of the inorganic compound is set to 50% by mass or less, decrease in the adhesive force can be easily inhibited.

**[0096]** The shape of the inorganic compound is not particularly limited, and a plate shape is preferable.

**[0097]** The aspect ratio of the inorganic compound is preferably 3 or more, more preferably 10 or more, and further preferably 40 or more. The aspect ratio of the inorganic compound is preferably 500 or less.

**[0098]** A preferable inorganic compound is one that is low water-swellable, is nonionic, and has no charge, from the viewpoint of inhibition of increase in the viscosity of the adhesive and inhibition of increase in the thixotropy of the adhesive. Particularly in the case of an inorganic compound having a plate shape, the inorganic compound preferably exhibits the properties described above.

**[0099]** Examples of the plate-like inorganic compound include hydrous silicates such as phyllosilicate minerals; kaolinite-serpentine clay minerals such as halloysite, kaolinite, endellite, dickite, and nacrite, and antigorite and chrysotile; pyrophyllite-talc such as pyrophyllite, talc, and kerolite; smectite clay minerals such as montmorillonite, beidellite, nontronite, saponite, hectorite, sauconite, and stevensite; vermiculite clay minerals such as vermiculite; micas or mica clay minerals such as micas including muscovite and phlogopite, margarite, tetrasilicic mica, and taeniolite; chlorites such as cookeite, sudoite, clinochlore, chamosite, and nimite; hydrotalcite, plate-like barium sulfate, boehmite, and aluminum polyphosphate. The plate-like inorganic compounds described above may be natural clay minerals or synthetic clay minerals, and may be used singly or in combination of two or more.

**[0100]** Among those described above, kaolinite-serpentine clay minerals, pyrophyllite-talc, micas or mica clay minerals, chlorites, hydrotalcite, and plate-like barium sulfate are preferable because of being non-swellable in water, and kaolinite-serpentine clay minerals and pyrophyllite-talc are more preferable because of being nonionic with no further interlayer charge.

**[0101]** The average particle diameter of the inorganic compound is not particularly limited, and is preferably 0.1 μm or more and 100 μm or less and more preferably 1 μm or more and 20 μm or less. When the average particle diameter is set to 0.1 μm or more, the plate-like inorganic compound mentioned above can be made to easily exert an effect. When the average particle diameter is set to 100 μm or less, decrease in the coatability can be easily inhibited.

**[0102]** The average particle diameter herein means a mass average value d50 in particle size distribution measurement by a laser light diffraction method.

**[0103]** Known commercially-available products of the adhesive that protects the inorganic vapor-deposited layer are a solvent-type barrier adhesive PASLIM (base agent: VM001/curing agent: 108CP), a solvent-free type barrier adhesive PASLIM (base agent NSRD011/curing agent: NSRD006) manufactured by DIC Corporation, and the like.

**[0104]** The adhesive layer can be formed by coating a coating liquid containing components constituting the adhesive layer on the paper substrate layer, on the inorganic vapor-deposited layer (on the inorganic vapor-deposited layer of the inorganic vapor-deposited layer donor), or on the separator, drying the coated liquid, and, as required, curing the dried coated liquid.

<Inorganic Vapor-deposited Layer>

**[0105]** The inorganic vapor-deposited layer is located on the side of the adhesive layer opposite to the paper substrate layer. Additionally, the inorganic vapor-deposited layer is in contact with the adhesive layer. In other words, no other layer is included between the inorganic vapor-deposited layer and the adhesive layer.

**[0106]** The inorganic vapor-deposited layer is preferably included on the substantially entire surface of the adhesive layer on the side opposite to the paper substrate layer. The phrase "substantially entire surface" means 95% or more, preferably 97% or more, more preferably 99% or more, and most preferably 100% of the area of the side of the adhesive layer opposite to the paper substrate layer.

**[0107]** In the barrier paper of the present embodiment, when the arithmetic average roughness of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, and the standard deviation of the Ra1 is defined as σRa1, σRa1 is preferably 0.030 μm or less.

**[0108]** The arithmetic average roughness herein means the arithmetic average roughness Ra as specified in JIS B0601:2001. However, both the cut-off λs and the cut-off λc on calculating the arithmetic average roughness are set to "0".

**[0109]** The surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer means the surface X in Figs. 1 to 4. Figs. 1 to 3 are schematic cross-sectional views each illustrating one embodiment of the barrier paper of the present invention, and Fig. 4 is a schematic cross-sectional view illustrating one embodiment of conventional barrier paper.

**[0110]** Hereinafter, the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer may be referred to as the "surface X".

**[0111]** When σRa1 is set to 0.030 μm or less, the barrier properties can be easily rendered favorable. This reason can be considered as follows.

**[0112]** First, σRa1 exceeding 0.030 μm means that the arithmetic average roughness value of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer markedly differs from location to location. When the arithmetic average roughness value of the inorganic vapor-deposited layer markedly differs from location to location, the physical properties of the inorganic vapor-deposited layer are more likely to differ from location to location. Thus, in the case of σRa1 exceeding 0.030 μm, it is considered that points having lowered barrier properties are more likely to be generated in a local region in the surface of the inorganic vapor-deposited layer. Then, as a result of permeation of water vapor or gas through a region locally having weak barrier properties, it is considered that, in barrier paper having σRa1 exceeding 0.030 μm, the barrier properties are not easily rendered favorable.

**[0113]** In contrast, when σRa1 is 0.030 μm or less, points having lowered barrier properties are not easily generated in a local region in the surface of the inorganic vapor-deposited layer. Thus, it is considered that, in the barrier paper having σRa1 of 0.030 μm or less, the barrier properties are easily rendered favorable.

**[0114]** σRa1 is preferably 0.025 μm or less, more preferably 0.022 μm or less, and further preferably 0.020 μm or less. The lower limit of oRal is not particularly limited, and is preferably 0.001 μm or more, more preferably 0.002 μm or more, and further preferably 0.005 μm or more.

**[0115]** Ra1 herein means the average value of the arithmetic average roughnesses Ra at 72 points. σRa1 herein means the standard deviation (standard deviation 1σ) of the arithmetic average roughness Ra at the 72 points.

**[0116]** Herein, 72 measurement points for use in calculation of parameters for the surface profile such as Ra1, σRa1, Rku, which is mentioned below, and the like are preferably measured in 36 regions, which regions are obtained by taking

a region extending for 1 cm from the outer edge of a measurement sample as the margin and equally dividing the region inside the margin into 6 parts in both the transverse and longitudinal directions. Specifically, the surface profile in both the transverse and longitudinal directions in the 36 regions are measured to obtain 72 (36 points × 2 directions = measurements at 72 points) measurements. The surface profile is preferably measured in the vicinity of the center in each of the 36 regions. The measurement sample is preferably sampled except for the folded portion(s) (e.g., in the case of sampling from a container formed using barrier paper, sampling is preferably conducted except for the folded portion(s)).

**[0117]** In the case of a quadrangular measurement sample, as shown in Fig. 5, measurement is conducted in 36 regions, which are obtained by taking a region extending for 1 cm from the outer edge of the quadrangle and equally dividing the region inside the margin into 6 parts in both the transverse and longitudinal directions. Then, the surface profiles in both the transverse and longitudinal directions in the 36 regions are measured to obtain 72 measurements. Then, Ra1 is calculated from the average of the 72 measurements, and σRa1 is calculated from the standard deviation (standard deviation 1σ) of the 72 measurement. In the case where the measurement sample has a shape other than a quadrangle, such as a circle, an oval, a triangle, or a pentagon, a quadrangle inscribed in the shape is drawn, and 72 measurements with respect to the quadrangle are preferably obtained in accordance with the method described above.

**[0118]** The surface profile of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer can be measured with a contactless surface profiler, for example. Examples of contactless surface profilers include confocal-type and white interference-type contactless surface profilers. In the present embodiment, the surface profile is measured with a confocal-type surface profiler among contactless-type surface profilers.

**[0119]** As shown in Fig. 2 and Fig. 3, in the case where the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer (surface X) is not exposed on the surface, the light of the confocal-type surface profiler is focused on the surface X enables the surface profile of the surface X to be measured.

**[0120]** An example of the confocal-type surface profiler is trade name "VK-X150" from KEYENCE CORPORATION.

**[0121]** With a confocal-type surface profiler, the surface profile of any area can be measured. Then, within the any area measured, choosing the transverse direction at any position enables Ra1 of the transverse direction at the position to be calculated, and choosing the longitudinal direction at any position enables the arithmetic average roughness of the longitudinal direction at the position to be calculated. In the case of the confocal-type surface profiler (trade name "VK-X150" from KEYENCE CORPORATION) described above, choosing the transverse direction at any position or the longitudinal direction at any position on the screen of the surface profile displayed in two dimensions enables the arithmetic average roughness of the direction chosen to be calculated.

**[0122]** The size of the measurement region in each measurement is not particularly limited. The lower limit thereof is preferably set to 100 μm in length ×100 μm or less in width, and the upper limit thereof is preferably set to 500 μm in length × 500 μm or less in width.

**[0123]** Ra1 and σRa1 herein can be calculated by the following procedure: (A1) to (A4), for example. Rku1 mentioned below also can be calculated by a procedure similar to the following (A1) to (A4), for example (provided that the "arithmetic average roughness" in the following (A3) and (A4) is read as "kurtosis of the roughness curve", and "Ra1" in the following (A4) is read as "Rku1").

(A1) A measurement sample is divided into 36 regions as described above.

(A2) The surface profile of any area in the vicinity of the center in each of the 36 regions is measured using a confocal-type surface profiler.

(A3) The arithmetic average roughness Ra of the transverse direction and the arithmetic average roughness Ra of the longitudinal direction in each of the 36 regions are calculated based on the surface profile data of the any area measured in (A2) described above. The operation so far can give 72 (36 points × 2 directions = measurements at 72 points) arithmetic average roughnesses Ra.

(A4) The average value of the arithmetic average roughnesses Ra at the 72 points is calculated, and the average value calculated is taken as Ra1 of the sample. The standard deviation of the arithmetic average roughnesses Ra at the 72 points is also calculated, and the standard deviation calculated is taken as σRa1 of the sample.

**[0124]** In order to easily allow σRa1 to be 0.030 μm or less, it is preferable to inhibit the roughness of the paper substrate layer from being reflected on the inorganic vapor-deposited layer. Thus, an adhesive layer is preferably disposed between the paper substrate layer and the inorganic vapor-deposited layer, and a sealing layer and an adhesive layer are more preferably disposed therebetween.

**[0125]** Additionally, in order to easily allow σRa1 to be 0.030 μm or less, it is preferable to form the inorganic vapor-deposited layer by a transfer method and to use a support having a substantially smooth surface profile as a support having mold-releasability. The inorganic vapor-deposited layer formed as mentioned above, on which the substantially smooth surface profile of the support having mold-releasability is reflected, easily enables σRa1 to be smaller.

**[0126]** The means to easily allow σRa1 to be smaller mentioned above is also useful as a means to easily allow Ra1

to be within the range mentioned below and a means to easily allow Rku to be within the range mentioned below.

