

SPECIFICATION

TITLE

Heat resistant Composite Sheet and Manufacturing Method therefor

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TECHNICAL FIELD

The disclosure relates to a heat-resistant composite sheet, and more particularly to a heat-resistant composite sheet which is a glass fiber fabric impregnated with a fluorine-containing resin. The disclosure also relates to a method of manufacturing the heat-resistant composite sheet.

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RELATED ART

A composite sheet of a glass fiber fabric impregnated with a fluorine-containing resin has excellent heat resistance, insulation, corrosion resistance, tack-free properties, and the like, and is used in many fields such as a conveyor belt, a heat-resistant sheet, an anti-corrosion tack-free sheet, and the like. However, no matter the composite sheet is used in what kind of field, the surface of the composite sheet is constantly abraded as the use time increases. It can be seen that how to realize a longer service life of the composite sheet is a problem to be solved.

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When an adhesive tape is used in the field of heat sealing, after being attached to a hot plate, the adhesive tape is abraded due to contact between the adhesive tape and the heat sealed article. Since the surface of the existing heat-resistant adhesive tape is uneven, the abrasion is uneven during use, and some of the glass fibers are easily exposed, so the service life is lowered.

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Besides, in order to increase the service life of the existing products, the substrate fluororesin layer is thickened, and in general, the processing cost is greatly increased, and the effect is not the best. For example, for an adhesive tape formed by increasing the thickness in a large amount, when it is attached to a hot plate having an angle, the counter force is large after the bending, so that it is not easy to stick and is easily detached from the adherend, resulting in a decrease in the service life of the adhesive tape.

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SUMMARY

Problem to be solved by the disclosure

The object of the disclosure is to provide a heat-resistant composite sheet which has good flatness and strong abrasion resistance and can be widely applied to heat-resistant, insulating, anti-corrosive, tack-free uses and the like, and has a long service life, and to provide a method

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for manufacturing the heat-resistant composite sheet, an adhesive tape comprising the heat-resistant composite sheet and a method of manufacturing the same.

Solution for solving the problem

5 The present application provides a heat-resistant composite sheet which is a glass fiber fabric impregnated with a fluorine-containing resin, wherein, with the glass fiber fabric as a center, the composite sheet has two opposite surfaces in a thickness direction, at least one of which has a surface roughness of $R_z \leq 21 \mu\text{m}$ or $R_a \leq 7.5 \mu\text{m}$.

10 In the heat-resistant composite sheet according to the present application, the thinnest thickness between the surface having the surface roughness and the glass fiber fabric is 3 to 30 μm .

In the heat-resistant composite sheet according to the present application, the glass fiber fabric has a thickness of 10 to 500 μm .

15 In the heat-resistant composite sheet according to the present application, with the glass fiber fabric as the center, the composite sheet has two opposite surfaces in the thickness direction, and the ratio of the thinnest thickness between the two surfaces and the glass fiber fabric is 0.5 to 2.0.

20 In the heat-resistant composite sheet according to the present application, the fluorine-containing resin is one or more of polytetrafluoroethylene (PTFE), perfluoro(alkoxy alkane) (PFA), perfluoroethylene-propylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE), and polyvinylidene fluoride (PVdF).

The present application further provides a heat-resistant adhesive tape comprising the heat-resistant composite sheet according to the present application, and an adhesive layer provided on at least one surface of the heat-resistant composite sheet.

25 The present application further provides a method for manufacturing the heat-resistant composite sheet according to the present application, comprising the following steps:

treating a glass fiber fabric with a silicon-containing agent;

impregnating the glass fiber fabric treated as above with a fluorine-containing resin;

heating the glass fiber fabric impregnated with the fluorine-containing resin to form the composite sheet.

30 In the method for manufacturing the heat-resistant composite sheet according to the present application, after the glass fiber fabric is impregnated with the fluorine-containing resin and before the heating step, the glass fiber fabric impregnated with the fluorine-containing resin is processed with a scraper to control the thickness of the fluorine-containing resin on both sides of the glass fiber fabric.

35 In the method for manufacturing the heat-resistant composite sheet according to the

present application, the step of impregnating the glass fiber fabric with the fluorine-containing resin and the step of heating to form the composite sheet are repeated for 2 to 8 times.

