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- (71) **Applicant:** DOU YEE ENTERPRISES (S) PTE LTD  
[SG/SG]; 2304 Bedok Reservoir Road, Bedok Industrial  
Park C, Singapore 479223 (SG).
- (72) **Inventors:** YUEN, Cheok Pui; 2304 Bedok Reservoir  
Road, Bedok Industrial Park C, Singapore 479223 (SG).  
TAN, Shu Fang; 2304 Bedok Reservoir Road, Bedok In-  
dustrial Park C, Singapore 479223 (SG).
- (74) **Agent:** NG, Kim Tean; Nanyang Law LLC, P.O. Box  
1861, Robinson Road Post Office, Singapore 903711 (SG).
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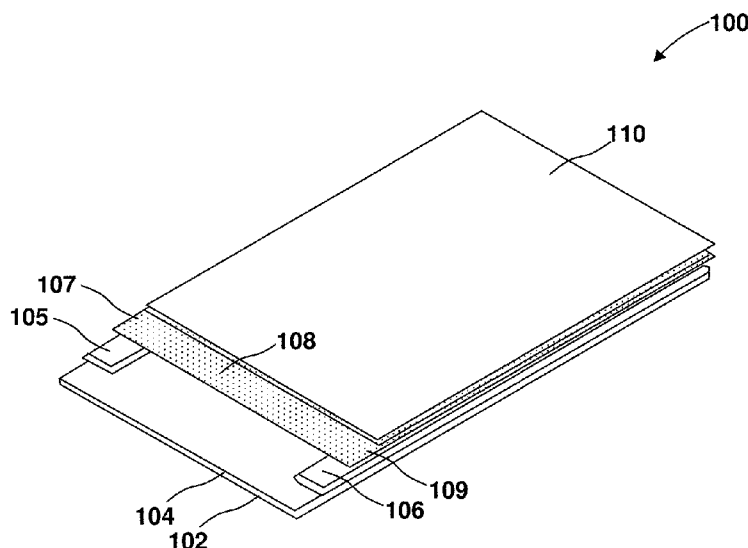


FIG. 1

(57) **Abstract:** The present invention relates to a heating tape comprises a polymer film with an adhesive backing, a continuous parallel stripe of conductive paste printed along the polymer film, a conductive carbon ink printed across the surface bridging the electrodes and an insulating polymer overcoat printed over the conductive carbon ink. At least two electrodes are formed on the polymer film. The heating tape is cut to desired length and the tape with the adhesive backing is installed on the surface of the object to be heated. A power supply unit is connected to the heating tape and a temperature controller installed on the tape comprises at least one sensor to sense temperature of the tape. The sensor turns on/off the power supply unit when the sensed temperature is below/above the preset value, to maintain the desired temperature throughout the tape.

## SELF ADHESIVE HEATING TAPE AND MANUFACTURING PROCESS THEREOF

### TECHNICAL FIELD

5   **[0001]**     The present invention relates to a self-adhesive heating tape suitable for low temperature applications and, in particular, to the fabrication of heating tape using a combination of materials of different electrical resistances through a screen printing process, to produce a light, flexible, paper thin heating tape with self-adhesive backing.

### 10   **BACKGROUND**

**[0002]**     Resistance electric heating tapes are well known and generally take the form of a relatively fine wire resistance element which is disposed in a tape, either in a zigzag fashion, side to side, or longitudinally. When the resistance element is supplied with  
15   electrical energy, the electrical energy is converted into heat energy as a consequence of the electrical resistance of the heating tape. This heat is transmitted to a surface to which the heating tape is attached.

**[0003]**     US 7862375 discloses a roll-up heating for a floor, or wall, comprising an  
20   insulating layer, a heating element and a cladding. The insulating layer is intended for lying on a floor and the heating element extends between the cladding and the insulating layer. The cladding is intended to support a floor covering and comprises a force distribution layer for transmitting a force which is exerted on the cladding in a distributed manner to the insulating layer. The wooden floor is fixedly connected to the  
25   cladding by means of an adhesive layer. In so far as a part of the heating element is at the location or in the vicinity of the exerted force, the load which will be exerted on it will be lower than the original load, due to the force being transmitted in a distributed manner. This lowers the risk of the heating element being damaged. Advantageously, the heating element comprises an elongated heating element, such as an electrical  
30   resistance cable. An electrical connector or socket is also disclosed. The socket comprises a plurality of electrically conductive connecting pieces, including zero

connecting strip, phase connecting strip and earth connecting strip. Incidentally, zero and phase may also be reversed and the socket is also suitable for direct current voltage. The roll-up heating for a floor or wall can be rolled up due to the flexibility of the materials used, including the incorporated electrical connector. This makes it easy to produce, transport and subsequently lay the heating for a floor, or wall. The roll-up heater is designed specifically for floor and wall heater and makes use of resistive cables. Heating effects will be terminated if the resistive cable/wire is broken.

