

PROCESS OF PRODUCING PRINTED WIRING BOARD

Field

The present invention relates to a printed wiring board production process, and more particularly, to a process of producing a flexible printed wiring board comprised of a base film and a wiring pattern layer built into a circuit area on its surface, and provided with a reinforcing sheet at a site that does not overlap with the wiring pattern layer of the circuit area.

Background

As is widely known, tremendous advances have been made in electronic devices, and various types of electronic devices have appeared in recent years offering higher performance and reduced size. Thus, improvements are also progressing in the printed wiring boards widely used in electronic devices, and typical issues facing these printed wiring boards include reduce size, lower mounting height, flexibility and higher mounting density. Since flexible printed wiring boards in particular are not only effective for reducing the size and weight of electronic devices as well as increasing mounting density, but are also able to accommodate increases in the number of connections between components and the number of mounted components, the demand for these boards is increasing. In addition, in order to compensate for shortcomings attributable to their flexibility (such as decreased connection strength between components and breakage during component mounting), flexible printed wiring boards are frequently provided with a reinforcing sheet composed of a metal material or plastic material that is adhered with adhesive.

Reinforcing sheets have conventionally been adhered to flexible printed wiring boards by various methods. For example, Patent Document 1 describes a production process for laminating a flexible printed wiring board and reinforcing sheet using a thermosetting resin adhesive, wherein after pressing together a flexible printed wiring board equipped with a reinforcing sheet in a heated roller pressing step in individual sheet units, it is hot pressed in a single sheet hot pressing step in individual sheet units to produce a flexible printed wiring board equipped with a reinforcing sheet. Namely, this patent document proposes a production process composed of a flexible printing board and

reinforcing sheet temporarily pressing step, a pressing step using a heated roller press, a hot pressing step using a single sheet hot press, and an after-baking step. However, since this production process contains a large number of processing steps, not only is the procedure complex, but it requires considerable time and costs for production. In addition, since processing is carried out in batches for each sheet, it is not suited for large-volume production, while also having the disadvantage of poor yield.

On the other hand, Patent Document 2 describes a reinforcing sheet adhesion process for adhering a reinforcing sheet to a flexible printed wiring board in which conductor wiring is formed on a film base, comprising a lamination step in which reinforcing sheet and a flexible printed wiring board are arranged in opposition to each other and laminated using a thermosetting adhesive, and a pressing step in which pressure is applied to the laminate of the reinforcing sheet and flexible printed wiring board from both sides; wherein, in the aforementioned pressing step, pressure is applied to at least one of the reinforcing sheet side and flexible printed wiring board side by a member having deforming resiliency at an arbitrary area. Namely, this patent document proposes an improved hot pressing system in which heat-conducting rubber and cushioning materials are affixed to the upper and lower pressing surfaces of a hot press to eliminate the non-uniform application of pressure by the hot press machine. However, upon use of this system, the problem cannot be avoided in which the uniform application of pressure to the flexible printed wiring board has a detrimental effect on the circuit area of the flexible printed wiring board (namely, the area containing the already deformed conductor wiring pattern). This is because, since the pressing surfaces of the hot press have a fixed length and width, if the length and width of the circuit area on the flexible printed wiring board change, sections that are not pressed or sections that are pressed twice may occur in the circuit area depending on the particular case.

Brief Description Of The Drawings

Fig. 1 is an overhead view showing a preferable mode of a printed wiring board equipped with a reinforcing sheet according to an embodiment of the present invention.

Fig. 2 is a flow chart showing a production process of a printed wiring board equipped with a reinforcing sheet according to an embodiment of the present invention in the order of that process.

Fig. 3 is a schematic cross-sectional view showing a reinforcing sheet preparation step that is included in the production process of a printed wiring board equipped with a reinforcing sheet according to an embodiment of the present invention.

Fig. 4 is a schematic cross-sectional view showing a reinforcing sheet temporary mounting step that is included in the production process of a printed wiring board equipped with a reinforcing sheet according to an embodiment of the present invention.

Fig. 5 is a schematic cross-sectional view showing a reinforcing sheet final adhesion step that is included in the production process of a printed wiring board equipped with a reinforcing sheet according to an embodiment of the present invention.

Fig. 6 is a schematic cross-sectional view showing the mechanism used to control the pressure of a heated roller in the reinforcing sheet final adhesion step shown in Fig. 5.

DISCLOSURE OF THE INVENTION

An object of the present invention is to provide a production process of a flexible printed wiring board equipped with a reinforcing sheet that improves on methods employed in the prior art for adhering a reinforcing sheet to a flexible printed wiring board by having simple processing steps, having a small number of steps and therefore being able to be carried out easily, simply and in a short period of time even by a person not familiar with the procedure, and allowing en bloc, large-volume production instead of batch production.