In the method for manufacturing the heat-resistant composite sheet according to the present application, the amount of the silicon-containing agent is 0.05 to 0.2% by weight of the total weight of the glass fiber fabric.

The present application further provides a method for manufacturing the adhesive tape according to the present application, comprising the following steps:

manufacturing a heat-resistant composite sheet according to the method for manufacturing the heat-resistant composite sheet according to the present application;

providing an adhesive layer on at least one surface of the heat-resistant composite sheet.

Effects of the disclosure

By adjusting the surface roughness of the heat-resistant composite sheet of the disclosure, the abrasion resistance of the composite sheet can be improved, the production efficiency can be improved, and the cost can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view illustrating a cross-sectional structure of an example of the heat-resistant composite sheet of the disclosure;

Fig. 2 is a schematic view illustrating a cross-sectional structure of an example of a heat-resistant adhesive tape using the heat-resistant composite sheet of the disclosure;

Fig. 3 is an enlarged view illustrating a cross-sectional structure of an example of a heat-resistant adhesive tape using the heat-resistant composite sheet of the disclosure.

Description of the reference numerals

10 a composite sheet

11 the first surface of the composite sheet

12 the second surface of the composite sheet

13 a glass fiber fabric

14 the thinnest thickness between the first surface of the composite sheet and the glass fiber fabric

15 the thinnest thickness between the second surface of the composite sheet and the glass fiber fabric

20 an adhesive layer

DETAILED DESCRIPTION

The disclosure will now be described in detail with reference to the drawings.

[Heat-resistant composite sheet]

<Composite sheet>

In the disclosure, the composite sheet 10 is a glass fiber fabric impregnated with a fluorine-containing resin, wherein, with the glass fiber fabric 13 as a center, the composite sheet has two opposite surfaces 11 and 12 in the thickness direction, at least one of which has a surface roughness of $R_z \leq 21 \mu\text{m}$ or $R_a \leq 7.5 \mu\text{m}$. Preferably, R_z is $\leq 13 \mu\text{m}$, and more preferably, R_a is $\leq 2.9 \mu\text{m}$. Preferably, the at least one surface meets $R_z \leq 21 \mu\text{m}$ and $R_a \leq 7.5 \mu\text{m}$ at the same time. More preferably, the at least one surface meets $R_z \leq 13 \mu\text{m}$ and $R_a \leq 2.9 \mu\text{m}$ at the same time.

It should be noted that, in the disclosure, the two opposite surfaces 11 and 12 both may serve as the opposite first surface and second surface. If one surface is called the first surface, then the other surface is called the second surface, and vice versa, which is not particularly limited.

In the disclosure, the heat-resistant composite sheet is preferably an adhesive tape substrate, an adhesive tape release film, a food transfer belt, a corrosion resistant film, or a durable film for construction.

In the disclosure, the glass fiber fabric 13 is treated with a silicon-containing agent, the treated glass fiber fabric is impregnated with a fluorine-containing resin, and the glass fiber fabric impregnated with the fluorine-containing resin is heated to form the composite sheet 10. The thickness of the composite sheet 10 is, for example, 10 to 500 μm , preferably 40 to 300 μm .

<Glass fiber fabric>

In the disclosure, the glass fiber fabric is a fabric obtained by weaving glass fiber yarns. The glass strand used as the glass fiber fabric is usually formed by pulling and aligning glass fibers having a diameter of about several microns in units of several hundred. The characteristics of the glass fiber fabric are determined by fiber properties, warp and weft density, yarn structure and texture. The warp and weft density is determined by the yarn structure and texture. The warp and weft density plus the yarn structure determines the physical properties of the fabric, such as weight, thickness and breaking strength. The basic texture is plain, twill, satin, rib and basket. The type and configuration of the glass fiber fabric are not particularly limited. For example, it is preferable to use a glass fiber plain fabric having a basis weight of 15 to 110 g/m^2 , a yarn density of 10 to 100 / 25 mm in the warp direction and the weft direction, and a thickness of about 10 μm to about 500 μm , more preferably about 30 μm to about 250 μm . The glass fiber fabric may be split before use to improve the effect of the subsequent silicon-containing treatment process.

