(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 929 354 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
29.12.2021 Bulletin 2021/52

(21) Application number: **20759667.7**

(22) Date of filing: **12.02.2020**

(51) Int Cl.:
D21H 13/26 *(2006.01)* ***D04H 1/4342*** *(2012.01)*

(86) International application number:
PCT/JP2020/005278

(87) International publication number:
WO 2020/170902 (27.08.2020 Gazette 2020/35)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **22.02.2019 JP 2019030228**

(71) Applicant: **Dupont Teijin Advanced Papers (Japan), Ltd.**
Tokyo 100-6111 (JP)

(72) Inventors:
- **FUJIMORI Tatsushi**
  Tokyo 100-6111 (JP)
- **NARUSE Shinji**
  Tokyo 100-6111 (JP)

(74) Representative: **Dehns**
St. Bride's House
10 Salisbury Square
London EC4Y 8JD (GB)

(54) METHOD FOR PRODUCING ARAMID PAPER

(57) A method for producing aramid paper that involves performing a hot-pressing step of mixing short aramid fibers and aramid fibrids in a mass ratio of 60/40 to 10/90 and forming a sheet, sandwiching the sheet obtained between a pair of heating elements, and applying a pressure of at least 500 kg/cm^2 at least two times, wherein the hot-pressing step that is performed at least two times comprises a hot-pressing step (a) at a temperature exceeding the glass transition temperature of aramid and a hot-pressing step (b) performed thereafter at a temperature less than the glass transition temperature of aramid.

EP 3 929 354 A1

Description

Technical Field

[0001] The present invention relates to a method for producing an electrically insulating material having excellent heat resistance, particularly a method for producing aramid paper which makes it possible to produce thin aramid paper having high strength and insulating property.

Background Art

[0002] The application of molding materials made of heat-resistant polymers has been considered for the field of electrical insulation where heat resistance is required, and paper with improved strength and/or thermal stability, produced using these heat-resistant polymers, has been developed. For example, aramid paper, which is a synthetic paper made of aromatic polyamide, has been used as a base for electrically insulating materials and aircraft honeycombs due to its excellent heat resistance, flame retardance, electrical insulating property, toughness, and flexibility. Among these materials, paper containing Nomex (registered trademark) fibers manufactured by DuPont (USA) is produced by mixing poly(meta-phenylene isophthalamide) short fibers and fibrids in water, then papermaking the mixed slurry, followed by calendering process. This paper is known to still have high strength and toughness as well as excellent electrical insulating property, even at high temperatures.

[0003] In recent years, since equipment requiring insulating materials, such as transformers and motors, has become smaller and lighter, there has been a need for materials that are even thinner and have higher electrical insulating performance.

[0004] A common method to make paper thinner is to reduce the basis weight of the resulting aramid paper, but this also reduces the density of the resulting aramid paper, leading to a problem that sufficient strength and insulating property cannot be obtained. In view of this, as a method for obtaining thin aramid paper, Patent Literature 1, for example, discloses a method for producing aramid paper that includes sandwiching aramid paper made of a mixture of fibrids formed from aromatic polyamides and short fibers between at least a pair of heating elements, followed by hot pressing, wherein the shrinkage rate of the aramid paper after hot pressing by the heating elements is 3% or less. In this method, a pair of calender rolls is used as the pair of heating elements, and the hot pressing is performed once at a calender roll surface temperature of 250°C and a roll pressure of 2500 kg/cm^2 or 1250 kg/cm^2. This method has been shown to produce a thin electrical insulating sheet material with high heat resistance (Examples). On the other hand, it has been shown that aramid paper of the desired thinness cannot be obtained when the hot pressing is performed at 330°C, which is a temperature above the glass transition temperature of aramid paper (Comparative Examples 2 and 3).

Citation List

Patent Literatures

[0005] Patent Literature 1: Japanese Patent Application Publication No. 2016-223021

Summary of Invention

[0006] An object of the present invention is to provide a method for producing aramid paper which, in addition to being thin, dense, and excellent in electrical properties, can further produce aramid paper having high mechanical properties, in particular, high tensile strength.