**[0127]** In the barrier paper of the present embodiment, Ra1 is preferably 0.100 μm or less. When Ra1 is set to 0.100 μm or less, an effect caused by setting σRa1 to 0.030 μm or less can be more easily exerted.

**[0128]** Ra1 is more preferably 0.080 μm or less, more preferably 0.070 μm or less, and more preferably 0.065 μm or less.

**[0129]** The lower limit of Ra1 is not particularly limited, and is preferably 0.001 μm or more, more preferably 0.002 μm or more, and further preferably 0.005 μm or more.

**[0130]** In the barrier paper of the present embodiment, σRa1/Ra1 is preferably 0.40 or less and more preferably 0.30 or less. When σRa1/Ra1 is set to 0.40 or less, an effect caused by setting σRa1 to 0.030 μm or less can be more easily exerted.

σRa1/Ra1 is a dimensionless value obtained by dividing the standard deviation by the average value and is a so-called coefficient of variance.

**[0131]** In the barrier paper of the present embodiment, when the kurtosis of the roughness curve of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Rku1, Rku1 is preferably more than 3.0. In the case where the height distribution of the surface profile is divided into low points, average points, and high points, Rku1 exceeding 3.0 means that there are many mean points and fewer low points and high points. Accordingly, when Rku1 exceeds 3.0, it is possible to inhibit the barrier properties from lowering in a local region in the surface of the inorganic vapor-deposited layer and to easily make the barrier properties favorable.

**[0132]** Rku1 is more preferably 5.0 or more, more preferably 7.5 or more, and more preferably 10.0 or more.

**[0133]** The upper limit of Rku1 is not particularly limited, and is preferably 30.0 or less, more preferably 25.0 or less, and further preferably 20.0 or less.

**[0134]** Rku1 herein means the average value of the kurtosises of the roughness curve at the 72 points.

**[0135]** The kurtosis of the roughness curve herein means the kurtosis of the roughness curve Rku as specified in JIS B0601:2001. However, both the cut-off λs and the cut-off λc on calculating the arithmetic average roughness are set to "0".

**[0136]** Examples of a method for forming the inorganic vapor-deposited layer include physical vapor deposition methods (PVDs) such as a vacuum evaporation method, a sputtering method, and an ion plating method, and chemical vapor deposition methods (CVDs) such as a plasma chemical vapor deposition method, a thermochemical vapor deposition method, and a photochemical vapor deposition method.

**[0137]** The inorganic vapor-deposited layer may be transparent or opaque. When the inorganic vapor-deposited layer is opaque, it is possible to impart light-shielding properties to the barrier paper to easily maintain the quality of the contents. A transparent inorganic vapor-deposited layer is preferable in respect of ease of use in a microwave oven, ease of inspection with a metal detector after filling of the contents, and unlikeliness of the color of the printing layer to become somber.

**[0138]** Examples of the inorganic compound constituting the inorganic vapor-deposited layer include metals, metal oxides, metal nitrides, and metal carbides. For the inorganic compound constituting the inorganic vapor-deposited layer, two or more inorganic compounds may be mixed.

**[0139]** Specific examples of metal elements constituting the inorganic compound described above include aluminum (Al), silicon (Si), magnesium (Mg), calcium (Ca), potassium (K), tin (Sn), sodium (Na), boron (B), titanium (Ti), lead (Pb), zirconium (Zr), yttrium (Y), zinc (Zn), vanadium (V), barium (Ba), and chromium (Cr).

**[0140]** Specific examples of inorganic compounds include the metals described above, oxides of the metals described above, nitrides of the metals described above, and carbides of the metals described above, and further, also include composite inorganic compounds such as indium tin oxide (ITO) and $SiO_xC_y$ films. Oxides of metals are preferable in respect of ease of making the inorganic vapor-deposited layer transparent and a tendency to be chemically stable. Oxides of metals are preferable also in respect of ease of use in a microwave oven, ease of inspection with a metal detector after filling of the contents, and unlikeliness of the color of the printing layer to become somber.

**[0141]** Among inorganic compounds, aluminum, aluminum oxide, and silicon oxide are preferable, and aluminum oxide and silicon oxide are more preferable.

**[0142]** The notation of the average composition of the inorganic compounds is represented by, for example, $MO_x$, $MO_xC_y$ such as $SiO_x$, $AlO_x$, and $SiO_xC_y$, wherein M represents a metal element, and the range of the values of x and y depends on each metal element. In the case of metal oxides, the value of x can range from 0 to 2 for silicon, from 0 to 1.5 for aluminum, from 0 to 1 for magnesium, from 0 to 1 for calcium, from 0 to 0.5 for potassium, from 0 to 2 for tin, from 0 to 0.5 for sodium, from 0 to 1.5 for boron, from 0 to 2 for titanium, from 0 to 1 for lead, from 0 to 2 for zirconium, and from 0 to 1.5 for yttrium.

**[0143]** $MO_x$ described above is a metal in case of x = 0. The upper limit of the range of x is a value in case of complete oxidation.

**[0144]** In the present embodiment, a preferable aluminum oxide has a value of x in the range of 0.5 to 1.5, and a preferable silicon oxide has a value of x in the range of 1.0 to 2.0.

**[0145]** The inorganic vapor-deposited layer may be composed of a single layer or may be composed of multiple layers of the same or different composition.

**[0146]** The thickness of the inorganic vapor-deposited layer is preferably 30 Å or more and 3000 Å or less, more preferably 40 Å or more and 2500 Å or less, and further preferably 50 Å or more and 2000 Å or less. When the thickness of the inorganic vapor-deposited layer is set to 30 Å or more, the barrier properties can be easily rendered favorable. When the thickness of the inorganic vapor-deposited layer is set to 3000 Å or less, generation of cracking in the inorganic vapor-deposited layer can be easily inhibited.

**[0147]** More specifically, in the PVD method described above, the thickness of the inorganic vapor-deposited layer comprised of aluminum oxide is preferably 30 Å or more and 1000 Å or less and more preferably 50 Å or more and 500 Å or less.

**[0148]** In the CVD method described above, the thickness of the inorganic vapor-deposited layer comprised of silicon oxide is preferably 30 Å or more and 3000 Å or less and more preferably 100 Å or more and 300 Å or less.

**[0149]** The inorganic vapor-deposited layer can be formed by "a formation technique for vapor-depositing an inorganic compound directly on the adhesive layer (direct vapor deposition method)" or "a transfer method", for example.

**[0150]** The transfer method is a technique for bonding an inorganic vapor-deposited layer donor having an inorganic vapor-deposited layer on a support having mold-releasability to a paper substrate layer with an adhesive layer interposed therebetween to thereby form the inorganic vapor-deposited layer on the paper substrate layer by transfer.

**[0151]** In comparison between the direct vapor deposition method and the transfer method, the transfer method is preferable in respect that no failure occurs due to exposure of the paper substrate layer to a vapor deposition atmosphere and the adhesiveness between the adhesive layer and the inorganic vapor-deposited layer is easily rendered favorable. The transfer method is preferable also in respect that Ra1, $\sigma$Ra1, and Rku1 are easily allowed to be within the range mentioned above.

**[0152]** There are four types of the transfer method, which are different in the manner of forming the adhesive layer: "1. A type in which an adhesive layer is formed on the inorganic vapor-deposited layer of an inorganic vapor-deposited layer donor", "2. A type in which an adhesive layer is formed on a paper substrate layer", "3. A type in which an adhesive layer is each formed on both the inorganic vapor-deposited layer of an inorganic vapor-deposited layer donor and a paper substrate", and "4. A type in which an adhesive layer is supplied between a paper substrate layer and an inorganic vapor-deposited layer donor". Among these, the types "2" and "4" are preferable. This is because although defects may be generated in the inorganic vapor-deposited layer on forming another layer such as an adhesive layer on the inorganic vapor-deposited layer, the types "2" and "4" can eliminate the possibility mentioned above. Among "2" and "4", preferable is "2", which easily makes the adhesiveness between the paper substrate layer and the adhesive layer favorable.

**[0153]** The interlayer adhesion strength between the adhesive layer and the inorganic vapor-deposited layer preferably corresponds to any of the classes 0, 1, and 2 and more preferably either of the class 0 or 1 in a crosscut test in accordance with JIS K5600-5-6. In the case of the class 3, 4, or 5, which is lower than the range described above, delamination occurs between the adhesive layer and the inorganic vapor-deposited layer, and thus the gas barrier properties is likely to lower.

**[0154]** Evaluation on the interlayer adhesion strength described above is outlined as below.

**[0155]** A right-angle lattice pattern is formed by cutting into the inorganic vapor-deposited layer on the barrier paper with a cutter knife or the like through to the inorganic vapor-deposited layer. In this case, it is preferable to use a crosscut tool that may cleanly form a plurality of lattice squares in the right-angle lattice pattern serially.

**[0156]** Next, adhesive tape having a tacking agent layer on one side such as adhesive cellophane tape is applied to the entire lattice formed above so as to cover the entire lattice.

**[0157]** Then, a Tensilon is used to peel off the adhesive cellophane tape applied from the end, the degree of peeling-off of the inorganic vapor-deposited layer is visually observed, and the results are classified in accordance with the following evaluation criteria.

**[0158]** The size of one side of a lattice square in the lattice pattern is preferably 1 mm or more and 5 mm or less, more preferably 1.5 mm or more and 3 mm or less, and further preferably about 2 mm. The number of lattice squares in the lattice pattern is preferably from 15 or more and 50 or less, more preferably from 20 or more and 30 or less, and further preferably about 25. The width and length of the adhesive tape are preferably sized such that the tape can cover the entire lattice pattern and is easily peeled off. The adhesive tape is peeled off using a Tensilon or the like at a constant speed of preferably 1 mm/minute or more and 5 mm/minute or less, more preferably 2 mm/minute or more and 4 mm/minute or less, and further preferably about 3 mm/minute.

**[0159]**

Class 0: The edges of the cuts are completely smooth, and none of the lattice squares is detached.

Class 1: A small detachment of the coated film at the intersections of the cuts. However, the area to be affected will not clearly exceed 5% in the cross-cut portion.

Class 2: The coated film has detached along the edges and/or at the intersections of the cuts. The area to be affected is clearly 5% or more and 15% or less in the cross-cut portion.

Class 3: The coated film has markedly detached along the edges of the cuts partly or wholly, and/or has detached

partly or wholly on different parts of the lattice squares. The area to be affected is in the range of more than 15% and less than 35% in the cross-cut portion.

Class 4: The coated film has markedly detached along the edges of the cuts partly or wholly, and/or some lattice squares have detached partly or wholly. The area to be affected is in the range of clearly 35% or less in the cross-cut portion.

Class 5: Any degree of detachment that cannot even be classified by Class 4.