**[0004]** US 2719907 provides a heating tape and a method of making the same, and more particularly to a heating tape which comprises a heating unit adapted to be connected to an electrical current in order to be heated by the resistance which the unit offers to the current passing through. The heating tape is made in a continuous strip and after its manufacture could be cut into the length desired for any practical use, as the tape is in the form of a flat elongated strip so that it may be wrapped about an object to be heated. The tape includes a central core which comprises the heating element itself and the support or backing upon which this heating element is mounted in order to insulate the loops of the element from each other. In addition to this central core, a tape may include a layer or strip of insulating material such as glass fiber upon each side of the central core, the central core being sandwiched between these two layers. Also, the tape is provided with outside covering strips which may be made of synthetic rubber. The heating tape consists of a rubber supporting strip upon which is supported or in which is embedded a resistance element. The heater is designed for heating by resistive cables/wires. The heating performance will be lost if the cables are broken.

**[0005]** US 20110073586 discloses a defrost heater using a surface heat emission element of a metal thin film having a fast temperature response performance and a low thermal density. The defrost heater includes a strip type surface heat emission element made of a strip-type metal thin plate, an insulation layer that coats the outer circumference of the strip type surface heat emission element, and a heat transfer board. One side surface of the heat transfer board includes the surface heat emission element. The outer circumferential surface of the heat transfer board supports the

insulation layer, and that contacts evaporator fins so that heat generated from the surface heat emission element is transferred to an evaporator. There is a bimetal thermostat or a temperature sensor to sense when ambient temperature drops to a predetermined temperature. The shape and size of the defrost heater is fixed by the design, with no versatility offered to the users. Further, the defrost heater makes use of an evaporator to produce defrosting rather than directly by heat conduction. The application of the heater is only for defrosting subjects and involves complex manufacturing processes.

**[0006]** EP 0123476 A2 discloses a heat tracing tape which can be cut to required lengths. The heat tracing tape has a heating element including at least two lengths of woven or braided resistance wire each in the form of a flat strip. The strips are encased in extruded silicone rubber whereby they are spaced from one another. The strips are electrically connected at one end by a connector and the tape is provided with a power supply termination either at its other end, or at a T-branch connection, for connecting the tape to a power control system. The power control system is adjustable to set an estimated value of power required to maintain a predetermined process temperature. The system automatically adjusts the power supplied to the tape to the estimated value by means of a feedback control system. A process temperature sensor also regulates the power supplied to the tape in accordance with a sensed temperature. The drawback of such heat tracing tape is that the heating effects will be terminated if the resistive cable/wire is broken.

**[0007]** CN 102264163 discloses an electric film, wherein the electric film includes nano-film, conductive copper, conductive silver tape, carbon ink layer and a polyester film heat generator. The carbon ink is printed on a polyester film layer of the heat generator. This electric film was designed for room and floor heating with high voltage inputs, probably directly from wall sockets. Further, the electric film is not versatile and not ideal for easy installation.

**[0008]** The common commercial heating tapes are usually available in fixed pre-

determined sizes, and do not provide an easy-to-install solution, for example, by providing an adhesive backing to adhere to the surface to be heated. The heating tapes that are available in roll forms are usually silicone rubber based which can be thick and unsuitable to wind around delicate surfaces. Most of the prior art heating tapes are operated with high alternating current voltages which may pose a danger to users, and emits electromagnetic radiation (EMI) which may interfere with sensitive devices in the near proximity.

**[0009]** A need, therefore, exists for improved a light, flexible, paper thin heating tape with self-adhesive backing suitable for low temperature applications that overcomes the above drawbacks.

## SUMMARY OF THE INVENTION

**[0010]** The following summary is provided to facilitate an understanding of some of the innovative features unique to the disclosed embodiment and is not intended to be a full description. A full appreciation of the various aspects of the embodiments disclosed herein can be gained by taking into consideration the entire specification, claims, drawings, and abstract as a whole.

**[0011]** It is, therefore, one aspect of the disclosed embodiments to provide for a heating tape that is lightweight, flexible, operated under lower direct-current voltages and with adhesive backing to facilitate easy installations.

**[0012]** It is, therefore, another aspect of the disclosed embodiments to provide a heating tape that can be used for all low temperature (e.g., less than 100°C), as the tape is not affected by the external elements, for example rain, ultraviolet (UV) rays from the sun and snow. The tape can be used for all low temperature application including but not limited to laboratory heating, domestic comfort heating, public comfort heating, deicing functions, healthcare, etc.