[0007] In view of the above circumstances, the present inventors have made earnest studies and arrived as a result at the present invention based on the knowledge that the above object can be achieved by performing, at least twice, a hot-pressing treatment step under specific temperature conditions in which a sheet-shaped material formed from a mixture with specific ratios of aramid short fibers and aramid fibrids is sandwiched between a pair of heating elements and subjected to a high pressure.

[0008] Specifically, the present invention provides the following [1] to [10].

[1] A method for producing aramid paper, including: performing, at least twice, a hot-pressing treatment step in which aramid short fibers and aramid fibrids are mixed in a mass ratio of 60/40 to 10/90 to form a sheet-shaped material, and the resulting sheet-shaped material is sandwiched between a pair of heating elements and subjected to a pressure of 500 kg/cm^2 or more, wherein the hot-pressing treatment step performed at least twice includes a hot-pressing treatment step (a) at a temperature above a glass transition temperature of aramid and a subsequent hot-pressing treatment step (b) at a temperature below the glass transition temperature of aramid.

[2] The production method according to [1], wherein the hot-pressing treatment step (a) is performed at a temperature higher than the glass transition temperature of aramid by 15°C or higher and lower than a decomposition temperature of aramid.

[3] The production method according to [1] or [2], wherein the hot-pressing treatment step (b) is performed at a temperature lower than the glass transition temperature of aramid by 10°C to 180°C.

[4] The production method according to any one of [1] to [3], further including a pressure releasing step between the hot-pressing treatment steps (a) and (b), in which pressure on the hot-pressed sheet is released.

[5] The production method according to any one of [1] to [4], wherein the pair of heating elements is a pair of calender rolls.

[6] The production method according to any one of [1] to [5], wherein aramid constituting the aramid short fibers and the aramid fibrids is polymetaphenylene isophthalamide.

[7] Aramid paper which is made into a sheet by mixing aramid short fibers and aramid fibrids in a mass ratio of 60/40 to 10/90, with a thickness of 5 to 35 μm, a density of 0.70 to 1.0 g/cm^3, and a tensile strength of 45 MPa or more.

[8] The aramid paper according to [7], which has a density of 0.75 to 0.95 g/cm^3.

[9] The aramid paper according to [7] or [8], which has a basis weight of 5 to 25 g/m^2.

[10] The aramid paper according to any one of [7] to [9], which is obtained by the production method according to any one of [1] to [6].

[0009] According to the production method of the present invention, by appropriately adjusting the amount of aramid short fibers and aramid fibrids used as raw materials for the production of aramid paper, as well as the pressing pressure in the hot-pressing treatment step, it is possible to easily produce aramid paper with a wide range of thicknesses, for example, up to 200 μm, and with excellent mechanical properties, electrical properties, and heat resistance. In particular, according to the production method of the present invention, it is possible to produce aramid paper having the same or smaller thickness than the aramid paper disclosed in Patent Literature 1 having even higher mechanical properties, particularly high tensile strength.

[0010] Thus, according to the production method of the present invention, it is possible to obtain an excellent industrial effect that aramid paper with high heat resistance and thinness, as well as excellent mechanical and electrical properties can be easily produced to meet the needs for smaller and lighter transformers, motors, and the like.

[0011] Hereinafter, the present invention is described in detail.

Description of Embodiments

[Aramid]

[0012] In the present invention, aramid means a linear polymer compound in which 60% or more of its amide bonds are directly bonded to an aromatic ring. Such an aramid includes, for example, polymetaphenylene isophthalamide and copolymers thereof, polyparaphenylene terephthalamide and copolymers thereof, copolyparaphenylene 3,4'-diphenyl ether terephthalamide, and the like. These aramids are industrially produced, for example, by a solution polymerization method involving a condensation reaction between an aromatic acid dichloride and an aromatic diamine, a two-step interfacial polymerization method, or the like, and are available as commercial products, but are not limited thereto. Among these aramids, polymetaphenylene isophthalamide is preferably used because it has properties such as good molding processability, heat adhesion, flame retardance, and heat resistance.