<Fluorine-containing resin>

In the disclosure, the fluorine-containing resin is not particularly limited, which, for example, is one or more of polytetrafluoroethylene (PTFE), perfluoro(alkoxy alkane) (PFA), perfluoroethylene-propylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE),
5 and polyvinylidene fluoride (PVdF).

<Surface roughness Rz>

The surface roughness Rz is measured in accordance with the JIS-B0601-1994 test method. At least one of the two opposite surfaces 11 and 12 of the composite sheet 10 has a surface roughness of $Rz \leq 21 \mu\text{m}$, preferably $Rz \leq 13 \mu\text{m}$.

10 <Surface roughness Ra>

The surface roughness Ra is measured in accordance with the JIS-B0601-1994 test method. At least one of the two opposite surfaces 11 and 12 of the composite sheet 10 has a surface roughness of $Ra \leq 7.5 \mu\text{m}$, preferably $Ra \leq 2.9 \mu\text{m}$.

The surface roughness of at least one of the two opposite surfaces 11 and 12 of the
15 composite sheet 10 is particularly important for the service life of the composite sheet. When the above surface roughness Rz is $> 21 \mu\text{m}$, the surface roughness greatly affects the surface abrasion performance, for example, affecting the friction coefficient, affecting the surface stress when the composite sheet is subjected to friction, and thereby causing surface damage phenomenon of the fluorine-containing resin surface layer. Therefore, when Rz is $> 21 \mu\text{m}$, the
20 surface layer is more likely to cause microcrystalline damage of the surface layer resin, further causing destruction of the entire surface layer resin, resulting in a low service life of the composite sheet.

On the other hand, when Ra is $> 7.5 \mu\text{m}$, as also the mechanism discovered by the inventors as described above, since the surface roughness greatly affects the surface abrasion
25 performance, for example, affecting the friction coefficient, affecting the surface stress when the composite sheet is subjected to friction, and thereby causing surface damage phenomenon of the fluorine-containing resin surface layer. Therefore, when Ra is $> 7.5 \mu\text{m}$, the surface layer is more likely to cause microcrystalline damage of the surface layer resin, further causing destruction of the entire surface layer resin, resulting in a low service life of the composite
30 sheet.

Besides, for consideration of manufacturability and service life, the thinnest thickness of the fluorine-containing resin layer on both sides of the glass fiber fabric (the thickness from the outer surface of the composite sheet to the nearest glass fiber) is generally 3 to $30 \mu\text{m}$, preferably 5 to $50 \mu\text{m}$. When the thinnest thickness is less than $3 \mu\text{m}$, since the thickness of
35 the fluorine-containing resin layer is too thin, it is very liable to expose the internal glass fibers

after abrasion, resulting in irregular surface morphology of the composite sheet, which causes the composite sheet to lose effects such as release and chemical resistance. On the other hand, when the thinnest thickness is more than 30 μm , the thickness of the fluorine-containing resin layer is too thick, resulting in deterioration of workability (mainly resistance to counter force) of the composite sheet during use, and an increase in use cost.

With the glass fiber fabric as the center, the ratio of the thinnest thickness 14 and 15 (vice versa) between the two opposite surfaces 11 and 12 of the composite sheet 10 and the glass fiber fabric 13 is 0.5 to 2.0, preferably 0.8 to 1.3, and more preferably 0.9 to 1.1. When the ratio is less than 0.5, the composite sheet is prone to curling in one direction during processing, resulting in deterioration of the practical use performance of the composite sheet. When the ratio is larger than 2.0, based on the same principle, the composite sheet is prone to curling in one direction during processing, resulting in deterioration of the practical use performance of the composite sheet.

<Method for manufacturing the composite sheet>

The method for manufacturing the heat-resistant composite sheet according to the disclosure comprises the following steps: treating a glass fiber fabric with a silicon-containing agent (a silicon-containing agent treating step); impregnating the glass fiber fabric treated as above with a fluorine-containing resin (an impregnating step); heating the glass fiber fabric impregnated with the fluorine-containing resin to form the composite sheet (a heating step).