In addition, another object of the present invention is to provide a production process of a flexible printed wiring board equipped with a reinforcing sheet that prevents the occurrence of problems such as non-pressing and excessive pressing in a circuit area when pressing on the reinforcing sheet even if the length and width of the circuit area on the flexible printed wiring board have changed.

These objects and other objects of the present invention can be easily understood from the following detailed explanation.

As a result of conducting extensive studies to solve the aforementioned problems, the inventors of the present invention found that it is effective to produce a flexible printed wiring board and a flexible sheet each from long materials, preferably guide those starting materials to a production process from a wound state, and carry out the reinforcing sheet

adhesion step in two stages consisting of a temporary mounting step (temporary adhesion step) and its subsequent final adhesion step, thereby leading to completion of the present invention.

Namely, the present invention is a process of producing a flexible printed wiring board, comprising at least a base film and a wiring pattern layer built into a circuit area on its surface, and provided with a reinforcing sheet at a site other than the site of the wiring pattern of the circuit area; comprising:

a step in which a long base film defined by at least one circuit area corresponding to the printing wiring board is produced;

a step in which the wiring pattern layer is formed in each circuit area;

a step in which, together with continuously moving the base film before, during or after the wiring pattern layer is formed in each of the circuit areas, a reinforcing sheet, produced locally or at another location, is adhered through an adhesive layer to a predetermined location of the base film during its movement; and,

a step in which the laminate of the base film and reinforcing sheet is cut and separated into individual printed wiring boards each having the wiring pattern layer and the reinforcing sheet; wherein,

the reinforcing sheet adhesion step is carried out in two stages consisting of a reinforcing sheet temporary mounting step and its subsequent reinforcing sheet final adhesion step.

As can be easily understood from the following detailed explanation, according to the present invention, in the case of adhering a reinforcing sheet to a flexible printed wiring board, flexible printed wiring boards equipped with a reinforcing sheet can be produced en bloc and in large volume since the processing and adhesion steps are simple, only a small number of processing steps are required, the process can be carried out easily, simply and in a short period of time even by a person not familiar with the procedure, and the process is not dependent on batch production. These effects can be embodied more advantageously by employing a system in which printed wiring boards are unwound from a reel, and the ultimately obtained flexible printed wiring boards equipped with a reinforcing sheet are rewound onto the reel.

In addition, according to the present invention, problems such as non-pressing and

excessive pressing in a circuit area when pressing on the reinforcing sheet do not occur even if the length and width of the circuit area on the flexible printed wiring board have changed.

According to the present invention, together with naturally being able to realize effects inherent to flexible printed wiring boards such as reduced size and weight of electronic devices and high mounting density, increases in the number of connections between components and the number of mounted components can also be easily accommodated, and as a result of attaching a reinforcing sheet, additional effects such as improvement of connection strength between components and prevention of breakage during component mounting, can also be realized.

A production process of a flexible printed wiring board according to the present invention can be carried out advantageously in various forms. Although the following provides an explanation of preferable embodiments of the present invention with reference to the drawings, it goes without saying that the present invention is not limited to these embodiments.

A printed wiring board of the present invention is at least comprised of a base film which is itself flexible and can be deformed to an arbitrary shape, and a wiring pattern layer built into a circuit area on the surface of the base film, and is provided with a reinforcing sheet at a site other than the site of the wiring pattern layer of the aforementioned circuit area. The reinforcing sheet is generally applied to a back surface of the base film, however, if desired, it may be applied to an upper surface of the base film. A printed wiring board equipped with a reinforcing sheet of the present invention is normally produced in the form of a long film provided with a plurality of printed wiring boards equipped with a reinforcing sheet which is then able to be separated into individual printed wiring boards by cutting. Namely, a printed wiring board of the present invention, in its precursor form, consists of a plurality of printed wiring boards formed continuously at mutual predetermined intervals on a long film. Fig. 1 is an overhead view showing a preferable form of a long strip of printed wiring boards equipped with a reinforcing sheet.

The long strip of printed wiring boards shown in Fig. 1 is composed of a flexible film base 1 in the form of a TAB tape equipped with sprocket holes 12 for its transport. Film base 1 can be processed into individual printed wiring boards 10-1, 10-2 and so forth by cutting along cutting line c. Although each printed wiring board can be

formed to various sizes corresponding to its constitution, application and so forth, in the case of the example shown in the drawing, the tape width w is 70 mm, length l is 38 mm, and pitch p of sprocket holes 12 is 4.75 mm. Each printed wiring board has a circuit area 2 in its center in the form of its substantial area. Circuit area 2 is normally rectangular. In addition, although not shown in the drawing, circuit area 2 is provided with a mounting section where devices are mounted, and a wiring pattern layer in close proximity thereto in which an arbitrary, desired pattern is formed. In addition, as is typically common for printed wiring boards, the wiring pattern layer is composed of wiring, inner leads, outer leads and so forth. Moreover, a reinforcing sheet 3 is further attached in accordance with the process of the present invention to a back surface of the circuit area 2 of the printing wiring board, i.e., a surface opposed to the wiring pattern layer-bearing surface of the film base 1, as shown in the drawing. Reinforcing sheet 3 is partly extended to an outside area of the circuit area 2.