**[0013]** It is, therefore, yet another aspect of the disclosed embodiments to provide a heating tape having a polymer film with an adhesive backing, a continuous parallel stripe of conductive paste printed along the polymer film, a conductive carbon ink printed across the surface bridging the electrodes, and an insulating polymer overcoat printed over the conductive carbon ink. At least two electrodes are formed on the polymer film. The adhesive backing is placed onto the surface of the object to be heated.

**[0014]** It is, therefore, yet another aspect of the disclosed embodiments to provide for the heating tape wherein the electrodes are supplied with low direct-current voltages.

**[0015]** It is, therefore, one another aspect of the disclosed embodiments to provide for the heating tape that uses resistive heating to convert the electrical energy into heat energy. The current will first flow along the electrodes and subsequently across the conductive carbon ink, whereby the electrical energy is transformed into heat energy.

**[0016]** It is, therefore, another aspect of the disclosed embodiments to provide for the heating tape wherein the conductive carbon ink creates a closed path for the current to flow from the terminal points throughout the surface.

**[0017]** It is, therefore, another aspect of the disclosed embodiments to provide for the heating tape wherein the insulating polymer overcoat protects the tape against moisture, handling and electrical leakages.

**[0018]** It is, therefore, another aspect of the disclosed embodiments to provide for the heating tape wherein the temperature distribution is consistent along the entire length of the tape.

**[0019]** It is, therefore, yet another aspect of the disclosed embodiments to provide for the heating tape of thickness ranging from 120  $\mu\text{m}$  to 300  $\mu\text{m}$  and hence lightweight

and flexible.

**[0020]** It is, therefore, yet another aspect of the disclosed embodiments to provide for the heating system comprising a heating tape roll, a power supply unit and a temperature controller. The heating tape roll comprises at least one heating tape. The heating tape comprises a polymer film with an adhesive backing, a continuous parallel stripe of conductive paste printed along the polymer film, a conductive carbon ink printed across the surface bridging the electrodes and an insulating polymer overcoat printed over the conductive carbon ink. At least two electrodes are formed on the polymer film. The adhesive backing is installed onto the surface of the object to be heated. The power supply unit is connected to the heating tape and the temperature controller comprising at least one sensor are installed to sense temperature of the tape and to turn the power supply unit on or off when the sensed temperature is below or above the preset value.

**[0021]** It is, therefore, yet another aspect of the disclosed embodiments to provide for the heating system wherein the sensor is a contact-type temperature sensor.

**[0022]** It is, therefore, yet another aspect of the disclosed embodiments to provide for the heating system wherein the preset value is based on the voltage from the power supply unit.

**[0023]** It is, therefore, yet another aspect of the disclosed embodiments to provide for a method of fabricating the heating tape, including the steps of: installing a polymer film with an adhesive backing onto a continuous screen printing machine, printing a continuous parallel stripe of conductive paste along the polymer film, forming at least two electrodes on the polymer film, printing a conductive carbon ink across the surface bridging the electrodes, and printing an insulating polymer overcoat over the conductive carbon ink.

**[0024]** It is, therefore, yet another aspect of the disclosed embodiments to provide for a method of using a heating tape roll, including the steps of: cutting a portion of heating tape from the heating tape roll into a desired length, installing the heating tape by adhering the adhesive backing of the heating tape to the surface of an object to be heated, connecting a power supply unit to the heating tape, and installing a temperature controller on the heating tape. The temperature controller comprises at least one sensor to sense the temperature of the heating tape and to turn on/off the power supply unit when the sensed temperature is below/above the preset value. The preset value is based on the voltage from the power supply unit.

**[0025]** Other aspects and advantages of the invention will become apparent from the following detail description which, when taken in conjunction with the accompanying drawings, illustrate by way of example the principles of the invention.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0026]** The summary above, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, exemplary constructions of the disclosure are shown in the drawings. However, the disclosure is not limited to specific methods and instrumentalities disclosed herein. Moreover, those in the art will understand that the drawings are not to scale. Wherever possible, like elements have been indicated by identical numbers.