<Silicon-containing agent treating step>

Silicon-containing agent treatment is a process of treating the glass fiber fabric with a silicon-containing agent. The silicon-containing agent is a class of organosilicon compounds containing two groups having different chemical properties in one molecule, and its structural formula may be represented by a general formula YSiX_3 . In this formula, Y is a non-hydrolyzable group, including an alkenyl group (mainly a vinyl group), and a hydrocarbon group having a functional group such as Cl, NH_2 , $-\text{SH}$, an epoxy group, N_3 , a (meth)acryloyloxy group and an isocyanate group at the end, that is, a carbon functional group; X is a hydrolyzable group, including Cl, OCH_3 , OCH_2CH_3 , $\text{OC}_2\text{H}_4\text{OCH}_3$, $\text{OSi}(\text{CH}_3)_3$, and the like. Due to the presence of the silicon-containing agent, the glass fiber fabric has a great influence on the flattening property of the fluorine-containing resin material on the surface of the glass fiber fabric and the internal immersion property of the fluorine-containing resin material. In the present application, the amount of the silicon-containing agent is 0.05 to 0.2% by weight based on the total weight of the glass fiber fabric.

<Impregnating step>

In the impregnating step, the glass fiber fabric may be impregnated with a

fluorine-containing resin emulsion.

The fluorine-containing resin emulsion is a polymer resin emulsion in which a polymer main chain is carbon element, and the element bonded to the carbon element is fluorine element. For example, polytetrafluoroethylene (PTFE) emulsion is formed by emulsion
5 polymerization of tetrafluoroethylene (TFE). The content (solid content ratio) of the fluorine-containing resin in the fluorine-containing resin emulsion is preferably from about 40 to about 60% by weight.

In the impregnating step, the glass fiber fabric is impregnated into the fluorine-containing resin emulsion. The impregnation can be carried out, for example, by a method of
10 impregnating the glass fiber fabric in the fluorine-containing resin emulsion, a method of coating the fluorine-containing resin emulsion on the glass fiber fabric, or a method of spraying the fluorine-containing resin emulsion on the glass fiber fabric.

After the aforesaid impregnating step, the glass fiber fabric impregnated with the fluorine-containing resin may be processed with a scraper or a squeegee to separately control
15 the thickness of the fluorine-containing resin on both sides of the glass fiber fabric.

<Heating step>

In the heating step, the dispersion medium is lost from the fluorine-containing resin emulsion impregnated into the glass fiber fabric in the impregnating step, and the fluorine-containing resin is fused to each other (the emulsion is converted into a fusion body),
20 to form a glass fiber fabric impregnated with the fluorine-containing resin.

The specific method of the heating step is not limited, provided that the glass fiber fabric impregnated with the fluorine-containing resin emulsion can be heated to a temperature equal to or higher than the melting point of the fluorine-containing resin, generally 15°C to 60°C above the melting point of the fluorine-containing resin. For example, when a PTFE emulsion
25 is used, the heating temperature is preferably 330°C to 400°C, and more preferably 340°C to 380°C.

The formed glass fiber fabric may be further repeatedly subject to the impregnating step and the heating step as needed. By this repetition, for example, the thickness of the glass fiber fabric impregnated with the fluorine-containing resin can be increased. The total thickness of
30 the composite sheet formed by the above steps is, for example, 10 to 500 μm, preferably 40 to 300 μm. In general, the impregnating step and the heating step are repeated 2 to 8 times. If too many times of repetitions are performed, the composite sheet may be too thick, so that when the composite sheet is attached to a hot plate having an angle, the counter force is large after the bending, so it is not easy to stick and is easily detached from the adherend.

35 The method for manufacturing the composite sheet in the disclosure may comprise any

steps in addition to the impregnating step and the heating step, as long as the effects of the disclosure can be obtained.

Thereby, a composite sheet in which the fluorine-containing resin is impregnated in the glass fiber fabric is obtained.

Because of the adjustment of the surface roughness, the composite sheet of the disclosure has characteristics of good flatness, strong abrasion resistance, being easy to stick and not easy to be detached from the adherend, and a high production efficiency. The composite sheet of the present application can be used for various applications requiring abrasion resistance, acid and alkali resistance, heat resistance, such as an adhesive tape substrate, an adhesive tape release film, a food conveyor belt, a corrosion resistant film or durable film, thin film, adhesive tape and the like for construction.