In a printed wiring board of the present invention, although the flexible film base can be formed from various materials able to impart flexibility to a film base, it is normally advantageous to mold into the shape of a film by an arbitrary molding methods from a plastic material. Examples of plastic materials preferable for the film base include polyimide resin, acrylic resin, polyester resin, polyurethane resin and polyvinyl chloride resin. In addition, examples of molding methods for these plastic materials include various types of coating methods and calendaring methods. Although the film base can be used at various thicknesses corresponding to the constitution, application and so forth of the printed wiring board, the thickness is normally about 300 μm or less, preferably within the range of about 50 to 200 μm , and more preferably within the range of about 50 to 150 μm . If the film base is excessively thin, workability decreases and there is increased susceptibility to breakage. Conversely, if the film base is excessively thick, it is counterproductive with respect to reducing weight, while also making it difficult to wind onto a reel and so forth. In addition, the film base is normally formed into a long strip, is preferably stored and transported by winding onto a reel, and is used by unwinding as necessary during production of printed wiring boards.

As was previously stated, circuit elements such as a wiring pattern layer containing a mounting section where devices are mounted and wiring and so forth are provided in an arbitrary, desired pattern in the circuit area of the printed wiring board. These elements

can be formed in a pattern similar to that typically employed in printed circuit boards and using similar techniques. For example, the wiring and other components of the wiring pattern layer can be formed from a conducting metal such as copper, nickel or gold, or an alloy thereof, using a technique such as plating or vapor deposition. In addition, the wiring pattern layer may also be formed by adhering a conductor film over the entire surface of the film base followed by selective etching thereof. The wiring pattern layer may also be formed using techniques such as soldering as necessary. Although the wiring pattern layer can be used at various thicknesses corresponding to the constitution of the printed wiring board and constitution of the wiring pattern layer, the thickness is normally about 50 μm or less, preferably within the range of about 5 to 40 μm , and more preferably within the range of about 10 to 30 μm .

A reinforcing sheet is attached in relation to the wiring pattern layer to the back surface of the film base. The reinforcing sheet is attached by utilizing the space where the wiring pattern layer and other functional devices are not built into the circuit area. Thus, it can be arranged in a continuous or discontinuous, arbitrary pattern. Typical examples of reinforcing sheet patterns include rectangles, L-shapes and circles. Regardless of which type of pattern is used, the reinforcing sheet can be easily formed using an ordinary technique, preferably by stamping from a sheet-like reinforcing sheet. Examples of locations where the reinforcing sheet is arranged include the locations of connectors.

As is conventionally carried out in the field of printed wiring boards, the reinforcing sheet can be formed in the form of a metal layer, plastic layer or composite thereof from a metal material or plastic material and so forth that does not have a detrimental effect on the characteristics, etc. of the printed wiring board. Examples of suitable metal materials include stainless steel and titanium. In addition, examples of suitable plastic materials include polyimide resin, polyester resin and glass epoxy resin. In addition, examples of the composite include a composite of metal layers, a composite of plastic layers and a composite layer consisting of laminated metal and plastic layers. For example, a composite of plastic layers includes a laminate of polyimide layers bonded with an adhesive, and a composite layer consisting of laminated metal and plastic layers include a laminate of stainless steel layer and polyimide layer bonded with an adhesive. The reinforcing sheet is typically used in the form of a film, and although its thickness can be altered over a wide range, it is normally about 300 μm or less, and preferably within the

range of 25 to 200 μm . If it is excessively thin, it is not possible to achieve the desired level of reinforcing effects. Furthermore, although the proportion of the surface area occupied by the reinforcing sheet in the circuit area cannot generally be defined since it is dependent on such factors as the area of the circuit area and area over which the wiring pattern layer is formed, in the case, for example, the width of the printed wiring board is 70 mm and the length is 38 mm, the proportion of that area occupied by the reinforcing sheet is typically within the range of 20 to 70%.

The reinforcing sheet is adhered and fixed to the base film by means of an adhesive layer. Although the adhesive used here may be a thermoplastic adhesive as necessary, a thermosetting adhesive is typically useful. Examples of suitable thermosetting adhesives include acrylic adhesives and epoxy adhesives. Furthermore, in the present invention, fixation of the reinforcing sheet to the base film is not carried out in a single stage, but rather as will be explained in detail hereinafter, is carried out in at least two stages. Namely, after positioning the reinforcing sheet at a predetermined location on the base film, a portion of the reinforcing sheet is temporarily attached to the base film (also referred to as "temporary adhesion" in the present invention) in a first stage, after which final adhesion of the reinforcing sheet is carried out in a second stage. Namely, the printed wiring board of the present invention combines a temporarily adhered section and a final adhered section with respect to the reinforcing sheet attached to its base film.