**[0027]** **FIG. 1** shows a perspective view of a heating tape showing its various elements, in accordance with the present invention;

**[0028]** **FIG. 2** shows a side view of the heating tape of **FIG. 1** showing the various elements in detail;

**[0029]** **FIG. 3A** shows a top view of the heating tape of **FIG. 2**;

[0030] FIG. 3B shows detailed view of a portion of heating tape depicted in FIG. 3A;

5 [0031] FIG. 4 shows a perspective view of a manufacturing process of the heating tape of FIG. 1, in accordance with the present invention;

[0032] FIG. 5 shows a heating system showing various components, in accordance with the present invention;

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[0033] FIG. 6 shows a flow chart pertaining to a process of fabricating the heating tape roll of FIG. 4, in accordance with an aspect of the present invention; and

[0034] FIG. 7 shows a flow chart pertaining to a process of installation and working  
15 of heating system of FIG. 5.

## DETAILED DESCRIPTION OF THE INVENTION

[0035] The particular values and configurations discussed in these non-limiting  
20 examples can be varied and are cited merely to illustrate at least one embodiment and are not intended to limit the scope thereof.

[0036] The heating tape of the present invention is lightweight, flexible, operates under lower direct-current voltages, and provides an adhesive backing to facilitate easy  
25 installations. The tape can be used for low temperatures (e.g., less than 100°C) as the tape is not affected by the external elements, for example rain, ultraviolet (UV) rays from the sun, snow, etc. The tape can be used for all low temperature application including but not limited to laboratory heating, domestic comfort heating, public comfort heating, deicing functions, healthcare, etc.

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**[0037]** FIG. 1 shows a perspective view of a heating tape **100**, in accordance with the present invention. The heating tape **100** comprises a layer of a flexible heat resistant polymer film **104**, an adhesive backing **102** disposed on a lower surface of the polymer film **104**, at least two substantially parallel stripes of conductive paste **105** and **106** disposed on an upper surface of the polymer film **104**, a layer of conductive carbon ink **108** disposed over the conductive paste **105** and **106**, and an insulating polymer overcoat **110** disposed over the layer of conductive carbon ink **108**. It can be seen that, as the layer of conductive ink **108** is disposed over the conductive paste **105** and the conductive paste **106**, a first edge **107** of the carbon ink **108** electrically connects with the conductive paste **105** and a second edge **109** of the carbon ink **108** electrically connects with the conductive paste **106**. The region of the conductive carbon ink **108** between the first edge **107** and the second edge **109** is disposed on the polymer film **104**.

**[0038]** The heating tape **100** can be manufactured and wound into a roll using a manufacturing process. The manufacturing process can be for example, screen printing process, die coating, rotary screen printing, gravure printing, etc, without limitation. The length of the heating tape **100** has the continuous parallel stripes of conductive paste **105** and **106** printed along the outer edges of the length of flexible polymer film **104**. The two parallel stripes of conductive paste **105** and **106** function as electrical conductors, or electrodes. The conductive carbon ink **108** is printed across the upper surface of the polymer film **104** in a linear array of separate, similarly-sized sections, bridging the conductive paste **105** and **106** electrodes at approximately equally-spaced intervals. The conductive carbon ink **108** forms a closed electrical path for the current to flow from stripes of a conductive paste **105** and **106** throughout the conductive surface of the heating tape **100**. Then, the insulating polymer overcoat **110** is printed over the conductive carbon ink **108** and serves as protection against moisture, handling, and electrical leakages.

**[0039]** In an exemplary embodiment, the heating tape **100** is produced in meter lengths, for example two meter rolls. The temperature distribution is generally uniform

along the entire length of the heating tape **100** because of the plurality of parallel conductive paths provided by the sections of conductive carbon ink **108** from one stripe of conductive paste **105** and **106** to the other stripe of conductive paste **105** and **106**. The adhesive backing **102** on the underside of the flexible polymer film **104** facilitates  
5 easy installation onto various types of surfaces without additional material or tools. The choice of materials and manufacturing process, with an overall thickness of only 250  $\mu\text{m}$  ensures that the heating tape **100** is flexible for most application, including wrapping around water pipes for heating purposes.

10 **[0040]** In another explanatory embodiment, the heating tape when applied to stainless steel metal, the adhesive backing is not affected by water, mild acidic and mild alkaline condition for about 48 hours. The heating tape can adhere to the surface of materials such as stainless steel, polycarbonate, polypropylene, glass, high density polyethylene, low density polyethylene, etc, without limitation. In case, if the adhesive  
15 backing of the heating tape is applied to anyone of the surface of the above mentioned material that is operated at 40 °C for about 10 days, the adhesive backing is not affected by the exposure. In case, if the heating tape is applied to anyone of the surface of above mentioned material that is operated at 149 °C for about 24 hours, little shrinkage of the adhesive backing is experienced.