[Aramid short Fiber]

[0013] In the present invention, the aramid short fiber is a fiber made from aramid cut into a predetermined length, and such a fiber includes, but is not limited to, those available under the trade names "Teijinconex (registered trademark)" from Teijin Limited, "Nomex (registered trademark)" from DuPont, and the like, for example.

[0014] The length of the aramid short fibers can generally be selected from the range of 1 mm or more and less than 25 mm, and preferably 2 mm or more and less than 12 mm. When the length of the short fibers is 1 mm or more, the mechanical properties of the sheet material are good, and meanwhile, those having a length of 25 mm or less are preferable because they can suppress the occurrence of "entanglement" and "binding" in the production of aramid paper by the wet method described later.

[0015] The fiber diameter of the aramid short fibers can be selected from the range of, for example, 0.1 to 40 μm, preferably 0.5 to 25 μm, and more preferably 1 to 20 μm.

[Aramid Fibrid]

[0016] In the present invention, the aramid fibrid is a film-shaped fine particle composed of aramid, and is sometimes referred to as aramid pulp. The method for producing aramid fibrid include, for example, the methods described in Japanese Examined Patent Application Publication No. Sho 35-11851, Japanese Examined Patent Application Publication No. Sho 37-5732, and the like. The aramid fibrid has papermaking properties like ordinary wood (cellulose) pulp, and can be formed into a sheet by a papermaking machine after being dispersed in water. In this case, a so-called beating process can be performed for the purpose of maintaining the quality suitable for papermaking. This beating process can be performed by a disc refiner, beater, or other papermaking raw material processing device that exerts a mechanical cutting action. In this operation, the morphological change of the fibrid can be monitored at the freeness specified in JIS P8121. In the present invention, the freeness of the aramid fibrid after the beating process is preferably in the range of 10 to 300 cm^3 (Canadian standard freeness). With a fibrid having a freeness in this range, it is possible to suppress a decrease in the strength of the sheet-shaped material formed therefrom. On the other hand, when the freeness is larger than 10 cm^3, the progress of fibrid refinement can be suppressed, so that the so-called deterioration of the binder function can be suppressed.

[Method for Producing Aramid Paper]

[0017] Aramid paper in the present invention is produced by a method for producing aramid paper, including: performing, at least twice, a hot-pressing treatment step in which aramid short fibers and aramid fibrids are mixed in a mass ratio of 60/40 to 10/90 to form a sheet-shaped material, and the resulting sheet-shaped material is sandwiched between a pair of heating elements and subjected to a pressure of 500 kg/cm^2 or more, wherein the hot-pressing treatment step performed at least twice includes a hot-pressing treatment step (a) at a temperature above a glass transition temperature of aramid and a subsequent hot-pressing treatment step (b) at a temperature below the glass transition temperature of aramid.

[0018] In this production method, the aramid short fibers and aramid fibrids are first mixed in a mass ratio of 60/40 to 10/90, preferably in a mass ratio of 55/45 to 15/85, and more preferably in a mass ratio of 50/50 to 20/80 to form a sheet-shaped material. Specifically, for example, it is possible to apply a method in which the above aramid short fibers and aramid fibrids are dry blended and then airflow is used to form a sheet, a method in which aramid short fibers and aramid fibrids are dispersed and mixed in a liquid medium and then discharged onto a liquid-permeable support, such as a net or belt, to form a sheet, which is then dried by removing the liquid, and the like, but among these, the so-called wet paper making method using water as the medium is preferably selected.