It is advantageous to carry out the reinforcing sheet temporary mounting step by partially pressing the reinforcing sheet onto the base film using, for example, a heating pin or a heater rod to adhere it thereto. According to the present invention, this temporary mounting step in which the reinforcing sheet is partially temporarily mounted to the base film can be advantageously carried out by using a four-axis mechanical robot. In addition, the reinforcing sheet final adhesion step can be advantageously carried out using, for example, heated rollers composed of a plurality of stages.

A printed wiring board equipped with a reinforcing sheet as described above can be produced by sequentially carrying out the following steps according to the present invention:

- a step in which a long base film defined by at least one circuit area corresponding to the printing wiring board is produced;
- a step in which the wiring pattern layer is formed in each circuit area;

a step in which, together with continuously moving the base film before, during or after the wiring pattern layer is formed in each of the circuit areas, a reinforcing sheet, produced locally or at another location, is adhered through an adhesive layer to a predetermined location of the base film during its movement; and,

a step in which the laminate of the base film and reinforcing sheet is cut and separated into individual printed wiring boards each having the wiring pattern layer and the reinforcing sheet. In addition, in the case of the process of the present invention, the step in which the reinforcing sheet is adhered to the base film is carried out in two stages consisting of a reinforcing sheet temporary mounting step and its subsequent reinforcing sheet final adhesion step. Furthermore, in this production process of a flexible printed wiring board, the constitution and so forth of the printed wiring board is as previously described, and a detailed explanation is not provided below.

This process of the present invention can be advantageously carried out in various modes. Fig. 2 is a flow chart showing a production process of a printed wiring board equipped with a reinforcing sheet according to the present invention in the order of that process.

According to the process of the present invention, a printed wiring board is first produced. The printed wiring board can be produced by a step in which a long base film defined by at least one circuit area corresponding to a printed wiring board is produced, and a step in which a wiring pattern layer is formed corresponding to each circuit area. In particular, the base film preferably has a plurality of circuit areas. In addition, although normally the same circuit pattern layer is preferably formed in each circuit area in consideration of processing ease and so forth, different circuit patterns may also be formed as necessary. In addition, the long base film is preferably produced in advance and stored by winding onto a reel and so forth, and then used by unwinding from the reel as necessary. Moreover, in the subsequent wiring pattern formation step, after unwinding the base film from a reel and so forth, other constituents such as inner leads, outer leads and external connection pins required for the printed wiring board can be formed either simultaneous to or at a different time from the formation of wiring and so forth.

The reinforcing sheet is produced separate from production of the base film. Although the reinforcing sheet can be produced by various methods, it is preferably normally produced in the form of a long strip in which a plurality of reinforcing sheets are continuously built in so as to be able to be cut into individual reinforcing sheets as necessary, stored by winding onto a reel and so forth, and then used by unwinding as necessary. A rectangular reinforcing sheet in particular is preferably formed into the form of a long strip and used by winding onto a reel that has been slit to a width in consideration of the stamping step. In addition, reinforcing sheets that have been processed into a shape with a metal mold while in the wound state are preferably used for reinforcing sheets having a special shape. Furthermore, since the reinforcing sheet has an adhesive layer for adhering and fixing it to the base film, it is preferably protected with a release liner (backing paper) until immediately before adhesion. In addition, the presence of a release liner also makes it possible to avoid the problem of corresponding reinforcing sheets adhering to each other when wound into a reel and so forth.

Next, after cutting off individual reinforcing sheets from a strip of reinforcing sheets and peeling off the release liner, the reinforcing sheet is adhered to the predetermined position on the base film. Furthermore, the reinforcing sheet may be adhered to the base film before forming a wiring pattern layer at each circuit area of the base film, during formation of the wiring pattern layer, or after formation of the wiring pattern layer, and in any case, a wiring pattern layer is formed at a predetermined location of the base film at the final stage.

The base film is normally continuously unwound from a reel and so forth, and after being moved to the reinforcing sheet temporary mounting site, a reinforcing sheet produced either locally or a different location is adhered by means of an adhesive layer to the predetermined position of the base film. Furthermore, the reinforcing sheet adhesion step carried out here is the reinforcing sheet temporary mounting step referred to in the present invention, wherein the reinforcing sheet is temporarily mounted by partially adhering to the base film. In addition, in the process of the present invention, the reinforcing sheet is continuously guided by matching the movement speed of the base film, and is preferably temporarily mounted to the base film by means of an adhesive layer at the junction with the base film. Moreover, the reinforcing sheet is preferably temporarily mounted on the base film by at least partially heating with the end of a heating