20 **[0041]** **FIG. 2** shows a cross-sectional end view of the heating tape **100** of **FIG. 1** showing the various elements in detail, in accordance with the present invention. In one embodiment of the invention, each stripe of conductive paste **105** and **106** is formed along the total length of tape and may be approximately 12 mm wide. Further, the  
25 conductive carbon ink **108** is formed as a layer approximately 200 mm in length and approximately 70 mm wide. The insulating top coat, also known as insulating polymer overcoat **110** is formed throughout the total length of the heating tape **100** and is approximately 70 mm wide. The space between the stripes of conductive paste **105** and **106** is approximately 46 mm and is filled with the conductive carbon ink **108**. In an  
30 exemplary embodiment, the overall thickness of the heating tape **100** is approximately 250  $\mu\text{m}$ .

[0042] FIG. 3A shows a top view of the heating tape 100 of FIG. 2 with the insulating polymer overcoat 110 removed for clarity of illustration. FIG. 3B shows a detailed view of a portion 112 of the heating tape 100 depicted in FIG. 3A, in accordance with the present invention. As shown in FIG. 3A, the conductive carbon ink 108 is formed in substantially similarly-sized segments about 200 mm in length and about 70 mm wide. The portion 112 on the heating tape 100 is a spacing of about 2 mm between adjacent segments of the conductive carbon ink 108. From FIG. 3B, it can be seen that the portion 112 includes the conductive paste 105 and 106, which is formed in stripes throughout the total length of the heating tape 100 under a plurality of the adjacent segments of the conductive carbon ink 108.

[0043] It should be noted that for clarity of illustration, and to clearly show that the stripes of conductive paste 105 and 106 are formed along the edges of the surface of the heating tape 100, the insulating polymer overcoat 110 is not shown in FIGS. 3A-3B. It can be appreciated by one skilled in the art that the disclosed configuration of the heating tape 100 provides a plurality of electrical conductive paths along the length of the heating tape 100. Each conductive path includes electrical conduction through a segment of the conductive carbon ink 108 such that, when electrical current passes through an individual segment of the conductive carbon ink 108, the electrical current is converted to heat at the corresponding segment of the conductive carbon ink 108. As the segments of conductive carbon ink 108 are substantially uniformly distributed along the length of the heating tape 100, the result is a substantially uniform source of heat distributed along the heating tape 100.

[0044] Further the operating temperature of the heating tape 100 ranges from -15 °C to 100 °C and the adhesive thermal stability ranges from -40 °C to 149 °C. Further, the base material of the tape can be made of polyethylene terephthalate (PET), polyetherimide (PEI), polyimide (PI), polyether ether ketone, etc.

[0045] FIGS. 1-3B shows an embodiment of the heating tape having a preset dimension of each element in the heating tape, however other possible dimensions are also possible. For example, the overall thickness of the heating tape is not limited to 250  $\mu\text{m}$ , ranges from 120  $\mu\text{m}$  to 300  $\mu\text{m}$ . Further, the spacing between the conductive carbon ink segments is not limited to 2 mm, ranges from 0.1 mm to 3 mm. Similarly, width of the conductive carbon ink segment ranges from 30 mm to 120 mm and a length ranges from 10 mm to 250 mm. Also, the width of conductive paste is not limited to 12 mm, ranges from 5 mm to 50 mm.

[0046] FIG. 4 shows a perspective view of a manufacturing process of the heating tape of FIG. 1, in accordance with the present invention. As shown in FIG. 4, the polymer film 104 is installed onto a conveyor 135 of a continuous screen printing machine 120. Continuous parallel stripes of conductive paste 105 and 106 are printed along the thin polymer film 104 and then the conductive carbon ink 108 and insulating polymer overcoat 110 are printed. The conveyor 135 allows the continuous movement of the polymer film 104, hence, the various elements of the heating tape, such as the conductive paste 105 and 106, the conductive carbon ink 108, the polymer overcoat 110 can be printed over the polymer film 104 using the screens 133, to manufacture the heating tape 100 depicted in FIG. 1. It should be noted that in the printing process as shown in FIG. 4, a continuous three heating tapes 100 are manufactured.

[0047] It should be noted that the heating tapes 100 may be manufactured and placed onto the roller using a screen printing process. The roll can have any number of heating tapes 100 rolled onto the roll without limitation. The heating tape roll can be easily carried to the place of heating tape 100 installation. According to the application, the required length of the heating tape 100 can be cut from the heating tape roll and used on the surface to be heated.

[0048] The heating tape 100 is a highly effective, flexible, paper-thin and self-adhesive heating tape. The heating tape 100 may be trimmed to various lengths to suit users' needs while providing excellent adhesion on many surfaces. The heating tape

**100** works intelligently with a temperature sensor **134** in conjunction with a power supply unit **122**, both shown in **FIG. 5**.