<Sealing Layer>

**[0160]** The barrier paper of the present embodiment preferably has a sealing layer between the paper substrate layer and the adhesive layer. When a sealing layer is included, the standard deviation and the coefficient of variance of the thickness of the adhesive layer can be easily allowed to be within the ranges mentioned above. When a sealing layer, in addition to an adhesive layer, is included between the paper substrate layer and the inorganic vapor-deposited layer, the surface profile such as $\sigma$Ra1 can be easily allowed to be within the ranges described above.

**[0161]** Examples of the sealing layer include a clay-coated layer and a resin layer.

**[0162]** The clay-coated layer preferably contains clay and a binder.

**[0163]** Clay can be used without particular limitation as long as it is one generally called clay. Specific examples of the clay include kaolin, talc, bentonite, smectite, vermiculite, mica, chlorite, kibushi clay, gairome clay, halloysite, and mica. Talc, which has low hardness (Moh's hardness: 1) and excellent heat resistance, can improve heat resistance and improve dimensional stability during embossing.

**[0164]** Examples of the binder usually include latex-based binders (e.g., styrene butadiene latex, acrylic latex, vinyl acetate-based latex), and water-soluble binders (e.g., starch (modified starch, oxidized starch, hydroxyethyl-etherified starch, and phosphoric-esterified starch), polyvinyl alcohol, and casein).

**[0165]** The clay-coated layer preferably contains a pigment such as calcium carbonate, titanium dioxide, amorphous silica, effervescent barium sulfate, or satin white in order to improve the smoothness of the surface of the clay-coated layer. Among pigments, calcium carbonate and titanium dioxide are preferable, and calcium carbonate is more preferable.

**[0166]** The clay-coated layer may further contain additives such as a pigment dispersant, a defoaming agent, an antifoaming agent, a viscosity modifier, a lubricant, a water-resistance imparting agent, and a water-retaining agent.

**[0167]** For the thickness of the clay-coated layer, the basis weight after drying is preferably 5 g/m$^2$ or more and 40 g/m$^2$ or less and more preferably 10 g/m$^2$ or more and 40 g/m$^2$ or less. When the basis weight after drying is set to 5 g/m$^2$ or more, the effect of the sealing layer mentioned above can be easily exerted. When the basis weight after drying is set to 40 g/m$^2$ or less, cohesive failure of the clay-coated layer can be easily inhibited. The thickness of the clay-coated layer is preferably 3 $\mu$m or more and 40 $\mu$m or less and more preferably 10 $\mu$m or more and 30 $\mu$m or less.

**[0168]** The clay-coated layer can be formed by, for example, coating a coating liquid including components constituting the clay-coated layer on a paper substrate layer by a general-purpose coating method and drying the coated liquid. Examples of the solvent for clay-coated layer coating liquid include water and alcohol.

**[0169]** Examples of the resin constituting the resin layer include polyolefin-based resins, acrylic resins, urethane-based resins, and PVA (polyvinyl alcohol). The resin layer can be formed by, for example, applying coating on a paper substrate layer.

**[0170]** The thickness of the resin layer is preferably 10 $\mu$m or more in order for the effect of the sealing layer mentioned above to be easily exerted. The thickness of the resin layer is preferably 60 $\mu$m or less for recyclability.

<Release Layer, Protective Layer, Heat Seal Layer, Sealant Layer>

**[0171]** The barrier paper of the present embodiment preferably has one or more layers selected from a release layer, a protective layer, a heat seal layer, and a sealant layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

«Release Layer»

**[0172]** The barrier paper may have a release layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0173]** The release layer is a layer to be provided as required in order for the support having mold-releasability to be easily released from the inorganic vapor-deposited layer donor.

**[0174]** In the case where an inorganic vapor-deposited layer donor having a release layer and an inorganic vapor-deposited layer on a support having mold-releasability is used to transfer the inorganic vapor-deposited layer and release layer on a paper substrate layer with an adhesive layer interposed therebetween, the release layer is located on the side of the inorganic vapor-deposited layer opposite to the adhesive layer. When the release layer is located on the side

of the inorganic vapor-deposited layer opposite to the adhesive layer, the release layer can be allowed to function as a protective layer for the inorganic vapor-deposited layer.

**[0175]** The release layer also enables the surface profile of the support having mold-releasability to be easily averaged and planarized. Thus, when the release layer is included, the surface profile such as σRa1 can be easily allowed to be within the range mentioned above.

**[0176]** The release layer is preferably included on the substantially entire surface of the inorganic vapor-deposited layer on the side opposite to the adhesive layer. The phrase "substantially entire surface" means 95% or more, preferably 97% or more, more preferably 99% or more, and most preferably 100% of the area of the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0177]** The release layer is not particularly limited as long as the release layer exerts well-balanced adhesive strength in order to achieve transfer of the inorganic vapor-deposited layer, and preferably contains resin and/or wax.

**[0178]** Examples of the resin include polyester-based resins, acrylic resins, silicone-based resins, polyvinyl butyral-based resins, and acetal-based resins. Among these, polyester-based resins and acrylic resins are preferable.

**[0179]** Examples of the wax include carnauba wax, paraffin-based wax, polyethylene-based wax, and polypropylene-based wax. Among these, polyethylene-based wax is preferable.

**[0180]** The release layer preferably contains substantially no particles such as a pigment or a matting agent in order to easily allow the surface profile such as σRa1 to be within the range mentioned above. The phrase "contains substantially no" means 0.1% by mass or less, and is preferably 0.01% by mass or less, more preferably 0.001% by mass or less, and most preferably 0% by mass, with respect to the total solids constituting the release layer.

**[0181]** The amount of the release layer coated is preferably 0.2 g/m$^2$ or more and 5.0 g/m$^2$ or less. The thickness of the release layer is preferably 0.1 μm or more and 10 μm or less.

«Protective Layer»

**[0182]** The barrier paper may have a protective layer. The protective layer is preferably included on the side of the inorganic vapor-deposited layer opposite to the adhesive layer in order to protect the inorganic vapor-deposited layer.

**[0183]** The protective layer also enables the surface profile of the support having mold-releasability to be easily averaged and planarized. Thus, when the protective layer is included, the surface profile such as σRa1 can be easily allowed to be within the range mentioned above.

**[0184]** The protective layer is preferably included on the substantially entire surface of the inorganic vapor-deposited layer on the side opposite to the adhesive layer. The phrase "substantially entire surface" means 95% or more, preferably 97% or more, more preferably 99% or more, and most preferably 100% of the area of the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0185]** The protective layer can be formed by, for example, "1. Coating a protective layer coating liquid on the inorganic vapor-deposited layer and drying the coated liquid", "2. Transferring a protective layer on the inorganic vapor-deposited layer", and "3. Providing an inorganic vapor-deposited layer donor having a protective layer and an inorganic vapor-deposited layer in this order on a support having mold-releasability and transferring the inorganic vapor-deposited layer and protective layer on a paper substrate layer with an adhesive layer interposed therebetween". Among these, "3" is preferable for improving the workability and inhibiting defects of the inorganic vapor-deposited layer.

**[0186]** The protective layer may comprise a resin component singly, an inorganic component singly, or a mixture of a resin component and an inorganic component.

**[0187]** The protective layer preferably contains one or more selected from water-soluble polymers and metal alkoxide-based compounds, by way of example. The protective layer contains more preferably one or more selected from water-soluble polymers and further preferably one or more selected from water-soluble polymers and one or more selected from metal alkoxide-based compounds, among water-soluble polymers and metal alkoxide-based compounds.

**[0188]** Examples of water-soluble polymers include polyvinyl alcohol, polyvinylpyrrolidone, and ethylene-vinyl alcohol copolymers. Among these, from the viewpoint of barrier properties, polyvinyl alcohol and ethylene-vinyl alcohol copolymers are preferable, and polyvinyl alcohol is more preferable. In other words, the protective layer contains preferably one or more selected from polyvinyl alcohol and ethylene-vinyl alcohol copolymer and more preferably polyvinyl alcohol.

**[0189]** In the case where the protective layer contains a water-soluble polymer and a metal alkoxide-based compound, the content of the water-soluble polymer based on the total 100 parts by mass of the metal alkoxide-based compound is preferably 5 parts by mass or more and 500 parts by mass or less, more preferably 7 parts by mass or more and 100 parts by mass or less, and further preferably 8 parts by mass or more and 50 parts by mass or less.

**[0190]** Examples of metal alkoxide-based compounds include metal alkoxides, metal alkoxide hydrolysates, and metal alkoxide polymers.

**[0191]** A metal alkoxide is a compound represented by the general formula $M(OR)_n$, wherein M represents a metal such as Si, Ti, Al, and Zr, and R represents an alkyl group such as a methyl group and an ethyl group. Specific examples of the metal alkoxide include tetramethoxysilane, tetraethoxysilane, and isopropoxy aluminum.

**[0192]** A protective layer can be formed by, for example, coating a coating liquid including components constituting the protective layer on the support having mold-releasability of an inorganic vapor-deposited layer donor and drying the coated liquid. The coating liquid may contain additives such as a silane coupling agent, a curing agent, a dispersant, and the like.

**[0193]** The protective layer preferably contains substantially no particles such as a pigment or a matting agent in order to easily allow the surface profile such as $\sigma$Ra1 to be within the range mentioned above. The phrase "contains substantially no" means 0.1% by mass or less, and is preferably 0.01% by mass or less, more preferably 0.001% by mass or less and most preferably 0% by mass, with respect to the total solids constituting the protective layer.

**[0194]** The lower limit of the thickness of the protective layer is preferably 70 nm or more, more preferably 85 nm or more, and further preferably 100 nm or more in order to protect the inorganic vapor-deposited layer to thereby easily make the barrier properties favorable.

**[0195]** The upper limit of thickness of the protective layer is preferably 480 nm or less, more preferably 400 nm or less, and further preferably 300 nm or less. When the thickness of the protective layer is set to 480 nm or less, generation of a stress in the protective layer is inhibited, and generation of cracking in the inorganic vapor-deposited layer due to the stress can be easily inhibited.

«Heat Seal Layer»

**[0196]** The barrier paper may have a heat seal layer. The heat seal layer is preferably included on the side of the inorganic vapor-deposited layer opposite to the adhesive layer. In the case where the barrier paper has a heat seal layer, in order to protect the inorganic vapor-deposited layer from the heat seal layer, at least either of a release layer and a protective layer is preferably included between the inorganic vapor-deposited layer and the heat seal layer.

**[0197]** The heat seal layer has a function of an adhesive layer in forming the barrier paper into a form of a container, for example.

**[0198]** The heat seal layer can be formed from a general-purpose thermoplastic resin, for example. The thickness of the heat seal layer is usually about 15 $\mu$m or more and 100 $\mu$m or less.

**[0199]** The heat seal layer can be formed by, for example, "1. Melt-extruding a heat seal layer on the inorganic vapor-deposited layer", "2. Coating a heat seal layer coating liquid on the inorganic vapor-deposited layer and drying the coated liquid", "3. Transferring a heat seal layer on the inorganic vapor-deposited layer", "4. Providing an inorganic vapor-deposited layer donor having a heat seal layer and the inorganic vapor-deposited layer in this order on a support having mold-releasability and transferring the inorganic vapor-deposited layer and heat seal layer on a paper substrate layer with an adhesive layer interposed therebetween", and "5. Dry-laminating a heat seal layer on an inorganic vapor-deposited layer.