pin or heater rod to allow that heat to act on the adhesive layer. Furthermore, a flat plate-like heater or other means may be used instead of that having a pointed tip in the manner of a heater rod and so forth as necessary for the heating means of the temporary mounting step. In addition, this temporary mounting step can be advantageously carried out by
5 using a four-axis mechanical robot. A four-axis mechanical robot used in the present invention is preferably able to simultaneously demonstrate: a function that transports reinforcing sheets equipped with an adhesive layer cut to a desired size in four axial directions, a function that guides the reinforcing sheets over flexible printed wiring boards, a function that positions a reinforcing sheet on a printed wiring board and laminates it
10 thereto by means of an adhesive layer, a function that applies pressure to the reinforcing sheet to press it onto the printed wiring board, and a temporary mounting function that adheres a portion of the reinforcing sheet to the printed wiring board by using a heating means provided. Namely, the width and edge location of the reinforcing sheet are preferably measured with an image measuring system, the location of the printed wiring
15 board is also measured, and this positional information is sent to a four-axis mechanical robot and used to control its position. Thus, the four-axis mechanical robot picks up a cut reinforcing sheet, holds into it, moves it and then pressed it onto a predetermined location of a printed wiring board. At the same time, the heating means provided is pressed onto the reinforcing sheet to partially mount (temporarily mount) it to the printed wiring board.
20 Furthermore, this type of four-axis mechanical robot can be acquired in the form of the "PCX40" (trade name) from Yamaha Motor Co., Ltd.

Following completion of the reinforcing sheet temporary mounting step, final adhesion of the reinforcing sheet is carried out. Although the reinforcing sheet final adhesion step can be carried out by various methods, the reinforcing sheet is preferably
25 completely adhered and fixed to the base film by heating the entire temporarily mounted reinforcing sheet to soften the adhesive. Furthermore, since the reinforcing sheet is temporarily fastened to the base film by temporary mounting, the problem of the reinforcing sheet separating from the base film during the time it is guided to the final adhesion step does not occur. In the final adhesion step, the base film equipped with the
30 reinforcing sheet is preferably guided to at least one pair of heated rollers where it is heated and pressed together. The final adhesion step is particularly preferably carried out sequentially by using heated rollers composed of, for example, 2 or more stages.

Furthermore, the temperature and pressure of each heated roller can be set and controlled independently. The rotating speeds (base film transport speeds) of the heated rollers are the same. The temperature, pressure and rotating speed of the heated rollers can be suitably determined according to the thickness of the reinforcing sheet and physical properties and type of adhesive layer applied to the reinforcing sheet.

In the case of carrying out the final adhesion step by combining a plurality of stages of heated rollers, air present between the laminated portion of the film base and reinforcing sheet is removed by the first stage heated roller (air removal). Air removal is not only able to prevent visual defects, but also is able to prevent variations in thickness and peeling of the reinforcing sheet caused by the presence of air that can impair device automated mounting steps and so forth. Thus, the temperature and pressure of the heated rollers are set in consideration of this objective. Next, full-scale heating and pressing for final adhesion are carried out with the second stage and subsequent heated rollers. Thus, the temperature and pressure of each heated roller are set in consideration of this objective.

A printed wiring board equipped with a reinforcing sheet (laminate) is obtained by going through the aforementioned series of steps that is composed of a long base film and a reinforcing sheet fixed at a predetermined site of each circuit area of the base film. This laminate can be advantageously stored while wound onto a reel and so forth prior to mounting various types of devices, can be transported as necessary, or can be supplied to a customer and so forth. In addition, in the case of winding the laminate onto a reel, it is normally advantageous to wind onto the reel together with an interleaf (insert film) using a winding mechanism. Printed wiring boards having a respective wiring pattern layer and reinforcing sheet can be obtained by separating into individual printed wiring boards. According to this process, since a large number of printed wiring boards can be built into a single base film, a large number of printed wiring boards can be mass produced and separated.

Detailed Description of Process

The following provides a more detailed explanation of a production process of a printed wiring board equipped with a reinforcing sheet according to the present invention. Fig. 3 is a schematic cross-sectional view showing a reinforcing sheet preparation step that is included in the production process of a printed wiring board equipped with a reinforcing

sheet according to the present invention. As shown in the drawing, reinforcing sheet 3 has an adhesive layer 4 on the side that adheres to the printed wiring board, and in order to prevent adhesion while in the wound state, the surface of adhesive layer 4 is covered with a release liner 5. This long reinforcing sheet 3 is unwound from reel 31 by passing
5 through a pair of guide rollers 32 in order to use in a step in which it is adhered. Next, after exposing adhesive layer 4 by peeling off release liner 5 with a reel 33, reinforcing sheet 3 is cut to a required size by a cutter 34 arranged after reel 33. Cut reinforcing sheet 3 is then guided beneath a four-axis mechanical robot 35, and is guided to a subsequent reinforcing sheet temporary mounting step while in the state of being suctioned to the
10 lower section of the robot. Here, four-axis mechanical robot 35 is designed to move in the directions of four axes, and is equipped with heater rods 36 for use in temporarily mounting reinforcing sheet 3. Furthermore, in the example shown in the drawing, although long reinforcing sheet 3 is processed into individual reinforcing sheets 3 by unwinding from reel 31, reinforcing sheets 3 already processed into individual sheets may
15 be prepared at a different location and then used to carry out the present invention as necessary.