**[0049]** **FIG. 5** shows a heating system **130** showing various components, in accordance with the present invention. The heating system **130** has the heating tape **100** depicted in **FIG. 1**, the power supply unit **122**, and a temperature controller **132**. The heating tape **100** can be trimmed to any length as required by the application. The heating tape **100** receives electrical power from the power supply unit **122**. The heating tape **100** works on the principal of resistive heating, which requires an input power applied at the pair of electrodes created from the stripes of conductive paste **105** and **106**. The current will first flow along one stripe of conductive paste **105** and **106** electrode, across any one of the plurality of adjacent segments of the conductive carbon ink **108**, and back along the other stripe of conductive paste **105** and **106** electrode, whereby the electrical energy is transformed into heat energy. Thus, a warm or hot surface temperature on the heating tape **100** is provided by the input voltage.

**[0050]** To regulate the surface temperature of the tape **100** within a certain desired range, a temperature sensor **134** installed on the heating tape **100**, continuously senses the temperature of the heating tape **100** and sends the sensed temperature information to the temperature controller **132**. Installing a contact-type temperature sensor is highly recommended, as it provides more accurate monitoring compared to the non-contact sensors, such as the infrared types. In one embodiment of the invention the temperature sensor **134** is a K-Type thermal sensor. As the surface temperature on the tape **100** is generally uniform, the temperature sensor **134** can be positioned anywhere along its length. The user can set a minimum temperature preset and a maximum temperature preset in the temperature controller **132** for achieving the required surface temperature of the tape **100**.

**[0051]** The power supply unit **122** receives power from an alternative power source **125**. By operating a switch **127**, the power supplied by the alternative power source **125** can be controlled. Another switch **128** positioned in the temperature controller **132**

controls the power supplied to the power supply unit **122** based on the sensed temperature of heating tape **100**. By closing (Turning 'ON') the switch **127**, the power supplied to the power supply unit **122** is ensured, depending on the open/close ('OFF'/'ON') state of the switch **128**. The temperature controller **132** opens the switch **128** thereby cutting the power supplied to the power supply unit **122**, when the temperature is breached, for example, when above maximum temperature preset. The temperature controller **132** closes the switch **128** thereby supplying power to the power supply unit **122**, when the temperature has dipped below the minimum temperature preset. Hence the switch **128** controlled by the temperature controller **132** depending upon the temperature sensed by the temperature sensor **134**, ensures that the temperature of the heating tape is always meeting the required values, within a pre-set range set by the user.

**[0052]** It should be noted that the temperature sensor **134** can be placed on any spot along the length of the heating tape **100**, within the heating zone. Referring to the **FIG. 3B**, the temperature sensor **134** can be placed along the length of the heating tape **100** with the width of 46 mm between the pair of electrodes. In one embodiment of the invention, the minimum temperature preset and the maximum temperature preset are determined by the temperature controller.

**[0053]** It should be noted that the tape can also be operated under low direct current (DC) voltage, hence the danger to users because of electromagnetic radiation (EMI) which may interfere with sensitive devices in the near proximity, can be avoided.

**[0054]** The various watt per length (W/m) of the heating tape and its corresponding temperature (°C) can be 15 W/m and 50 °C, 30 W/m and 70 °C, 45 W/m and 90 °C, 55 W/m and 100 °C. Watts per length (W/m) indicates the amount of power required to drive the heating tape to heat to the stated temperature.

**[0055]** **FIG. 6** shows a flow chart pertaining to a process of fabricating the heating tape roll, in accordance with an aspect of the present invention. The heating tape **100** is

manufactured as a roll using screen printing process. As at step **202**, a roll of polymer film **104** is installed onto a continuous screen printing machine. Then, continuous parallel stripes of conductive paste **105** and **106** are printed along the thin polymer film **104** and allowed to cure at elevated temperatures, as at step **204**. The electrodes are  
5 created on the polymer film **104** at this stage, as at step **206**.

**[0056]** Next, as at step **208**, the conductive carbon ink **108** is printed across the surface bridging the electrodes. This creates a closed system for current to flow from the terminal points throughout the product's surface. The conductive carbon ink **108** is  
10 dried by heating. The insulating polymer overcoat **110** is finally printed over the conductive carbon ink **108** to serve as protection against moisture, handling and electrical leakages, as at step **210**. Thus, the heating tape roll is a combination of materials of different electrical resistances obtained through a screen printing process, to produce a light flexible heating tape **100** with self-adhesive backing **102**. The heating  
15 tape **100** being in a roll format provides users additional versatility.