Only examples in which the composite sheet of the disclosure is applied to a heat-resistant adhesive tape will be described below, and those skilled in the art can understand that the examples are merely illustrative and not exhaustive.

[Heat-resistant adhesive tape]

With reference to Fig. 2, the heat-resistant adhesive tape of the disclosure comprises an adhesive layer 20 provided on one surface 11 of the above-mentioned composite sheet. In the disclosure, the heat-resistant adhesive tape may comprise an adhesive layer 20 provided on the other surface 12 of the above-mentioned composite sheet.

<Adhesive layer>

In the disclosure, the type of the adhesive used for the adhesive layer is not particularly limited, and acrylic, rubber, or silicone-based pressure-sensitive adhesive materials, which are conventionally used in an adhesive layer of an adhesive tape, may be used. From the viewpoint of heat resistance of the adhesive tape, a silicone-based adhesive is preferable.

The thickness of the adhesive layer is usually 5 to 100 μm , preferably 10 to 60 μm . When the thickness is less than 5 μm , the adhesive force is low, and peeling easily occurs during use. When the thickness is more than 100 μm , the thermal conductivity of the adhesive tape used for heat sealing in the thickness direction is lowered, which is not preferable.

[Method for manufacturing a heat-resistant adhesive tape]

The method for manufacturing a heat-resistant adhesive tape of the disclosure comprises: manufacturing said composite sheet according to the method for manufacturing a composite sheet described above; providing said adhesive layer on one surface (11 or 12) of said composite sheet.

<Surface treatment step>

The surface treatment step is a treatment for improving the adhesion (anchoring force)

between the surface (11 or 12 in the disclosure) on which the adhesive layer is provided in the composite sheet and the adhesive layer provided on the surface. This step may be carried out as needed. The specific method of performing the surface treatment step is the same as the known method carried out in the manufacture of an adhesive tape. The surface treatment step may be carried out, for example, by applying a surface treatment solution (adhesive treatment solution) containing a surface treatment agent (adhesive treatment agent) and a dispersant to the surface on which an adhesive layer is to be provided in the composite sheet.

The surface treatment agent is, for example, a polyester resin, a melamine resin, an acrylic resin, a silicone resin, and a fluorine-containing resin such as PTFE, PFA or ETFE. The dispersant is, for example, toluene, xylene, ethyl acetate, butanol, water, and a mixture thereof.

The surface treatment solution may contain a surface treatment agent and a material other than a dispersant, such as a crosslinking agent, a curing agent, an organic filler, an inorganic filler, and a surfactant. The organic filler is, for example, a powder of a melamine resin, an epoxy resin, or an acrylic resin, and the inorganic filler is, for example, a powder of iron oxide, aluminum oxide, or silica.

In the disclosure, the surface treatment solution is preferably a solution containing a fluorine-containing resin PFA as a surface treatment agent, water as a dispersant, and silica particles as an inorganic filler.

<Adhesive layer forming step>

In the adhesive layer forming step, an adhesive layer is provided on one surface 11 or 12 of the composite sheet. The specific method of performing the adhesive layer forming step is the same as the known method carried out in the manufacture of an adhesive tape. The adhesive layer forming step, for example, may be carried out by coating an adhesive on one surface 11 or 12 of the composite sheet.

Examples

In the examples,

(1) The surface roughness Rz and Ra both were measured according to the JIS-B0601-1994 test method.

(2) The abrasion resistance test was carried out by using a Taber abrasion machine, an abrading wheel CS-17, a load of 500 g, and grinding the composite sheet for 1000 times, weighing the weight before and after the abrasion, and calculating the abrasion loss.

(3) The thinnest thickness between the surface of the composite sheet and the glass fiber fabric was measured by the following method: the composite sheet was subject to sectional cut with a cutter and was cut into a sample having a thinness of 20 μm , which was placed under an

electron microscope magnified 100 times to observe the section and determine the thinnest thickness between the two surfaces of the composite sheet and the glass fiber fabric. Measurement was carried out at 5 points, and the average value was used.

(4) Whether or not the glass fiber is exposed in the composite sheet was determined by using a Taber abrasion machine, an abrading wheel CS-17, a load of 500 g, and abrading the composite sheet for 500 times, and using a microscope to observe the surface status of the composite sheet in an area of 1 cm × 1 cm after abrasion.