Fig. 4 is a schematic cross-sectional view showing a reinforcing sheet temporary mounting step included in the production process of a printed wiring board equipped with a reinforcing sheet according to the present invention. Although not shown in the
20 drawing, a base film 1 has a wiring pattern layer already built into its circuit area, and can therefore be said to be a precursor of a printed wiring board of the present invention. As shown in the drawing, base film 1 is supplied in the state of a long strip wound onto a reel 11. This long base film 1 is guided to a reinforcing sheet temporary mounting station 15 after being unwound from reel 11 in order to attach reinforcing sheet 3 to a back surface
25 thereof. Here, since the guiding speed of base film 1 is synchronized with the guiding speed of reinforcing sheet 3 produced in the reinforcing sheet preparation step previously explained with reference to Fig. 3, and guided to reinforcing sheet temporary mounting station 15, attachment of reinforcing sheet 3 to base film 1 can be carried out accurately and continuously. Simultaneous to reaching the predetermined site of base film 1 on
30 reinforcing sheet temporary mounting station 15, reinforcing sheet 3 produced in the reinforcing sheet preparation step also reaches reinforcing sheet temporary mounting station 15 while suctioned to four-axis mechanical robot 35, is pressed onto base film 1 by

lowering robot 35, and is partially temporarily mounted on base film 1 by heater rods (not shown) provided on robot 35. Since adhesive layer 4 is spot-heated by the ends of the heater rods, reinforcing sheet 3 is temporarily adhered to base film 1 and can be held stably. Base film 1 supporting reinforcing sheet 3 is guided to a subsequent reinforcing sheet final adhesion step while maintained in that state. Furthermore, although not shown in the drawing, base film 1 may be guided to an auxiliary roller (differential level roller) and removed of wrinkles prior to moving to the subsequent reinforcing sheet final adhesion step.

Fig. 5 is a schematic cross-sectional view showing a reinforcing sheet final adhesion step included in the production process of a printed wiring board equipped with a reinforcing sheet according to the present invention. After temporarily mounting reinforcing sheet 3 thereon, base film 1 is guided to reinforcing sheet final adhesion stations. The reinforcing sheet final adhesion station used here is composed of a first heated roller 21 and a second heated roller 22, each consisting of a pair of heated rollers. Although each heated roller can be equipped with an arbitrary heating means, it is typically advantageous to adopt a form in which a heater is contained within the roller. Base film 1 is guided first heated roller 21 in the state in which reinforcing sheet 3 is temporarily mounted thereon where it is preliminarily heated and removed of air. The heating temperature of first heated roller 21 is normally about 110 to 160°C, and the pressure when pressure is applied is normally about 3 to 7 kg. In addition, when base film 1 is guided to first heated roller 21, it is preferably stretched in a state in which suitable tension is applied, and may be preheated as necessary by an arbitrary heater in order to correct any heating delays prior to being guided to first heated roller 21. After passing first heated roller 21, base film 1 is guided to second heated roller 22 where it is fully heated causing reinforcing sheet 3 to be completely adhered and fixed to base film 1. The heating temperature of second heated roller 22 is normally about 120 to 180°C, and the pressure when pressure is applied is normally about 5 to 10 kg. After completing stepwise heating in this manner, the resulting printed wiring board 10 with reinforcing sheet is wound onto a product winding roller 25. Normally, the winding speed in this case is preferably synchronized to the laminating speed of reinforcing sheet 3 to base film 1.

However, in the case of pressing by heated rollers at the aforementioned reinforcing sheet final adhesion station, it is preferable to control the downward pressure

of the heated rollers in the process of the present invention. Fig. 6 is schematic cross-sectional view showing the mechanism of a heated roller downward pressure control mechanism in the reinforcing sheet final adhesion step shown in Fig. 5. As shown in the drawing, when printed wiring board 10 passes between a pair of heated rollers 22a and 22b, together with the product location being measured with a measuring instrument 23, pressure is applied from above (downward pressure) as indicated with arrows P so as to be able to control snaking of printed wiring board 10 to within $\pm 10\%$ of a reference pressure. Furthermore, the pressure when pressure is applied is, for example, 6 kg $\pm$ 600 g.