**[0200]** Among these, "1", "2", "3", and "5" are preferable, from the viewpoint of reduction in the vapor deposition cost of the inorganic vapor-deposited layer. In the case of "1", "2", "3", and "5", at least either of a release layer and a protective layer is preferably included between the inorganic vapor-deposited layer and the heat seal layer. In the case where at least either of a release layer and a protective layer is included between the inorganic vapor-deposited layer and the heat seal layer, among "1", "2", "3", and "5", "1", "2", and "5" are preferable, and "2" is more preferable (the release layer or protective layer blocks the solvent of the heat seal layer coating liquid, and thus, degradation of the inorganic vapor-deposited layer due to the solvent can be inhibited. Accordingly, in consideration of workability, "2" is more preferable).

«Sealant Layer»

**[0201]** The barrier paper may have a sealant layer. The sealant layer is preferably included on the side of the inorganic vapor-deposited layer opposite to the adhesive layer. In the case where the barrier paper has a sealant layer, in order to protect the inorganic vapor-deposited layer from the sealant layer, at least either of a release layer and a protective layer is preferably included between the inorganic vapor-deposited layer and the sealant layer.

**[0202]** When the barrier paper is used as a container, for example, the sealant layer has a function of preventing contents to be placed in the container from coming into contact with the other layers of the barrier paper to thereby protect the contents.

**[0203]** The thickness of the sealant layer is not particularly limited and is set appropriately in accordance with the application of the barrier paper and the type, properties, and the like of the content. The thickness of the sealant layer is preferably 10 $\mu$m or more and 200 $\mu$m or less. In the case where a container is formed with the barrier paper, the thickness of the sealant layer is more preferably 15 $\mu$m or more and 150 $\mu$m or less and further preferably 20 $\mu$m or more and 100 $\mu$m or less.

**[0204]** Examples of a material constituting the sealant layer include propylene-based resins such as propylene homopolymers, ethylene-propylene block copolymers, ethylene-propylene random copolymer, high-density polyethylene (HDPE), low-density polyethylene (LDPE), and linear low-density polyethylene (L-LDPE), and one or two or more of

these resins can be used.

**[0205]** The sealant layer may be composed of a single layer or may be composed of two or more multiple layers.

**[0206]** The sealant layer preferably has heat sealing properties. In the case of a sealant layer of a multi-layered structure, the side of the sealant layer opposite to the inorganic vapor-deposited layer preferably has heat sealing properties.

**[0207]** In the case where barrier paper is used as the lid body of a lidded container, the sealant layer preferably has easy peelability. Easy peelability refers to a feature, for example, on opening a lidded container, of easily releasing the lid body from the container body.

**[0208]** A sealant layer having easy peelability can be formed by, with use of 2 or more resins, mixing one resin (resin having favorable adhesiveness to the container body) and the other resin(s) (resin(s) having unfavorable adhesiveness to the container body and being incompatible with the one resin). Such resins may differ depending on the material of the container. Thus, although it depends on the case, in the case of a container body formed of polypropylene, forming the sealant layer from a resin obtained by mixing polypropylene as one resin (resin having favorable adhesiveness to the container body) and one or more selected from polyethylene, polybutene, and polystyrene as the other resin(s) (resin(s) having unfavorable adhesiveness to the container body and being incompatible with the one resin) enables easy peelability to be imparted to the container made of polypropylene.

**[0209]** The sealant layer may be formed to have a multi-layered structure to thereby impart easy peelability only to the side of the sealant layer to be bonded to the container body.

**[0210]** The sealant layer can be formed by, for example, "1. Melt-extruding a sealant layer on the inorganic vapor-deposited layer", "2. Coating a sealant layer coating liquid on the inorganic vapor-deposited layer and drying the coated liquid", "3. Transferring a sealant layer on the inorganic vapor-deposited layer", "4. Providing the inorganic vapor-deposited layer donor having a sealant layer and an inorganic vapor-deposited layer in this order on a support having mold-releasability and transferring the inorganic vapor-deposited layer and sealant layer on the paper substrate layer with an adhesive layer interposed therebetween", and "5. Dry-laminating a sealant layer on the inorganic vapor-deposited layer.

**[0211]** Among these, "1", "2", "3", and "5" are preferable, from the viewpoint of reduction in the vapor deposition cost of the inorganic vapor-deposited layer. In the case of "1", "2", "3", and "5", at least either of a release layer and a protective layer is preferably included between the inorganic vapor-deposited layer and the sealant layer.

<Printing layer>

**[0212]** The barrier paper may have a printing layer. The printing layer is preferably included on the side of the paper substrate layer opposite to the adhesive layer.

**[0213]** Examples of the printing layer include layers including characters (such as a trade name, a product indication, or a quality indication), a figure, a photograph, a symbol, a motif, or a pattern formed thereon by printing and layers printed entirely thereon (so-called solid printing layers).

**[0214]** The printing layer may be a single layer or may be multi-layered. The thickness of the printing layer is usually 0.2 μm or more and 10.0 μm or less, preferably 0.5 μm or more and 8.0 μm or less, and more preferably 0.7 μm or more and 5.0 μm or less.

**[0215]** As ink for use in formation of the printing layer, one obtained by mixing a colorant such as a pigment or dye, an extender pigment, a solvent, a stabilizer, a plasticizer, a catalyst, a curing agent, and the like, as appropriate, in a binder resin is used.

**[0216]** Examples of the binder resin include acrylic resins, styrene-based resins, polyester-based resins, polyurethane-based resins, chlorinated polyolefin-based resins, vinyl chloride-vinyl acetate copolymer-based resins, polyvinyl butyral resins, alkyd-based resins, petroleum-based resins, ketone resins, epoxy-based resins, melamine-based resins, fluorine-based resins, silicone-based resins, fibrin derivatives, and rubber-based resins. These may be used singly or in combinations of two or more.

<Reinforcing Layer>

**[0217]** The barrier paper may have a reinforcing layer. The reinforcing layer is preferably included on the side of the paper substrate layer opposite to the adhesive layer and/or on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0218]** The reinforcing layer is formed in order to impart one or more functions selected from mechanical strength, deformation resistance, drop impact resistance, pinhole resistance, heat resistance, sealing performance, quality maintainability, workability, and hygiene to the barrier paper, for example.

**[0219]** Examples of the reinforcing layer include resin films formed by extrusion or inflation, resin coating films, and synthetic paper.

**[0220]** Specific examples of the resin to be contained in the reinforcing layer include low density polyethylene, medium

density polyethylene, high density polyethylene, linear low density polyethylene, polypropylene, ethylene-propylene copolymers, ethylene-vinyl acetate copolymers, ionomer resin, ethylene-ethyl acrylate copolymers, ethylene-acrylic acid copolymers, ethylene-methacrylic acid copolymers, methylpentene polymers, polybutene-based resins, polyvinyl chloride-based resins, polyvinyl acetate-based resins, polyvinylidene chloride-based resins, vinyl chloride-vinylidene chloride copolymers, poly(meth)acrylic resins, polyacrylonitrile-based resins, polystyrene-based resins, acrylonitrile-styrene copolymers (AS-based resins), acrylonitrile-butadiene-styrene copolymers (ABS-based resins), polyester-based resins, polyamide-based resins, polycarbonate-based resins, polyvinyl alcohol-based resins, saponified products of ethylene-vinyl acetate copolymers, fluorine-based resins, diene-based resins, polyacetal-based resins, polyurethane-based resins, cellulose, and nitrocellulose.

**[0221]** As the resin film constituting the reinforcing layer, any of unstretched films, uniaxially stretched films, and biaxially stretched films can be used.

**[0222]** The thickness of the reinforcing layer is not particularly limited and is preferably 1 μm or more and 300 μm or less.

<Functional Layer>

**[0223]** The barrier paper may have a functional layer. The functional layer is preferably included on the side of the paper substrate layer opposite to the adhesive layer and/or on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

**[0224]** Examples of functional layers include functional layers that impart barrier properties against oxygen gas and water vapor, functional layers that scarcely adsorb fragrance components and the like contained in the contents and excel in aroma retaining properties, functional layers that impart light shieldability, and functional layers that absorb oxygen.

**[0225]** From the viewpoint of barrier properties and aroma retaining properties, the functional layer preferably contains one or more resins selected from saponified products of ethylene-vinyl acetate copolymers, polyamide-based resins, polyacrylonitrile-based resins, and polyester-based resins.

**[0226]** From the viewpoint of light shieldability, the functional layer preferably contains particles comprised of a material having high light shieldability such as titanium oxide, carbon black, and aluminum flakes and a binder resin.

**[0227]** From the viewpoint of oxygen absorbability, the functional layer preferably contains particles comprised of a material having high oxygen absorbability such as iron powder and a binder resin.

<Physical Properties>

**[0228]** The barrier paper has an oxygen transmission rate, as measured at a temperature of 23°C and a relative humidity of 90% in accordance with the JIS K7126 method, of preferably 0.01 cc/$m^2$/24 hr/atm or more and 10 cc/$m^2$/24 hr/atm or less, and more preferably 0.01 cc/$m^2$/24 hr/atm or more and 5 cc/$m^2$/24 hr/atm or less. It is difficult to make the oxygen transmission rate smaller than 0.01 cc/$m^2$/24 hr/atm. When the oxygen transmission rate is set to 10 cc/$m^2$/24 hr/atm or less, degradation of the contents can be easily inhibited.

**[0229]** The barrier paper has a water vapor transmission rate, as measured at a temperature of 40°C and a relative humidity of 90% in accordance with the JIS K7129 method, of preferably 0.01 g/$m^2$/24 hr or more and 20 g/$m^2$/24 hr or less, and more preferably 0.01 g/$m^2$/24 hr or more and 10 g/$m^2$/24 hr or less. It is difficult to make the water vapor transmission rate smaller than 0.01 g/$m^2$/24 hr. When the water vapor transmission rate is set to 20 g/$m^2$/24 hr or less, degradation of the contents can be easily inhibited.

<Secondary Processing>

**[0230]** The barrier paper can be subjected to secondary processing in order to impart a chemical function, an electrical function, a magnetic function, a dynamic function, an abrasion resistant function, a lubrication function, an optical function, a thermal function, a surface function such as biocompatibility, or the like thereto.

**[0231]** Examples of the secondary processing include embossing, painting, adhesion, printing, metallizing (such as plating), machining, and surface treatment (such as antistatic treatment, corona discharge treatment, plasma treatment, photochromism treatment, physical vapor deposition, chemical vapor deposition, and coating).

<Applications>

**[0232]** The barrier paper of the present embodiment can be used as a container that directly houses contents (primary container), a container that houses packaged contents (secondary container), or a lid, for example. In the case where the barrier paper of the present embodiment is used as a container or lid, the inorganic vapor-deposited layer side is preferably used as the inner layer side with reference to the adhesive layer.