[0019] In the wet paper making method, it is a general method that a single or mixed aqueous slurry containing at least aramid fibrids and aramid short fibers is pumped into a papermaking machine, dispersed, and then dehydrated, pressed, and dried before being rolled into sheets. As the papermaking machine, a long net papermaking machine, a circular net papermaking machine, an inclined papermaking machine, and a combination papermaking machine combining these, and the like are used. In the case of production with a combination papermaking machine, a composite sheet composed of multiple paper layers can be obtained by forming sheets of slurries having different mixing ratios and putting them together. Additives such as dispersibility improvers, defoamers, and paper strength enhancers are used during papermaking as needed.

[0020] Further, in addition to the above-mentioned aramid short fibers, other fibrous components (for example, organic fibers such as polyphenylene sulfide fibers, polyether ether ketone fibers, cellulosic fibers, PVA fibers, polyester fibers, polyarylate fibers, liquid crystal polyester fibers, and polyimide fibers, and inorganic fibers such as glass fibers, rock wool, asbestos, and boron fibers) can be added as long as the object of the present invention is not impaired. In this case, the proportion of the aramid short fibers in the total constituent fibers is 80% by mass or more, and more preferably 90% by mass or more.

[Hot Pressing]

[0021] A hot-pressing treatment step is performed at least twice in which the sheet-shaped material obtained as described above is sandwiched between a pair of heating elements and subjected to a pressure of 500 kg/cm^2 or more. Here, the hot-pressing treatment step performed at least twice includes a hot-pressing treatment step (a) at a temperature above a glass transition temperature of aramid and a subsequent hot-pressing treatment step (b) at a temperature below the glass transition temperature of aramid. By performing such a specific hot pressing, the thickness of the resulting aramid paper can be reduced, and the density and mechanical strength can be improved.

[0022] In the present invention, it is preferable to use a pair of calender rolls as the pair of heating elements.

[0023] The pressure is preferably 500 to 10000 kg/cm^2, and more preferably 1000 to 5000 kg/cm^2.

[0024] Here, the hot-pressing treatment step (a) is preferably performed at a temperature higher than the glass transition

temperature of aramid by 15°C or higher, preferably 20°C or higher, and below the decomposition temperature of aramid, preferably up to 380°C, while applying a pressure of 500 kg/cm^2 or more.

[0025] Generally, the glass transition temperature of aramid is considered to be around 280°C, and the decomposition temperature is considered to be around 400°C.

[0026] In addition, the hot-pressing treatment step (b) is preferably performed at a temperature lower than the glass transition temperature of aramid by 10°C, preferably by 20°C to 180°C, and preferably by 100°C, while applying a pressure of 500 kg/cm^2 or more. Note that it is more preferable that the heating temperature difference between the hot-pressing treatment steps (a) and (b) is 50°C or more.

[0027] In the present invention, the heating temperature in the hot-pressing treatment step can be expressed as the surface temperature of the heating elements, and when calender rolls are used as the heating elements, it can be expressed as the surface temperature of the calender rolls.

[0028] In the present invention, the mechanical strength can be further improved by performing hot pressing at a temperature above the glass transition temperature, and due to the high temperature of the heating elements, the sheet, once compressed in the thickness direction by the heating elements, also swells in the thickness direction immediately after being released from the heating elements, and the effect is particularly large for thinner sheets, which is a factor that makes it impossible to increase the strength of thin aramid paper and at the same time increase its density. In view of the above, by performing hot pressing more than once with the above temperature difference, it has become possible to obtain aramid paper that is thin and has both mechanical properties and electrical properties.

[0029] In the method for producing aramid paper of the present invention, it is preferable that there is a pressure releasing step between the hot-pressing treatment steps (a) and (b), in which pressure on the hot-pressed sheet is released. In this pressure releasing step, the temperature of the hot-pressed aramid paper is preferably cooled below the glass transition temperature by being released from the pressure by a pair of heating elements, preferably a pair of calender rolls, and coming into contact with outside air, preferably air. Such a pressure releasing step can be provided by installing a pair of calender rolls and a subsequent pair of calender rolls at a distance from each other.