A heated roller downward pressure control mechanism as shown in the drawing is effective in eliminating problems relating to surface irregularities stemming from the reinforcing sheet being attached to the printed wiring board. This is because the presence of surface irregularities in the printed wiring board can result in the risk of the occurrence of wrinkles and snaking. The use of this mechanism makes it possible to control the lateral balance of downward pressure of the heated rollers by accurately measuring the location of the printed wiring board when pressing with the heated rollers while controlling tension. In addition, since the heated rollers have a cylindrical shape, a constant pressure can be applied at all times without having to worry about the size in the lengthwise direction of the circuit area within the printed wiring board.

Examples

Next, the present invention is described with reference to examples thereof. Furthermore, in the examples, a flexible printed wiring board like that shown in Fig. 1 is produced by unwinding and laminating a reinforcing sheet and base film from a reel as shown in Figs. 3 and 4, respectively, temporarily mounting the reinforcing sheet on the base film, and then carrying out final adhesion as shown in Fig. 5. The following provides an explanation of each step.

1. Product Management

Printed wiring board products differ in product length and width according to the particular type. The product of the present example (before attaching the reinforcing sheet) has 8 sprocket holes, measures 38 mm in length and measures 70 mm in width. Although only two products are shown in Fig. 1 for the sake of simplicity, in actuality, a

large number of products are built continuously into a long tape containing one product each in the direction of width. Thus, tape-like products are normally wound into a reel and can be controlled based on the length of one product and the number of products within the product width.

5 2. Product Transport

Products wound into the reel are unwound and transported to the reinforcing sheet temporary mounting station. Transport of products is carried out in units of product length. The unit of product length is normally set based on the number of sprocket holes, and that set value is input in advance into an operating panel.

10 3. Reinforcing Sheet Delivery Quantity

The reinforcing sheet is also supplied wound onto a reel, is delivered from the reel at the time of use and cut to the required size. The reinforcing sheet is delivered in the amount of a preset length. Delivery is carried out in coordination with product transport.

15 4. Adhesion of Reinforcing Sheet to Products

In order to adhere the reinforcing sheet to the products, design information regarding the adhered location is instructed in advance for each product. This design information is corrected based on CAD information (information on design dimensions), and instructions corrected with actual products (finalized design information) are
20 registered in a four-axis mechanical robot.

Moreover, the width and edge location of the reinforcing sheet are measured with an image measuring system. The location of the product is also measured, and product location is recognized with high precision using a positional control function of the four-axis mechanical robot. Thus, the reinforcing sheet is accurately pressed onto a
25 predetermined location of a product.

5. Reinforcing Sheet Temporary Mounting

Simultaneous to being pressed onto a product, a portion of the reinforcing sheet is heated while pressure is applied for several seconds as a result of contacting a heating pin provided on the four-axis mechanical robot in the reinforcing sheet temporary mounting

station. The temperature and contact time of the heating pin are determined according to the thickness of the reinforcing sheet and the characteristics of the reinforcing sheet adhesive layer. For example, in the case the thickness of the reinforcing sheet is 200 μm and the setting temperature of the adhesive is 140°C, the reinforcing sheet can be temporarily mounted to each product in the short time of a pressurization time of 3 seconds at a heating pin temperature of 300°C, or in the short time of a pressurization time of 2 to 4 seconds at a heating pin temperature of 400°C.

Furthermore, although temporary mounting of the reinforcing sheet is carried out by pressing a heating pin onto the reinforcing sheet in the present example, temporary mounting of the reinforcing sheet may also be carried out by pressing the heating pin onto a product as necessary. In addition, although a long tape in which only one product is built into the tape in the direction of width in the present example, in the case of having two products in the direction of width, temporary mounting of the reinforcing sheet should be carried out repeatedly for each product.

6. Reinforcing Sheet Final Adhesion

Products that have been temporarily mounted with the reinforcing sheet are transported to the subsequent reinforcing sheet final adhesion station. Since the reinforcing sheet is partially attached to the products, the products are transported to heated rollers without the reinforcing sheet falling off.

The reinforcing sheet final adhesion station is composed of two stages of heated rollers. The temperature and pressure of each heated roller are set independently and can be controlled independently. Although the sizes (diameters) of the heated rollers may be the same or different, their rotating speeds are the same. The temperature, pressure and rotating speed of each heated roller is determined according to the thickness of the reinforcing sheet and physical properties and type of adhesive layer on the reinforcing sheet.