[Container]

**[0233]** The container of the present embodiment includes the barrier paper of the present embodiment mentioned above.

**[0234]** Examples of the container includes containers that directly house contents (primary containers) and containers that house packaged contents (secondary containers). Such primary containers and secondary containers may be lidded containers that each have a container body having a receiving portion and a lid body joined to the container body so as to seal the receiving portion.

**[0235]** Examples of the primary container include pouches, laminated tubes, cups, and trays.

**[0236]** In these containers, the barrier paper of the present embodiment mentioned above can be used as the container body or can be used as the lid for the container body, for example.

**[0237]** The barrier paper is preferably disposed such that the inorganic vapor-deposited layer side become the contents side of the container with reference to adhesive layer.

**[0238]** Examples of the contents include foods such as coffee beans, tea leaves, cheese, snacks, rice snacks, unbaked sweets, semi-baked sweets, fruits, nuts, vegetables, fruits, fish products, meat products, paste products, dried fish, smoked products, tsukudani (food boiled in soy sauce), uncooked rice, cooked rices, rice cakes, foodstuffs for infants, jam, mayonnaise, ketchup, edible oils, dressings, sauces, spices, dairy products, and pet food; beverages such as beer, wine, fruit juice, green tea, and coffee; pharmaceuticals; cosmetics; commodities such as shampoos, rinses, and detergents; metal components; and electronic components.

[Lid]

**[0239]** The lid of the present embodiment includes the barrier paper of the present embodiment mentioned above.

**[0240]** The lid of the present embodiment can be used as a lid for a lidded container that has a container body having a receiving portion and a lid body joined to the container body so as to seal the receiving portion, for example.

[Method for Producing Barrier Paper]

**[0241]** A method for producing the barrier paper of the present embodiment includes steps 1 to 2 below.

Step 1: a step of bonding an inorganic vapor-deposited layer donor comprising an inorganic vapor-deposited layer on a support having mold-releasability to a paper substrate layer with an adhesive layer interposed therebetween to prepare a barrier paper intermediate, wherein in step 1, the inorganic vapor-deposited layer donor is disposed such that the surface on the side having the inorganic vapor-deposited layer faces toward the paper substrate layer side with reference to the support having mold-releasability; and

Step 2: a step of releasing the support having mold-releasability from the barrier paper intermediate obtained in step 1 to obtain barrier paper described below:

<Barrier Paper>

**[0242]** Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

<Step 1>

**[0243]** Step 1 is a step of bonding an inorganic vapor-deposited layer donor comprising an inorganic vapor-deposited layer on a support having mold-releasability to a paper substrate layer with an adhesive layer interposed therebetween to prepare a barrier paper intermediate; wherein in step 1, the inorganic vapor-deposited layer donor is disposed such that the surface on the side having the inorganic vapor-deposited layer faces toward the paper substrate layer side with reference to the support having mold-releasability.

«Inorganic Vapor-deposited Layer Donor»

**[0244]** The inorganic vapor-deposited layer donor has an inorganic vapor-deposited layer on a support having mold-releasability.

**[0245]** The inorganic vapor-deposited layer donor may have one or more layers selected from a release layer and a protective layer between the support having mold-releasability and the inorganic vapor-deposited layer. In the case where both a release layer and a protective layer are included between the support having mold-releasability and the

inorganic vapor-deposited layer, the release layer and the protective layer are preferably included in the order mentioned from the side of the support having mold-releasability.

**[0246]** The embodiment of the release layer and protective layer is as mentioned above.

**[0247]** The inorganic vapor-deposited layer donor may have one or more layers selected from a heat seal layer and a sealant layer between the support having mold-releasability and the inorganic vapor-deposited layer. In the case where the inorganic vapor-deposited layer donor has one or more layers selected from a heat seal layer and a sealant layer, in order to protect the inorganic vapor-deposited layer from the heat seal layer and sealant layer, at least either of a release layer and a protective layer is preferably included between at least one or more layers selected from the heat seal layer and the sealant layer and the inorganic vapor-deposited layer.

**[0248]** The embodiment of the heat seal layer and sealant layer is as mentioned above.

**[0249]** The inorganic vapor-deposited layer donor may further include other layers such as a reinforcing layer and a functional layer as required.

-Support Having Mold-releasability-

**[0250]** The support having mold-releasability can be used without particular limitation as long as the support is appropriate for the formation step for the inorganic vapor-deposited layer and the transfer operation in steps 1 to 2.

**[0251]** The "support having mold-releasability" herein may be referred to as the "releasable support" in some cases.

**[0252]** The releasable support is preferably a film comprised of a resin. The releasable support may be composed of a single layer or may be a laminate of 2 or more resin layers having the same composition or of 2 or more resin layers each having a different composition.

**[0253]** Examples of resins to be contained in the releasable support include polyester-based resins such as polyethylene terephthalate (PET) and polybutylene terephthalate (PBT); polyamide-based resins such as aromatic polyamides including nylon MXD6, and general-purpose nylons; polyolefin-based resins such as polyethylene-based resins, polypropylene-based resins, polybutene-based resins, and cyclic polyolefin resins; polystyrene-based resins such as polystyrene-based resins, acrylonitrile-styrene copolymer (AS resins), and acrylonitrile-butadiene-styrene copolymers (ABS resins); polyvinyl chloride-based resins; polyvinylidene chloride-based resins (PVDCs); polycarbonate-based resins; polyimide-based resins; polyamide-imide-based resins; diaryl phthalate resins; silicone-based resins; polysulfone-based resins; polyphenylene sulfide-based resins; polyethersulfone-based resins; polyurethane-based resins; cellulose-based resins; poly(meth)acrylic resins; acetal-based resins; fluorine-based resins; ethylene-vinyl acetate copolymers; ethylene-vinyl alcohol copolymers (EVOHs); polyvinyl alcohol; polyacrylonitrile; biomass-derived polyethylene terephthalate; and biomass-derived polyethylene. These may be used singly or in admixture of two or more. These resins may be recycled (chemical-recycled, material-recycled, or the like) resins.

**[0254]** Among these, particularly, a polyester-based resin and/or a polyamide-based resin are/is preferably contained, and PET is particularly preferable.

**[0255]** The thickness of the releasable support is not particularly limited, and is preferably 6 μm or more and 300 μm or less and more preferably 10 μm or more and 100 μm or less.

**[0256]** In the releasable support, the surface on the side on which the inorganic vapor-deposited layer is formed is preferably substantially smooth. Specifically, in the surface of the releasable support on the side on which the inorganic vapor-deposited layer is formed, the arithmetic average roughness Ra is preferably 0.080 μm or less, more preferably 0.070 μm or less, and further preferably 0.065 μm or less.

**[0257]** The embodiment of the inorganic vapor-deposited layer of the inorganic vapor-deposited layer donor is as mentioned above.

**[0258]** Examples of a method for forming the inorganic vapor-deposited layer on the releasable support include physical vapor deposition methods (PVDs) such as a vacuum evaporation method, a sputtering method, and an ion plating method, and chemical vapor deposition methods (CVDs) such as a plasma chemical vapor deposition method, a thermochemical vapor deposition method, and a photochemical vapor deposition method.

**[0259]** Specifically, in the PVD method described above, for example, with use of a roll-to-roll type vapor depositing apparatus, in the vacuum chamber, a releasable support fed from the feed roll is placed in the vapor deposition chamber. Here, while the vapor deposition source heated in a crucible is vaporized and further, oxygen or the like is ejected from the oxygen vent, as required, an inorganic vapor-deposited layer is formed on the releasable support on the cooled coating drum with a mask interposed therebetween.

**[0260]** In the CVD method described above, a mixed gas comprised of an organosilicon compound, oxygen gas, inert gas, and the like, supplied as monomer gas from the vapor deposition raw material vaporization supplier, is introduced on the surface of the releasable support unwound from the feed roll disposed in the vapor deposition chamber, and then, an inorganic vapor-deposited layer of silicon oxide and the like can be formed by means of plasma.

**[0261]** On forming the inorganic vapor-deposited layer, close adhesive properties between the inorganic vapor-deposited layer and the releasable support (or a release layer, protective layer, or the like formed on the releasable support)

can be enhanced by cleaning the surface of the releasable support (or the release layer, protective layer, or the like formed on the releasable support) by pretreatment with $SiO_x$ plasma or the like to generate polar groups, free radicals, or the like on the surface.

**[0262]** Further, in continuous lamination of two or more inorganic vapor-deposited layers using a plasma chemical vapor deposition apparatus comprised of at least two or more film formation chambers, continuously vapor depositing without opening to air enables contamination of the inorganic vapor-deposited layer with foreign matter, dust, and the like, which are responsible for generation of cracking, to be prevented, enabling the gas barrier properties to be improved.

**[0263]** Furthermore, when the inorganic vapor-deposited layer is configured to have two or more layers each having a different composition, the inorganic vapor-deposited layer is in a form of different discontinuous layers, and thus, permeation of oxygen gas, water vapor, and the like can be more efficiently inhibited.

**[0264]** The embodiment of the paper substrate layer is as mentioned above.

**[0265]** In the method for producing the barrier paper of the present embodiment, a sealing layer is preferably formed on at least one surface of the paper substrate layer before step 1. The embodiment of the sealing layer is as mentioned above.

**[0266]** In the case where a sealing layer has been formed on the paper substrate layer, in step 1, the surface of the inorganic vapor-deposited layer donor on the side having the inorganic vapor-deposited layer (surface 1) is faced to the surface of the paper substrate layer on the side on which the sealing layer has been formed (surface 2), and the surface 1 is laminated to the surface 2 with the adhesive layer interposed therebetween.

**[0267]** The embodiment of the adhesive layer is as mentioned above.

**[0268]** In step 1, the adhesive layer can be formed or supplied as in the following 1 to 4, for example. In the case of the following "2", "3", and "4", it is preferable that a sealing layer be formed on the paper substrate layer and an adhesive layer be formed on the sealing layer. Among these, the types "2" and "4" are preferable. This is because, although defects may be generated in the inorganic vapor-deposited layer on forming an adhesive layer on the inorganic vapor-deposited layer, the types "2" and "4" can eliminate the possibility mentioned above. Among "2" and "4", preferable is "2", which easily makes the adhesiveness between the paper substrate layer and the adhesive layer favorable. In the case of "2", the adhesive layer is preferably formed by "B1. Means of coating and drying an adhesive layer coating liquid" mentioned below.

1. An adhesive layer is formed on the inorganic vapor-deposited layer of an inorganic vapor-deposited layer donor.
2. An adhesive layer is formed on a paper substrate layer.
3. An adhesive layer is formed each on the inorganic vapor-deposited layer of an inorganic vapor-deposited layer donor and a paper substrate.
4. An adhesive layer is supplied between a paper substrate layer and an inorganic vapor-deposited layer donor.

**[0269]** In the "1", "2", and "3" described above, example of a specific means for forming an adhesive layer include "B1. Means of coating and drying an adhesive layer coating liquid", "B2. Means of preparing a laminate 1 having an adhesive layer on a separator, dry-laminating the laminate 1, and then releasing the separator".