[0030] In the method for producing aramid paper of the present invention, in addition to the above-mentioned hot-pressing treatment steps (a) and (b), a pressure treatment step at room temperature or the like may be combined. In addition, the hot-pressing treatment step (b) may include multiple hot-pressing treatment steps having different pressures and temperatures. Further, before the hot-pressing treatment step (b) is performed, multiple hot-pressing treatment steps (a) may be performed.

[Aramid Paper]

[0031] In the production method of the present invention, by appropriately adjusting the amount of aramid short fibers and aramid fibrids used as raw materials for the production of aramid paper, as well as the pressurization pressure in the hot-pressing treatment step, it is possible to easily produce aramid paper with a wide range of thicknesses, for example, up to 200 μm (preferably 5 μm or more and 100 μm or less, with a density of 0.70 to 1.0 g/cm^3), and with excellent mechanical properties, electrical properties, and heat resistance. In particular, according to the production method of the present invention, it is possible to produce aramid paper having the same or smaller thickness than the aramid paper disclosed in Patent Literature 1 having even higher mechanical properties, particularly high tensile strength.

[0032] In the present invention, in particular, it is possible to produce aramid paper which is made into a sheet by mixing aramid short fibers and aramid fibrids in a mass ratio of 60/40 to 10/90, with a thickness of 5 to 35 μm, a density of 0.70 to 1.0 g/cm^3, preferably 0.75 to 0.95 g/cm^3, and a tensile strength of 45 MPa or more. Here, the thickness is preferably 10 to 30 μm, and more preferably 15 to 30 μm.

[0033] Further, it is possible to produce aramid paper having the above properties and having a basis weight of 5 to 25 g/m^2, and preferably 10 to 25 g/m^2.

[0034] In the present invention, the tensile strength represents the tensile strength per unit cross-sectional area, and the average value in the vertical direction and the horizontal direction is taken as the tensile strength. The tensile strength of the aramid paper of the present invention is preferably 45 MPa or more, more preferably 47 MPa or more, and further preferably 50 MPa or more. The upper limit of the tensile strength is preferably 120 MPa.

[0035] In the present invention, the glass transition temperature is a value obtained by raising the temperature of a test specimen from room temperature at a rate of 3°C/min and measuring the calorific value using a differential scanning calorimeter, drawing two extension lines on the endothermic curve, and then intersecting the endothermic curve with the 1/2 straight line between the extension lines, and the glass transition temperature of the aramid paper used in the Examples was 275°C.

[0036] According to the production method of the present invention, it is possible to obtain an excellent industrial effect that aramid paper with high heat resistance and thinness, as well as excellent mechanical and electrical properties can be easily produced to meet the needs for smaller and lighter transformers, motors, and the like.

Examples

[0037] Hereinafter, the present invention is described in more detail with reference to Examples. Note that these Examples are merely examples, and are not intended to limit the contents of the present invention.

[Measuring Method]

(1) Sheet Basis Weight, Thickness, and Density

[0038] It was carried out in accordance with JIS C 2300-2, and the density was calculated by (basis weight/thickness).

(2) Tensile Strength

[0039] It was carried out in the vertical direction and the horizontal direction in accordance with ASTM D-828, and after calculating the average value of both, it was calculated as the tensile strength per unit cross-sectional area by (tensile strength per unit width/thickness).

(3) Breakdown Voltage

[0040] It was carried out in accordance with ASTM D149 by the direct voltage increase method using alternating current with an electrode diameter of 51 mm.

[Preparation of Raw Materials]

[0041] Fibrids of polymetaphenylene isophthalamide were produced by a method using a pulp particle production apparatus (wet precipitator) composed of a combination of a stator and a rotor described in Japanese Examined Patent Application Publication No. Sho 52-15621. This was treated with a beating machine to adjust to a length-weighted average fiber length of 0.9 mm (freeness of aramid fibrids: 100 cm^3 (Canadian standard freeness)). On the other hand, meta-aramid fibers manufactured by DuPont (Nomex (registered trademark), single yarn fineness 2 denier, fiber diameter 15 μm) were cut into a length of 6 mm (hereinafter referred to as "aramid short fibers") and used as a raw material for papermaking.