The status that there was no obvious abrasion and no glass fiber was exposed was evaluated as ◎,

The status that there was abrasion on the surface but no glass fiber was exposed was evaluated as ○,

The status that a part of glass fibers were exposed was evaluated as ×;

The status that abrasion of glass fiber was observed was evaluated as ××.

(5) The evaluation of the curling property of the composite sheet was carried out by taking a composite sheet of 1 m × 15 mm, grasping one end thereof and floating the other end freely, and observing the curling condition of the composite sheet.

The case where the composite sheet was substantially not curled and substantially kept in a line shape was evaluated as ○;

The case where the composite sheet was merely slightly curled and could be used continuously after being straightened was evaluated as Δ;

The case where the composite sheet was curled into a plurality of circles was evaluated as ×.

Example 1

A glass fiber plain fabric having a thickness of 450 μm was treated with a silicon-containing agent, and the amount of the silicon-containing agent was 0.17% by weight based on the total weight of the glass fiber plain fabric. The glass fiber plain fabric treated with the silicon-containing agent was impregnated with a PTFE emulsion having a fluorine-containing resin content (solid content ratio) of about 55% by weight. After the impregnation, the thickness of the PTFE on both sides of the glass fiber was controlled by a scraper. After dehydration, the resultant was sintered at a high temperature of 350°C for 20 seconds. The aforesaid impregnation and sintering were repeated once. The scraper was controlled to adjust the spacing between the glass fibers so that a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.2. In the obtained composite sheet, the

adhesive-free surface (i.e., the second surface 12) had a surface roughness Ra of 6.2 μm and a Rz of 32 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 3.5 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Example 2

The steps in Example 1 were repeated, except for the following differences: a glass fiber plain fabric having a thickness of 30 μm was treated with a silicon-containing agent, and the amount of the silicon-containing agent was 0.09% by weight based on the total weight of the glass fiber plain fabric; in the obtained composite sheet, a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.0; the adhesive-free surface (i.e., the second surface 12) had a surface roughness Ra of 2.5 μm and a Rz of 6.3 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 6 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Example 3

The steps in Example 1 were repeated, except for the following differences: a glass fiber plain fabric having a thickness of 80 μm was treated with a silicon-containing agent, and the amount of the silicon-containing agent was 0.09% by weight based on the total weight of the glass fiber plain fabric; in the obtained composite sheet, a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.0; the adhesive-free surface (i.e., the second surface 12) had a surface roughness Ra of 2.2 μm and a Rz of 2.4 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 9 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Example 4

The steps in Example 1 were repeated, except for the following differences: a glass fiber plain fabric having a thickness of 80 μm was treated with a silicon-containing agent; in the obtained composite sheet, a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.5; the adhesive-free surface (i.e., the second surface 12) had a surface roughness R_a of 1.6 μm and a R_z of 2.1 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 11 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Example 5

The steps in Example 1 were repeated, except for the following differences: a glass fiber plain fabric having a thickness of 150 μm was treated with a silicon-containing agent; in the obtained composite sheet, a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.0; the adhesive-free surface (i.e., the second surface 12) had a surface roughness R_a of 0.4 μm and a R_z of 2.0 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 20 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Comparative example 1

The steps in Example 1 were repeated, except for the following differences: the amount of the silicon-containing agent was 0.02% by weight based on the total weight of the glass fiber plain fabric; in the obtained composite sheet, a ratio of the thickness at the thinnest portion between the adhesive-free surface (i.e., the second surface 12) and the glass fiber plain fabric to the thickness at the thinnest portion between the adhesive surface (i.e., the first surface 11) and the glass fiber plain fabric was 1.0; the adhesive-free surface (i.e., the second surface 12) had a surface roughness R_a of 9.8 μm and a R_z of 32.8 μm , and the thickness at the thinnest portion between the adhesive-free surface and the glass fiber plain fabric was 2 μm .

The abrasion loss of the obtained composite sheet was measured, and the glass fiber exposure condition and curling condition of the composite sheet were observed. The results are shown in Table 1.