**[0270]** An example of a specific means of the "4" described above is a means of preparing a laminate 1 having an adhesive layer on a separator and supplying the adhesive layer between the paper substrate layer and the inorganic vapor-deposited layer donor while the separator of the laminate 1 is released.

**[0271]** Prior to formation of the adhesive layer, an anchor coat layer may be formed.

**[0272]** An example of the means of bonding the inorganic vapor-deposited layer donor to the paper substrate layer with an adhesive layer interposed therebetween to obtain a barrier paper intermediate is a general-purpose lamination means.

**[0273]** Examples of a specific laminate structure of the barrier paper intermediate include laminate structures each obtained by adding a releasable support to the above (1) to (8) as exemplified as the laminate structures of the barrier paper of the present embodiment. The place where the releasable support is added is the outermost surface on the inorganic vapor-deposited layer side with reference to the adhesive layer.

<Step 2>

**[0274]** Step 2 is a step of releasing the support having mold-releasability from the barrier paper intermediate obtained in step 1 to obtain barrier paper described below:

(Barrier Paper)

**[0275]** Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

**[0276]** The barrier paper intermediate has a plurality of interfaces. Among the plurality of interfaces, the interface having the lowest adhesive force is usually released first. Thus, in the case of releasing only the releasable support, it is only required to cause the interface between the releasable support and the layer in contact with releasable support to have the lowest adhesive force. In the case of releasing the releasable support and the release layer, it is only required to cause the interface between the release layer and the layer in contact with the release layer to have the lowest adhesive force.

**[0277]** The embodiment of the barrier paper obtained in step 2 is the same as the embodiment of the barrier paper of the present embodiment as mentioned above. For example, in the barrier paper obtained in step 2, σRa1 is preferably 0.030 μm or less. In the barrier paper obtained in step 2, Ra1 is preferably 0.100 μm or less. In the barrier paper obtained in step 2, Rku1 is preferably more than 3.0. In the barrier paper obtained in step 2, the standard deviation of the thickness of the adhesive layer is preferably 0.80 μm or less. In the barrier paper obtained in step 2, the coefficient of variance of the thickness of the adhesive layer is preferably 0.17 or less.

**[0278]** In the case where the barrier paper has a printing layer on the side of the paper substrate layer opposite to the adhesive layer, the printing layer may be formed before step 1, may be formed between step 1 and step 2, or may be formed after step 2.

**[0279]** To the barrier paper obtained in step 2, a layer may be further added. For example, in the case where the barrier paper obtained in step 2 has no layer selected from a protective layer, a heat seal layer, and a sealant layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer, these layers may be formed. In the case where the barrier paper obtained in step 2 has no printing layer, a printing layer may be formed on the side of the paper substrate layer opposite to the adhesive layer after step 2.

**[0280]** In the method for producing the barrier paper of the present embodiment, an inorganic vapor-deposited layer is laminated on a paper substrate with an adhesive layer interposed therebetween without placing the paper substrate layer in a vapor deposition apparatus. Thus, the barrier paper obtained by the method for producing the barrier paper of the present embodiment has favorable adhesiveness between the paper substrate layer and the inorganic vapor-deposited layer to thereby enable the barrier properties to be favorable. In other words, according to the method for producing the barrier paper of the present embodiment, barrier paper having excellent barrier properties can be easily and stably produced.

## Examples

**[0281]** Next, the present invention will be described more in detail with reference to Examples, but the present invention is not limited in any way by the Examples.

### 1. Measurement and Evaluation

**[0282]** Barrier paper of Examples and Comparative Examples were subjected to the following evaluation and measurement. The results are shown in Table 1.

#### 1-1. Measurement of Surface Profile

**[0283]** The light was focused on the surface of the inorganic vapor-deposited layer of the barrier paper of each of Examples and Comparative Example on the side opposite to the paper substrate layer using a contactless and confocal-type surface profiler (trade name "VK-X150" from KEYENCE CORPORATION) to measure the surface profile of the surface (surface X). The barrier paper was placed on the glass plate of the measuring stage of the surface profiler, and measurement was conducted with both the edges of the barrier paper fixed with tape. The measurement region was sized to have 203.55 μn in length × 271.49 μm in width. Both the cut-off λs and cut-off λc on measuring the surface profile were set to "0".

**[0284]** Measurement on 72 points was conducted in accordance with the description in the Description text, and σRa1, Ra1, and Rku1 were calculated based on the measurements of the 72 points. The analysis software used was trade name "Multi-file Analysis Application VK-X series" from KEYENCE CORPORATION. The details of the measurement conditions are shown below.

**[0285]** The series of operations described above were conducted in an atmosphere of a temperature of 23°C±5°C and a relative humidity of 40% or more and 65% or less. The samples were subjected to the atmosphere for 30 minutes or more before the measurement was started.

<Measurement Condition Indication>

**[0286]**

- User mode: expert
- Objective lens: standard lens, 50.0 times of magnification
- Lens NA: 0.800
- Measurement size: standard
- Measurement mode: surface profile
- RPD: ON
- Measurement quality: high precision
- Measurement pitch: 0.13 μm
- Z measurement distance: a different value was set for each sample (because the irregularities and laminate structure of the inorganic vapor-deposited layer is different in each sample).
- Double scan: OFF
- Brightness 1: 6980 in Example 1, 6396 in Example 2, 6810 in Example 3, 6760 in Comparative Example 1, 6410 in Comparative Example 2, and 7018 in Comparative Example 3 (The reason for the difference in brightness is because of difference in the quantity of light of "Laser illumination filter" described below, difference in the laminate structure of the samples, and the like).
- Brightness 2: blank
- Laser illumination filter: the quantity of light is 100% in Examples 1 to 3 and Comparative Example 3, and the quantity of light is 30% in Comparative Examples 1 and 2 (The reason for the difference in the quantity of light is because the surface profiler automatically adjusts the quantity of light).
- Optical zoom: 1.0 time of magnification
- Average number of times: 1
- Filter: OFF
- Fine mode: ON
- Number of lines: blank
- Line position 1: blank
- Line position 2: blank
- Line position 3: blank
- Camera gain: 0 dB
- Shutter speed: auto
- White balance: manual
- White balance R: 135
- White balance B: 149
- Correction mode for received quantity of light : γ correction
- γ correction value: 0.45
- γ offset: 0%
- White/black inversion: OFF
- Head type: VK-X110
- Eccentricity correction for quantity of light: ON
- Field curvature correction: ON
- XY calibration: 265,391 nm/pixel
- Z calibration: 0.100 nm/digit
- Vividness: 6
- Contrast: 5
- Brightness: 53
- AI noise removal: ON
- Slope noise filter: ON

**[0287]** 1-2. Thickness (the thickness of the organic layer in contact with the inorganic vapor-deposited layer, the organic layer being located on the paper substrate layer side of the inorganic vapor-deposited layer)

**[0288]** Cut samples were prepared by cutting the barrier paper of each of Examples 1 to 3 and Comparative Examples 1 and 3 into a size of 50 mm × 50 mm. Then, each cut sample was embedded in an epoxy resin to prepare an embedded sample. Next, the embedded sample was cut in a direction perpendicular to the plane of the embedded sample with a diamond cutter. Subsequently, an osmium film was formed on the cross section of the sample by sputtering so as to enable the cross section to be imaged with a STEM. Next, a scanning electron microscope (STEM) was used to take a micrograph of the exposed cross section of the embedded sample. The STEM used was trade name "S-4800 TYPE I" manufactured by Hitachi High-Technologies Corporation.

**[0289]** The thickness of the adhesive layer of the barrier paper of each of Examples 1 to 3 and the thickness of the primer layer of the barrier paper of Comparative Example 1 were measured based on the cross-sectional micrographs

taken in accordance with the description of x1 to x4 in the Description text. The adhesive layer of the barrier paper of Example 1 and the primer layer of the barrier paper of Comparative Example 1 are organic layers in contact with the inorganic vapor-deposited layer, the layers being common in that the layers are located on the paper substrate layer side of the inorganic vapor-deposited layer. The thickness of the adhesive layer of the barrier paper of each of Examples 1 to 3 and the thickness of the primer layer of the barrier paper of each of Comparative Examples 1 and 3 were measured at 75 points in accordance with the description of x1 to x4 in the Description text. Then, the average values of the 75 points were taken as the thickness of the adhesive layer of the barrier paper of each of Examples 1 to 3 and the thickness of the primer layer of the barrier paper of each of Comparative Examples 1 and 3. The standard deviations of the thicknesses at the 75 points were taken as the standard deviation of the thickness of the adhesive layer of the barrier paper of each of Examples 1 to 3 and the standard deviation of the thickness of the primer layer of the barrier paper of each of Comparative Examples 1 and 3.

**[0290]** The series of operations described above were conducted in an atmosphere of a temperature of 23°C±5°C and a relative humidity of 40% or more and 65% or less. The samples were subjected to the atmosphere for 30 minutes or more before the measurement was started.

1-3. Adhesiveness

**[0291]** The barrier paper was subjected to a crosscut test in accordance with JIS K5600-5-6 to evaluate the interface adhesiveness between the inorganic vapor-deposited layer and the adhesive layer.

**[0292]** A crosscut tool was used to form 25 squares of 2 mm on a side (5 in the transverse direction × 5 in the longitudinal direction) with the single blade on the inorganic vapor-deposited layer side of the barrier paper. On forming the squares, the single blade was allowed to penetrate through the inorganic vapor-deposited layer. Next, cellophane tape (15 mm in width × 75 mm in length) was applied thereto so as to cover all the squares. Subsequently, a Tensilon was used to peel off the tape applied from the end at 3 mm/minute, the degree of peeling-off of the inorganic vapor-deposited layer was visually observed, and the results were classified in accordance with the following evaluation criteria.

**[0293]**

Class 0: The edges of the cuts are completely smooth, and none of the lattice squares is detached.

Class 1: A small detachment of the coated film at the intersections of the cuts. However, the area to be affected will not clearly exceed 5% in the cross-cut portion.

Class 2: The coated film has detached along the edges and/or at the intersections of the cuts. The area to be affected is clearly 5% or more and 15% or less in the cross-cut portion.

Class 3: The coated film has markedly detached along the edges of the cuts partly or wholly, and/or has detached partly or wholly on different parts of the lattice squares. The area to be affected is in the range of more than 15% and less than 35% in the cross-cut portion.

Class 4: The coated film has markedly detached along the edges of the cuts partly or wholly, and/or some lattice squares have detached partly or wholly. The area to be affected is in the range of clearly 35% or less in the cross-cut portion.

Class 5: Any degree of detachment that cannot even be classified by Class 4.

1-4. Oxygen Transmission Rate

**[0294]** A "Mocon oxygen transmission rate measurement apparatus, product number: OX-TRAN2/20" from Hitachi High-Tech Science Corporation was used to measure the oxygen transmission rate of the barrier paper at a temperature of 23°C and a relative humidity of 90%. "Fail" in the table indicates that the value was equal to or higher than the measurement limit (200 cc/$m^2$/day/atm).