[Examples 1 to 4]

[0042] Aramid fibrids and aramid short fibers prepared as described above were dispersed in water to prepare slurries. These slurries were mixed so that the aramid fibrids and aramid short fibers had the blending ratios (mass ratios) shown in Table 1, and sheet-shaped materials were prepared with a TAPPI-type manual paper machine (cross-sectional area 625 cm^2). Subsequently, the resulting sheets were adjusted by a pair of metal calender rolls so that the peripheral length of the contact between the rolls and the aramid paper was 1 mm, and then hot pressed twice under the conditions shown in Table 1 to obtain aramid paper. Table 1 shows the main characteristic values of the aramid paper thus obtained.

Table 1

Characteristic	Unit	Example 1	Example 2	Example 3	Example 4
Raw Material Composition	% by Mass				
Aramid Fibrid		80	80	50	50
Aramid short Fiber		20	20	50	50
Hot Pressing (1st Time)					
Pressure	kg/cm^2	2500	2500	2500	2500
Roll Surface Temperature	°C	330	330	330	330
Hot Pressing (2nd Time)					
Pressure	kg/cm^2	2500	2500	2500	2500
Roll Surface Temperature	°C	200	250	200	250
Basis Weight	g/m^2	20	20	20	20
Thickness	μm	23	24	25	26

(continued)

Characteristic	Unit	Example 1	Example 2	Example 3	Example 4
Density	g/cm^3	0.86	0.83	0.78	0.76
Tensile Strength	MPa	53	52	55	54
Breakdown Voltage	kV/mm	31	30	30	29

[0043] From the results in Table 1, regarding the aramid paper of the present invention (Examples 1 to 4), it can be seen that by performing a specific hot pressing multiple times, it is possible to obtain aramid paper which is thin and has both mechanical properties and electrical properties. Further, the aramid paper produced in this way is useful as an insulating material for transformers, motors, and the like due to the high heat resistance of the aramid material.

[Comparative Examples 1 to 4]

[0044] Aramid fibrids and aramid short fibers prepared as described above were dispersed in water to prepare slurries. These slurries were mixed so that the aramid fibrids and aramid short fibers had the blending ratios (mass ratios) shown in Table 2, and sheet-shaped materials were prepared with a TAPPI-type manual paper machine (cross-sectional area 625 cm^2). Subsequently, the resulting sheets were adjusted by a pair of metal calender rolls so that the peripheral length of the contact between the rolls and the aramid paper was 1 mm, and then hot pressed under the conditions shown in Table 2 to obtain aramid paper. Table 2 shows the main characteristic values of the aramid paper thus obtained.

Table 2

Characteristic	Unit	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Raw Material Composition	% by Mass				
Aramid Fibrid		80	80	50	20
Aramid Short Fiber		20	20	50	80
Hot Pressing Pressure	kg/cm^2	2500	2500	2500	2500
Roll Surface Temperature	°C	250	330	330	330
Basis Weight	g/m^2	20	20	20	20
Thickness	μm	27	52	39	49
Density	g/cm^3	0.74	0.38	0.51	0.41
Tensile Strength	MPa	33	30	44	31
Breakdown Voltage	kV/mm	25	16	18	14

[0045] As is clear from Table 2 above, regarding the aramid paper of Comparative Examples 1 to 4, although a certain thinness was obtained, high-density paper was not obtained. Further, the aramid paper of Comparative Examples 1, 2, and 4 also has low tensile strength per unit cross-sectional area. Therefore, in order to obtain aramid paper that is thin and has both mechanical properties and electrical properties, which is useful as a thin insulating material for downsizing and weight reduction of equipment such as transformers and motors, it has been found to be effective to use the aramid paper exemplified in the above Examples.