Table 1

	Fluorine-containing resin	Second surface Ra(μm)	Second surface Rz(μm)	The thinnest thickness between the second surface and the glass fiber fabric (μm)	Thickness of the glass fiber fabric (μm)	Ratio of the thinnest thickness	Amount of the silicon-containing agent (% by weight)	Abrasion loss (mg)	Exposure of glass fiber	Curling property
Example 1	PTFE	6.2	32	3.5	450	1.2	0.17	40	○	○
Example 2	PTFE	2.5	6.3	6	30	1.0	0.09	14	◎	○
Example 3	PTFE	2.2	2.4	9	80	1.0	0.09	11	◎	○
Example 4	PTFE	1.6	2.1	11	80	1.5	0.17	9	◎	△
Example 5	PTFE	0.4	2.0	20	150	1.0	0.17	8	◎	○
Comparative example 1	PTFE	9.8	32.8	2	450	1.0	0.02	85	××	○

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From the above examples and comparative example, it was evident that in the disclosure, by making the surface roughness $Rz \leq 21 \mu\text{m}$ or $Ra \leq 7.5 \mu\text{m}$ of at least one surface of the composite sheet, the resultant composite sheet could have excellent abrasion resistance and curling property, and no fiber was exposed. On the contrary, the composite sheet which did not satisfy the surface roughness condition of the disclosure had poor abrasion resistance, and a part of the fibers in the composite sheet were exposed or abraded.

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CLAIMS

1. A heat-resistant composite sheet which is a glass fiber fabric impregnated with a fluorine-containing resin, wherein, with the glass fiber fabric as a center, the composite sheet has two opposite surfaces in a thickness direction, at least one of which has a surface roughness of $R_z \leq 21 \mu\text{m}$ or $R_a \leq 7.5 \mu\text{m}$.

2. The heat-resistant composite sheet according to claim 1, wherein the thinnest thickness between the surface having the surface roughness and the glass fiber fabric is 3 to 30 μm .

3. The heat-resistant composite sheet according to claim 1 or 2, wherein the glass fiber fabric has a thickness of 10 to 500 μm .

4. The heat-resistant composite sheet according to claim 1 or 2, wherein, with the glass fiber fabric as the center, the composite sheet has two opposite surfaces in the thickness direction, and the ratio of the thinnest thickness between the two surfaces and the glass fiber fabric is 0.5 to 2.0.

5. The heat-resistant composite sheet according to claim 1 or 2, wherein the fluorine-containing resin is one or more of polytetrafluoroethylene (PTFE), perfluoro(alkoxy alkane) (PFA), perfluoroethylene-propylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE), and polyvinylidene fluoride (PVdF).

6. A heat-resistant adhesive tape, comprising the heat-resistant composite sheet according to any one of claims 1 to 5, and an adhesive layer provided on at least one surface of the heat-resistant composite sheet.

7. A method for manufacturing the heat-resistant composite sheet according to any one of claims 1 to 5, comprising the following steps:

treating a glass fiber fabric with a silicon-containing agent;

impregnating the glass fiber fabric treated as above with a fluorine-containing resin;

heating the glass fiber fabric impregnated with the fluorine-containing resin to form the composite sheet.

8. The method for manufacturing the heat-resistant composite sheet according to claim 7, wherein after the glass fiber fabric is impregnated with the fluorine-containing resin and before the heating step, the glass fiber fabric impregnated with the fluorine-containing resin is processed with a scraper to control the thickness of the fluorine-containing resin on both sides of the glass fiber fabric.

9. The method for manufacturing the heat-resistant composite sheet according to claim 7 or 8, wherein the step of impregnating the glass fiber fabric with the fluorine-containing resin and the step of heating to form the composite sheet are repeated for 2 to 8 times.

10. The method for manufacturing the heat-resistant composite sheet according to claim 7

or 8, wherein the amount of the silicon-containing agent is 0.05 to 0.2% by weight of the total weight of the glass fiber fabric.

11. A method for manufacturing the adhesive tape according to claim 6, comprising the following steps:

- 5 manufacturing a heat-resistant composite sheet according to the method for manufacturing the heat-resistant composite sheet according to any one of claims 7 to 10;
 providing an adhesive layer on at least one surface of the heat-resistant composite sheet.