1-5. Water Vapor Transmission Rate

**[0295]** A "Mocon oxygen transmission rate measurement apparatus, product number: PERMATRAN-W3/33" from Hitachi High-Tech Science Corporation was used to measure the water vapor transmission rate of the barrier paper at a temperature of 40°C and a relative humidity of 90%. "Fail" in the table indicates that the value was equal to or higher than the measurement limit (50 g/$m^2$/day).

2. Materials

**[0296]** The following materials were provided.

(1) Laminate 1

**[0297]** As a laminate 1 having a sealing layer on a paper substrate layer, provided was trade name "Ryuou coat (one-side coated, basis weight: 55 g/m$^2$, total thickness: about 49 μm, thickness of paper substrate layer: about 35μm, thickness of sealing layer (clay-coated layer): about 14 μm)" from Daio Paper Corporation.

(2) Laminate 2

**[0298]** As a laminate 2 having a sealing layer on a paper substrate layer, provided was trade name "Ryuou coat (one-side coated, basis weight: 80 g/m$^2$, total thickness: about 79 μm, thickness of paper substrate layer: about 65 μm, thickness of sealing layer (clay-coated layer): about 14 μm)" from Daio Paper Corporation.

(3) Paper substrate layer 1

**[0299]** As a paper substrate layer 1, provided was bleached paper comprised of a single layer of a paper substrate (basis weight: 50 g/m$^2$, trade name "Nagoya Sarashi Ryuou" from Daio Paper Corporation, thickness: about 58 μm).

(4) Adhesive 1

**[0300]** As an adhesive 1, provided was a solvent-type barrier adhesive "trade name: PASLIM (base agent: VM001/curing agent: 108CP) from DIC Corporation.

(5) Primer agent 1

**[0301]** As a primer agent 1, provided was "trade name: MC1548A" from Michelman, Inc.

3. Preparation of Inorganic Vapor-deposited Layer Transfer Member

**[0302]** A dilution fluid of a release agent (a mixture of a release agent (product number: k-45-3) from SHOWA INK MANUFACTURING CO., LTD. and ethyl acetate at a mass ratio of 1:1) was coated on the corona-treated side of a releasable support (a PET film from TOYOBO CO., LTD., thickness: 12 μm, corona-treated on one side) by a bar coat method such that the layer thickness after drying was 1.0 g/m$^2$ (about 1 μm), and the coated dilution fluid was dried in an oven at 80°C for 1 minute to form a release layer.

**[0303]** Then, an aluminum oxide vapor-deposited layer as an inorganic vapor-deposited layer was formed on the release layer by a vacuum vapor deposition method to obtain an inorganic vapor-deposited layer transfer member 1 having the releasable support (PET of 12 μm in thickness), the release layer (1.0 g/m$^2$), and the inorganic vapor-deposited layer (aluminum vapor-deposited layer of 40 nm in thickness) in this order.

4. Preparation of Barrier Paper

[Example 1]

**[0304]** The adhesive 1 was coated on the surface of the laminate 1 on the side having the sealing layer, and the coated adhesive 1 was dried to form an adhesive layer of 2.9 μm in thickness.

**[0305]** Then, the surface on which the adhesive 1 was coated was faced and bonded to the surface of the inorganic vapor-deposited layer transfer member 1 on the inorganic vapor-deposited layer side. Then, aging was conducted at 40°C for 3 days to obtain a barrier paper intermediate of Example 1 having the paper substrate layer, the sealing layer, the adhesive layer, the inorganic vapor-deposited layer, the release layer, and the releasable support (PET) in this order.

**[0306]** Subsequently, the releasable support was released from the barrier paper intermediate of Example 1 to obtain the barrier paper of Example 1 having the paper substrate layer, the sealing layer, the adhesive layer, the inorganic vapor-deposited layer, and the release layer in this order.

[Example 2]

**[0307]** The barrier paper intermediate and barrier paper of Example 2 were obtained in the same manner as in Example 1 except that the thickness of the adhesive layer was changed to 2.0 μm in Example 1.

[Example 3]

**[0308]** The barrier paper intermediate and barrier paper of Example 3 were obtained in the same manner as in Example 1 except that the laminate 1 was replaced by the laminate 2 in Example 1.

[Comparative Example 1]

**[0309]** The primer agent 1 was coated on one surface of the paper substrate layer 1, and the coated agent was dried to form a primer layer of 6.2 μm in thickness.

**[0310]** Next, an aluminum oxide vapor-deposited layer as an inorganic vapor-deposited layer was formed on the primer layer by a vacuum vapor deposition method to obtain the barrier paper of Comparative Example 1 having the paper substrate layer, the primer layer, and the inorganic vapor-deposited layer (aluminum vapor-deposited layer of 40 nm in thickness) in this order.

[Comparative Example 2]

**[0311]** An aluminum oxide vapor-deposited layer as an inorganic vapor-deposited layer was formed on the surface of the laminate 1 on the side having the sealing layer by a vacuum vapor deposition method to obtain the barrier paper of Comparative Example 2 having the paper substrate layer, the sealing layer, and the inorganic vapor-deposited layer (aluminum vapor-deposited layer of 40 nm in thickness) in this order.

[Comparative Example 3]

**[0312]** The primer agent 1 was coated on the surface of the laminate 1 on the side having sealing layer was coated, and the coated agent was dried to form a primer layer of 6.4 μm in thickness.

**[0313]** Next, an aluminum oxide vapor-deposited layer as an inorganic vapor-deposited layer was formed on the primer layer by a vacuum vapor deposition method to obtain the barrier paper of Comparative Example 3 having the paper substrate layer, the sealing layer, the primer layer, and the inorganic vapor-deposited layer (aluminum vapor-deposited layer of 40 nm in thickness) in this order.

5. Results

**[0314]**

Table 1

| | | Unit | Example | | | Comparative Example | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 1 | 2 | 3 |
| Surface profile | σRa1 | μm | 0.015 | 0.013 | 0.021 | 0.083 | 0.043 | 0.031 |
| | Ra1 | μm | 0.053 | 0.049 | 0.064 | 0.436 | 0.170 | 0.110 |
| | Rku | - | 16.7 | 8.3 | 14.7 | 2.5 | 3.5 | 2.8 |
| Thickness | Average thickness | μm | 2.9 | 2.0 | 2.9 | 6.2 | - | 6.4 |
| | Standard deviation | μm | 0.38 | 0.41 | 0.52 | 1.20 | - | 1.42 |
| Proportion of paper substrate layer with respect to total thickness of barrier paper | | % | 67.8 | 68.6 | 79.4 | 90.2 | 71.2 | 63.2 |
| Evaluation | Adhesiveness | - | 1 | 1 | 1 | 3 | 5 | 3 |
| | Oxygen vapor transmission rate | $cc/m^2/day/atm$ | 0.5 | 2.1 | 0.4 | Fail | Fail | Fail |
| | Water vapor transmission rate | $g/m^2/day$ | 7.4 | 9.1 | 5.3 | Fail | Fail | Fail |

**[0315]** The results of Table 1 can confirm that the barrier paper of Examples has favorable barrier properties.

Reference Signs List

**[0316]**

100: barrier paper

10: paper substrate layer

20: sealing layer

30: adhesive layer

40: inorganic vapor-deposited layer

50: release layer

60: heat seal layer

70: primer layer

## Claims

1. Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

2. The barrier paper according to claim 1, wherein, when the arithmetic average roughness of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, and the standard deviation of the Ra1 is defined as σRa1, σRa1 is 0.030 μm or less.

3. The barrier paper according to claim 1 or 2, wherein, when the arithmetic average roughness of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Ra1, the Ra1 is 0.100 μm or less.

4. The barrier paper according to any of claims 1 to 3, wherein, when the kurtosis of the roughness curve of the surface of the inorganic vapor-deposited layer on the side opposite to the paper substrate layer is defined as Rku1, Rku1 is more than 3.0.

5. The barrier paper according to any of claims 1 to 4, comprising a sealing layer between the paper substrate layer and the adhesive layer.

6. The barrier paper according to any of claims 1 to 5, comprising one or more layers selected from a release layer, a protective layer, a heat seal layer, and a sealant layer on the side of the inorganic vapor-deposited layer opposite to the adhesive layer.

7. The barrier paper according to any of claims 1 to 6, comprising a printing layer on the side of the paper substrate layer opposite to the adhesive layer.

8. The barrier paper according to any of claims 1 to 7, wherein the thickness of the adhesive layer is 1 μm or more and 20 μm or less.

9. The barrier paper according to any of claims 1 to 8, wherein the standard deviation of the thickness of the adhesive layer is 0.80 μm or less.

10. The barrier paper according to any of claims 1 to 9, wherein the coefficient of variance of the thickness of the adhesive layer is 0.17 or less.

**11.** The barrier paper according to any of claims 1 to 10, wherein the thickness proportion of the paper substrate layer in the barrier paper is 60% or more and less than 100%.

**12.** The barrier paper according to any of claims 1 to 11, wherein the interlayer adhesion strength between the adhesive layer and the inorganic vapor-deposited layer corresponds to any of the classes 0, 1, and 2 in a crosscut test according to JIS K5600-5-6.

**13.** A container comprising the barrier paper according to any of claims 1 to 12.

**14.** A lid comprising the barrier paper according to any of claims 1 to 12.

**15.** A method for producing barrier paper comprising steps 1 to 2 below:

Step 1: a step of bonding an inorganic vapor-deposited layer donor comprising an inorganic vapor-deposited layer on a support having mold-releasability to a paper substrate layer with an adhesive layer interposed therebetween to prepare a barrier paper intermediate, wherein in step 1, the inorganic vapor-deposited layer donor is disposed such that the surface on the side having the inorganic vapor-deposited layer faces toward the paper substrate layer side with reference to the support having mold-releasability; and
Step 2: a step of releasing the support having mold-releasability from the barrier paper intermediate obtained in step 1 to obtain barrier paper described below:
(Barrier Paper) Barrier paper comprising a paper substrate layer, an adhesive layer, and an inorganic vapor-deposited layer in this order, the adhesive layer being in contact with the inorganic vapor-deposited layer.