**[0057]** **FIG. 7** shows a flow chart pertaining to a process of installation and working of heating system of **FIG. 5**, in accordance with an aspect of the present invention. As at step **212**, a portion of the heating tape **100** from the heating tape roll is cut into desired  
20 length depending on the application. The adhesive backing **102** of the heating tape **100** is pressed onto the surface of an object to be heated, as at step **214**. As at steps **216** and **218**, the power supply unit **122** is connected to the heating tape **100** and the temperature controller **132** is installed on the heating tape **100**.

**[0058]** Then, as at steps **220** and **222**, the temperature of the heating tape **100** is sensed and the power supply unit **122** is turned ON/OFF depending upon the sensed temperature. For example, when the sensed temperature is below the preset temperature value, the power supply unit **122** is turned 'ON'. When the sensed temperature is above the temperature preset value, the power supply unit **122** is turned  
25 'OFF'. Thus, the surface temperature of the heating tape **100** is maintained uniform  
30 throughout the installed length and this makes it suitable for any type of all low

temperature application.

**[0059]** While installing the heating system, the temperature sensors are recommended to be used together with the heating tape **100**. The sensor is installed on the heating tape **100** before connecting the power supply unit **122**. It should always be ensured that the electrical contacts are secure, by selecting the proper power supply. While installing the heating tape **100**, overlapping of the heating tape **100** should be avoided to prevent overheating on the application area.

**[0060]** Thus, the present invention provides a light, flexible, paper thin heating tape with self-adhesive backing suitable for all low temperature applications.

**[0061]** It will be appreciated that variations of the above disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Also that various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

**[0062]** Although embodiments of the current disclosure have been described comprehensively, in considerable detail to cover the possible aspects, those skilled in the art would recognize that other versions of the disclosure are also possible.

**CLAIMS**

What is claimed is:

1. A heating tape comprising:

5 a polymer film having an upper surface and a lower surface;  
an adhesive backing disposed on said polymer film lower surface;  
a first stripe of conductive paste disposed along a first edge of said  
polymer film upper surface;  
a second stripe of conductive paste disposed along a second edge of said  
10 polymer film upper surface, said second stripe of conductive paste being  
substantially parallel to said first stripe of conductive paste;  
a linear array of conductive carbon ink segments disposed across said  
polymer film upper surface such that a first edge of each said conductive carbon  
ink segment is disposed on said first stripe of conductive paste and a second  
15 edge of each said conductive carbon ink segment is disposed on said second  
stripe of conductive paste; and  
an insulating polymer overcoat disposed on said first stripe of conductive  
paste, on said second stripe of conductive paste, and on said linear array of  
conductive carbon ink segments.

20 2. The heating tape of claim 1 wherein said heating tape comprises an overall  
thickness ranges from 120  $\mu\text{m}$  to 300  $\mu\text{m}$ .

25 3. The heating tape of claim 1 further comprising a plurality of spacings between  
adjacent said conductive carbon ink segments, wherein each said conductive carbon  
ink segment is spaced in a range of 0.1 mm to 3 mm from an adjacent said conductive  
carbon ink segment.

30 4. The heating tape of claim 1 wherein each said conductive carbon ink segment

has a width ranging from 30 mm to 120 mm and a length ranging from 10 mm to 250 mm.

5. The heating tape of claim 1 wherein each said stripe of conductive paste  
5 comprises a width ranging from 5 mm to 50 mm.

6. A heating system comprising:

a heating tape for placement onto a surface to be heated;

a power supply unit connected to said heating tape; and

10 a temperature controller connected to said power supply unit for regulating  
operation of said power supply unit, said temperature controller further connected  
to a temperature sensor on said heating tape to sense a temperature of said  
heating tape and to determine when to turn said power supply unit on or off.

15 7. The heating system of claim 6 wherein said temperature controller comprises at  
least one preset temperature value for determining when to turn said power supply unit  
on or off.

8. A method of fabricating a heating tape, said method comprising the steps of:

20 providing a polymer film having an adhesive backing to a continuous  
screen printing machine;

printing a first continuous stripe of conductive paste onto said polymer film  
to form a first electrode;

25 printing a second continuous stripe of conductive paste onto said polymer  
film to form a second electrode;

printing a linear array of conductive carbon ink segments onto said  
polymer film, each said conductive carbon ink segment having an electrical  
connection to said first continuous stripe of conductive paste and an electrical  
connection to said second continuous stripe of conductive paste; and

30 printing an insulating polymer overcoat over said linear array of conductive  
carbon ink segments and over said stripes of conductive paste.