Claims

1. A method for producing aramid paper, comprising: performing, at least twice, a hot-pressing treatment step in which aramid short fibers and aramid fibrids are mixed in a mass ratio of 60/40 to 10/90 to form a sheet-shaped material, and the resulting sheet-shaped material is sandwiched between a pair of heating elements and subjected to a pressure of 500 kg/cm^2 or more, wherein the hot-pressing treatment step performed at least twice includes a hot-

pressing treatment step (a) at a temperature above a glass transition temperature of aramid and a subsequent hot-pressing treatment step (b) at a temperature below the glass transition temperature of aramid.

2. The method according to claim 1, wherein the hot-pressing treatment step (a) is performed at a temperature higher than the glass transition temperature of aramid by 15°C or higher and lower than a decomposition temperature of aramid.

3. The method according to claim 1 or 2, wherein the hot-pressing treatment step (b) is performed at a temperature lower than the glass transition temperature of aramid by 10°C to 180°C.

4. The production method according to any one of claims 1 to 3, further comprising a pressure releasing step between the hot-pressing treatment steps (a) and (b), in which pressure on the hot-pressed sheet is released.

5. The production method according to any one of claims 1 to 4, wherein the pair of heating elements is a pair of calender rolls.

6. The production method according to any one of claims 1 to 5, wherein aramid constituting the aramid short fibers and the aramid fibrids is polymetaphenylene isophthalamide.

7. Aramid paper which is made into a sheet by mixing aramid short fibers and aramid fibrids in a mass ratio of 60/40 to 10/90, with a thickness of 5 to 35 μm, a density of 0.70 to 1.0 g/cm^3, and a tensile strength of 45 MPa or more.

8. The aramid paper according to claim 7, which has a density of 0.75 to 0.95 g/cm^3.

9. The aramid paper according to claim 7 or 8, which has a basis weight of 5 to 25 g/m^2.

10. The aramid paper according to any one of claims 7 to 9, which is obtained by the production method according to any one of claims 1 to 6.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/005278

A. CLASSIFICATION OF SUBJECT MATTER
D21H13/26(2006.01)i; D04H1/4342(2012.01)i
FI: D21H13/26; D04H1/4342
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)
D21B1/00-D21J7/00; D04H1/00-18/04

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	WO 2005/100688 A1 (DUPONT TEIJIN ADVANCED PAPERS, LTD.) 27.10.2005 (2005-10-27) claim 1, page 5, line 10 to page 6, line 25, page 7, line 27 to page 8, line 11, page 9, lines 18-24, examples	7-10
A	JP 2017-534486 A (E.I. DU PONT DE NEMOURS AND COMPANY) 24.11.2017 (2017-11-24) entire text	1-10
A	JP 2006-200066 A (TEIJIN TECHNO PRODUCTS LTD.) 03.08.2006 (2006-08-03) entire text	1-10
A	WO 2016/190163 A1 (DUPONT TEIJIN ADVANCED PAPERS, LTD.) 01.12.2016 (2016-12-01) entire text	1-10
P, A	JP 2019-183317 A (HIROSE PAPER MFG CO., LTD.) 24.10.2019 (2019-10-24) entire text	1-10

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

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 April 2020 (20.04.2020)	28 April 2020 (28.04.2020)

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application no.
PCT/JP2020/005278

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO 2005/100688 A1	27 Oct. 2005	US 2007/0167101 A1 claim 1, paragraphs [0033]-[0038], [0043]-[0045], [0049], examples CN 1938479 A	
JP 2017-534486 A	24 Nov. 2017	US 2016/0097162 A1 whole document WO 2016/053970 A1 EP 3201393 A1	
JP 2006-200066 A	03 Aug. 2006	(Family: none)	
WO 2016/190163 A1	01 Dec. 2016	CN 107636226 A entire text KR 10-2018-0012743 A TW 201704591 A	
JP 2019-183317 A	24 Oct. 2019	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2016223021 A **[0005]**
- JP 3511851 B **[0016]**
- JP 375732 B **[0016]**
- JP 52015621 B **[0041]**