Fig. 1

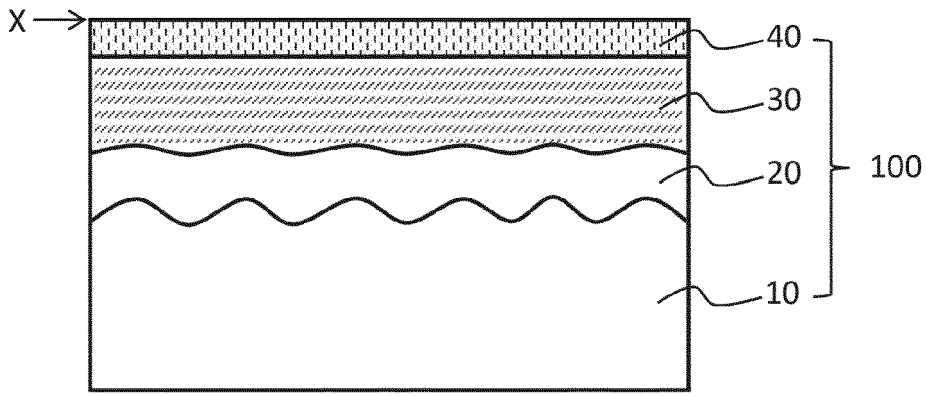



Fig. 2

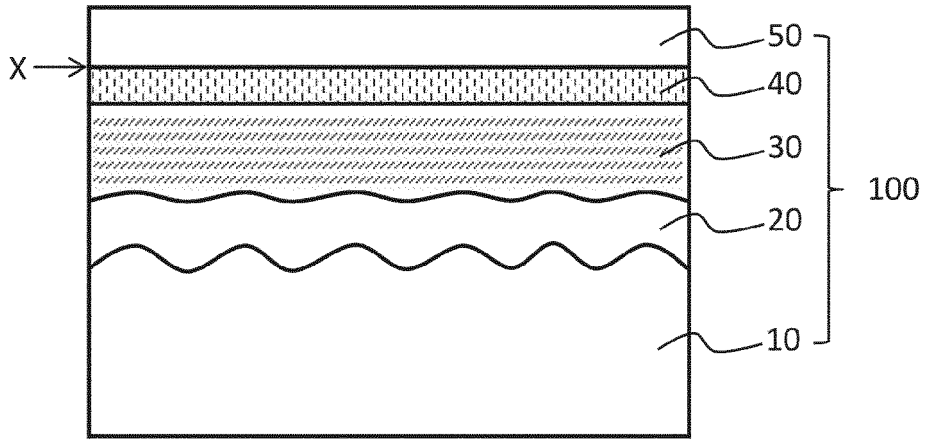



Fig. 3

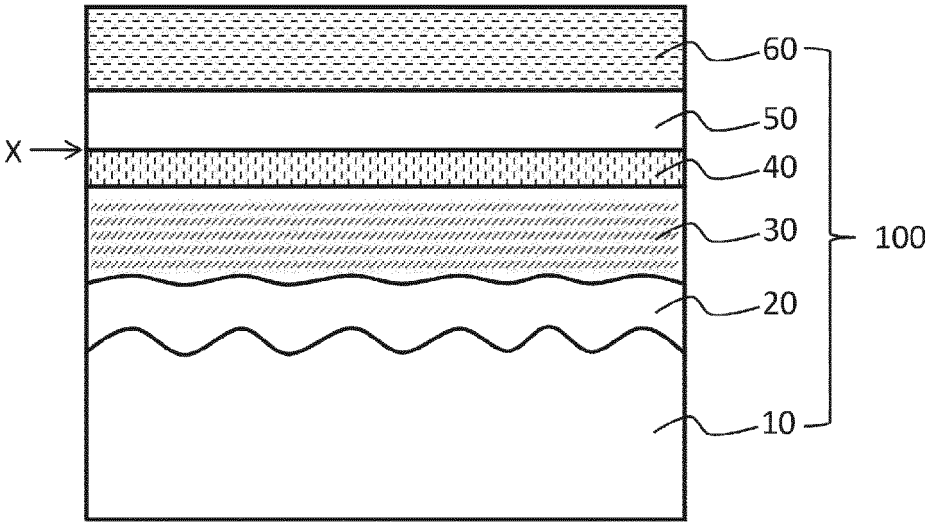


Fig. 4

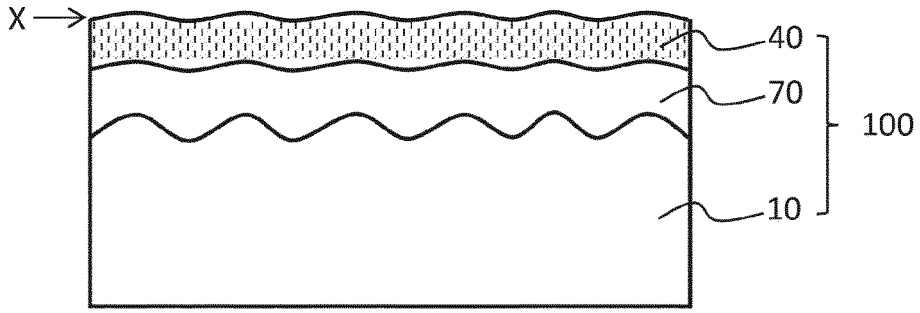
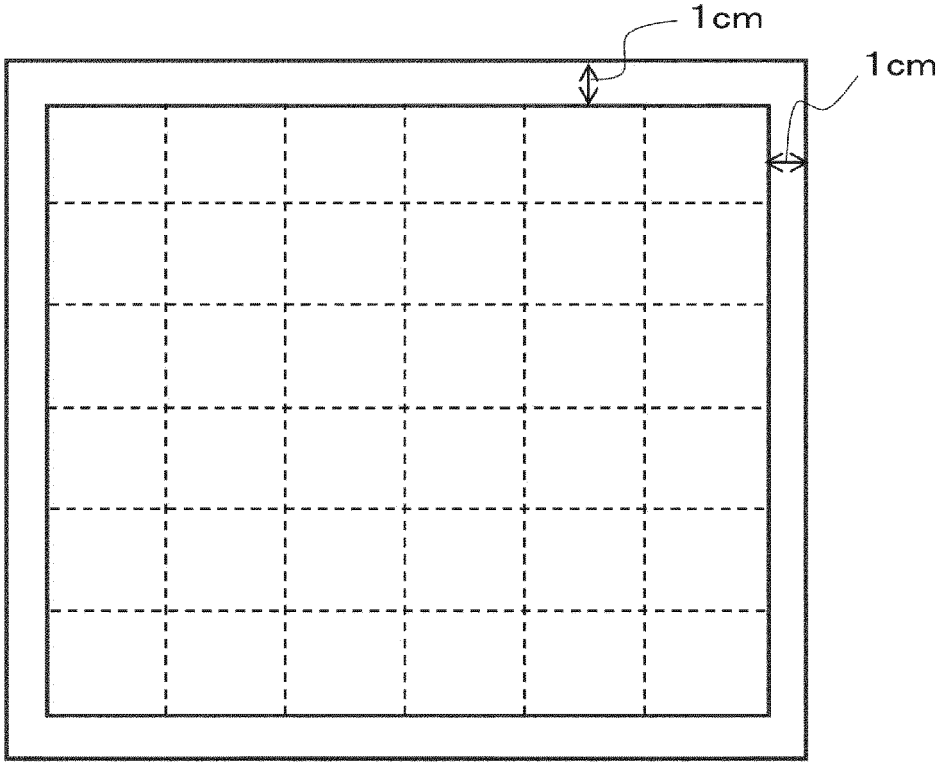



Fig. 5



# INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/043996

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B32B9/00(2006.01)i, B65D65/40(2006.01)i
FI: B32B9/00A, B65D65/40D

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B32B9/00, B65D65/40

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 | 1971-2020 |
| Registered utility model specifications of Japan | 1996-2020 |
| Published registered utility model applications of Japan | 1994-2020 |

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 | Relevant to claim No. |
|---|---|---|
| X<br>Y | JP 2004-351739 A (TOPPAN PRINTING CO., LTD.) 16 December 2004 (2004-12-16), claims (claim 1), fig. 1 | 1-4, 7-14<br>5 |
| X | JP 2010-264984 A (TOPPAN PRINTING CO., LTD.) 25 November 2010 (2010-11-25), claims (claim 1), example 1 | 1-14 |
| X<br>Y | JP 11-240535 A (NIHON TETRAPAK KK) 07 September 1999 (1999-09-07), claims (claims 1, 10, 13, etc.), example 1 | 1-4, 6-14<br>5 |
| X<br>Y | JP 2012-25439 A (TOPPAN PRINTING CO., LTD.) 09 February 2012 (2012-02-09), claims (claim 1), paragraph [0016], example 1 | 1-4, 6-14<br>5 |

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 25 December 2020 | 12 January 2021 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| Japan Patent Office<br>3-4-3, Kasumigaseki, Chiyoda-ku,<br>Tokyo 100-8915, Japan | Telephone No. |

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**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2020/043996

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 035906/1981 (Laid-open No. 149133/1982) (OIKE IND CO., LTD.) 18 September 1982 (1982-09-18), claims (claim 1) | 1-4, 6-14<br>5 |
| X<br>Y | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 082351/1980 (Laid-open No. 6534/1982) (NIPPON FOIL MFG. CO., LTD.) 13 January 1982 (1982-01-13), claims, page 2, second paragraph, fig. 1 | 1-4, 6-14<br>5 |
| X<br>Y | JP 59-85748 A (KANAE CO., LTD.) 17 May 1984 (1984-05-17), claims, fig. 2(a) | 1-4, 8-14<br>5 |
| X<br>Y | JP 2008-62990 A (TOPPAN PRINTING CO., LTD.) 21 March 2008 (2008-03-21), claims (claim 1), drawings (fig. 1, etc.) | 1-4, 6-13<br>5 |
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| X<br>Y | JP 55-71725 A (DAI NIPPON PRINTING CO., LTD.) 30 May 1980 (1980-05-30), claims, examples | 1-4, 6, 8-12, 15<br>5 |
| Y | JP 10-95462 A (TOPPAN PRINTING CO., LTD.) 14 April 1998 (1998-04-14), paragraph [0012] | 5 |
| A | JP 2019-147606 A (TOPPAN PRINTING CO., LTD.) 05 September 2019 (2019-09-05), entire text | 1-15 |
| A | JP 2003-291296 A (ISHIDA CO., LTD.) 14 October 2003 (2003-10-14), entire text | 1-15 |
| A | JP 2012-86858 A (TOPPAN PRINTING CO., LTD.) 10 May 2012 (2012-05-10), entire text | 1-15 |

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/043996

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| JP 2004-351739 A | 16 December 2004 | (Family: none) | |
| JP 2010-264984 A | 25 November 2010 | (Family: none) | |
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| JP 2012-25439 A | 09 February 2012 | (Family: none) | |
| JP 57-149133 U1 | 18 September 1982 | (Family: none) | |
| JP 57-6534 U1 | 13 January 1982 | (Family: none) | |
| JP 59-85748 A | 17 May 1984 | (Family: none) | |
| JP 2008-62990 A | 21 March 2008 | (Family: none) | |
| JP 2006-58408 A | 02 March 2006 | (Family: none) | |
| JP 55-71725 A | 30 May 1980 | (Family: none) | |
| JP 10-95462 A | 14 April 1998 | (Family: none) | |
| JP 2019-147606 A | 05 September 2019 | (Family: none) | |
| JP 2003-291296 A | 14 October 2003 | (Family: none) | |
| JP 2012-86858 A | 10 May 2012 | (Family: none) | |

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## REFERENCES CITED IN THE DESCRIPTION

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- JP 4622201 B **[0008]**