When a product to which the reinforcing sheet is temporarily mounted passes through the first stage of heated rollers, not only can air trapped between the product and reinforcing sheet in the previous step be removed, but since a predetermined temperature and pressure are applied from the heated rollers, the adhesive strength of the reinforcing plate relative to the product can be increased. Next, when the product is passed through

the second stage of heated rollers, since a higher temperature and pressure are applied than applied by the first stage of heated rollers, the adhesive strength of the reinforcing sheet relative to the product is further increased, thereby making it possible to complete final adhesion. Furthermore, as an example of the temperature, pressure and rotating speed of the heated rollers, when the thickness of the reinforcing sheet is 200 μm , the setting temperature of the adhesive is 140°C, and the thickness of the adhesive layer is 40 μm , then the first stage of heated rollers are set to a temperature of 140 to 150°C, pressure of 5 to 6 kg, and rotating speed of 0.75 m/min, while the second stage of heated rollers is set to a temperature of 160 to 170°C, pressure of 6 to 7 kg, and rotating speed of 0.75 m/min.

However, in the case of the present example, a differential level roller for controlling tension is provided between the reinforcing sheet temporary mounting station and reinforcing sheet final adhesion station. Although product tension fluctuates according to the width of the products, it is normally control to within a range of about 200 g to 1 kg.

In addition, since the products are equipped with a reinforcing sheet, their surface have topographic features such as projections and recesses due to presence of the reinforcing sheet, and since the heated rollers have a slight difference in expansion in the direction of width (direction perpendicular to the direction in which the products are transported) due to heat, snaking can occur in the products during transport caused by this combination. In the case of the present example, however, this is controlled using a mechanism like that described as follows. Namely, by measuring the pressure of cylinders arranged to the left and right of the heated rollers, if the product shifts to the right, the pressure of the cylinder on the right side is reduced or the pressure of the cylinder on the left side is increased. Conversely, if the product shifts to the left, the pressure of the cylinder on the left side is reduced or the pressure of the cylinder on the right side is increased. In this manner, product snaking can be prevented, and the range over which pressure is controlled at that time is within $\pm 10\%$ of a set pressure.

7. Winding of Finished Products

Finished products (products equipped with a reinforcing sheet) that have passed through the final heated roller are wound into a reel together with an interleaf (insert film) that is contacted with the reinforcing sheet side of the finished products. The winding

speed of the reel is synchronized with the product transport speed in the reinforcing sheet final adhesion station.

8. Monitoring System

In the present example, a monitoring system is installed separately to visually monitor products that have come out of the reinforcing sheet temporary mounting station and reinforcing sheet final adhesion station with CCD cameras. Processing of the captured images makes it possible to measure positional shifts in the reinforcing sheet or the presence or absence of reinforcing sheet, and a warning lamp can be made to light or operation of the apparatus can be interrupted as necessary.

10

CLAIMS:

1. A process of producing a flexible printed wiring board, comprising at least a base film and a wiring pattern layer built into a circuit area on its surface, and provided with a reinforcing sheet at a site other than the site of the wiring pattern of the circuit area; comprising:
 - a step in which a long base film defined by at least one circuit area corresponding to the printing wiring board is produced;
 - a step in which the wiring pattern layer is formed in each circuit area;
 - a step in which, together with continuously moving the base film before, during or after the wiring pattern layer is formed in each of the circuit areas, a reinforcing sheet, produced locally or at another location, is adhered through an adhesive layer to a predetermined location of the base film during its movement; and,
 - a step in which the laminate of the base film and reinforcing sheet is cut and separated into individual printed wiring boards each having the wiring pattern layer and the reinforcing sheet; wherein, the reinforcing sheet adhesion step is carried out in two stages consisting of a reinforcing sheet temporary mounting step and its subsequent reinforcing sheet final adhesion step.
2. The production process according to claim 1 wherein the reinforcing sheet is continuously guided according to the movement speed of the base film, and adhered to the base film by means of an adhesive at the junction with the base film.
3. The production process according to claim 1 wherein the reinforcing sheet has an adhesive layer on the side that adheres to the base film.
4. The production process according to any one of claims 1 to 3 wherein, in the reinforcing sheet temporary mounting step, the reinforcing sheet is temporarily adhered to the base film by at least partially heating.
5. The production process according to any one of claims 1 to 4 wherein, in the

reinforcing sheet final adhesion step, the reinforcing sheet is completely adhered and fixed to the base film by heating the entire reinforcing sheet following temporarily mounting and hardening the adhesive.

- 5 6. The production process according to claim 5 wherein, in the final adhesion step, the base film with the reinforcing sheet is guided between at least a pair of heated rollers.
- 10 7. The production process according to any one of claims 1 to 6 that additionally comprises a step in which a base film, which may or may not have a wiring pattern layer, is used in the state of being wound on a reel, and is unwound from the reel while being guided to the subsequent step.
8. The production process according to any one of claims 1 to 7 that additionally comprises a step in which the reinforcing sheet is used in the state of being wound on a reel, is unwound from the reel and cut to a predetermined size prior to being guided to the reinforcing sheet adhesion step.
- 15 9. The printed wiring board production process according to any one of claims 1 to 8 that additionally comprises a step in which a laminate of the base film and reinforcing sheet are wound onto a reel prior to the printed wiring board separation step.