9. The method of claim 8 wherein said second continuous stripe of conductive paste is substantially parallel to said first continuous stripe of conductive paste.

10. The method of claim 8 wherein each said conductive carbon ink segment has a  
5 width ranging from 30 mm to 120 mm and a length ranging from 10 mm to 250 mm.

11. The method of claim 8 further comprising the step of cutting a portion of said heating tape into a desired length.

12. The method of claim 8 wherein each said conductive carbon ink segment is  
10 spaced in a range of 0.1 mm to 3 mm from an adjacent said conductive carbon ink segment.

13. The method of claim 8 wherein each said stripe of conductive paste comprises a width ranging from 5 mm to 50 mm.

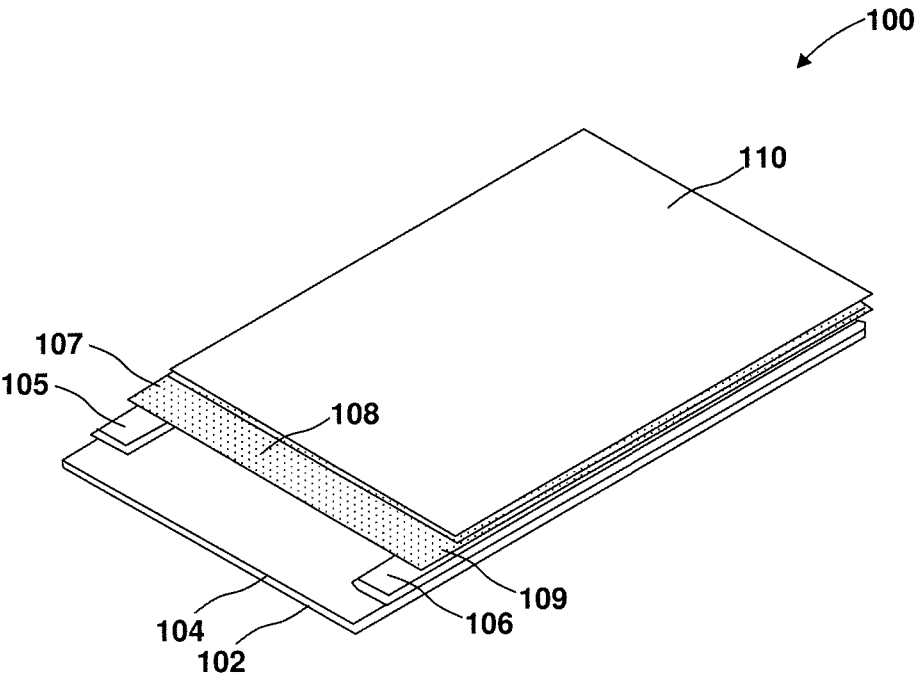


FIG. 1

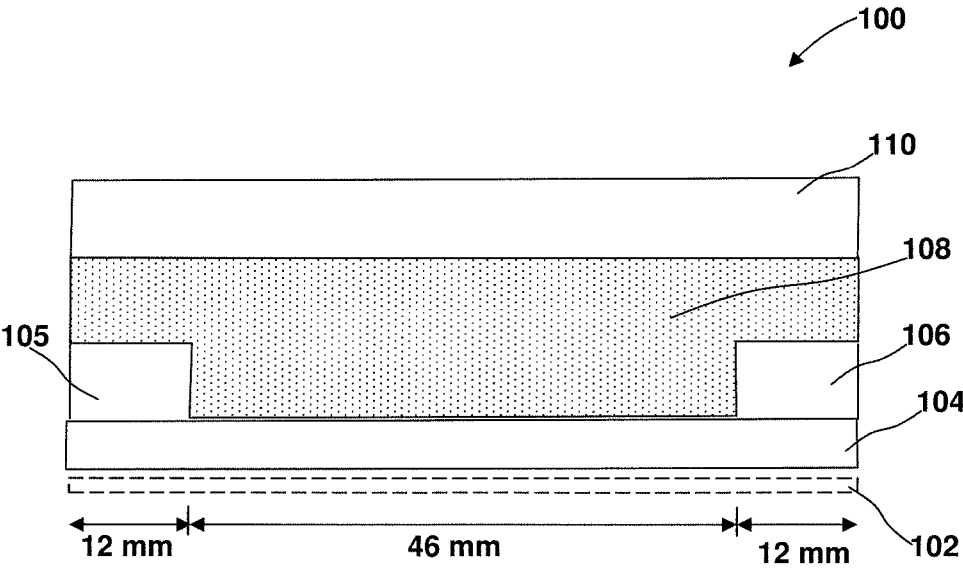


FIG. 2

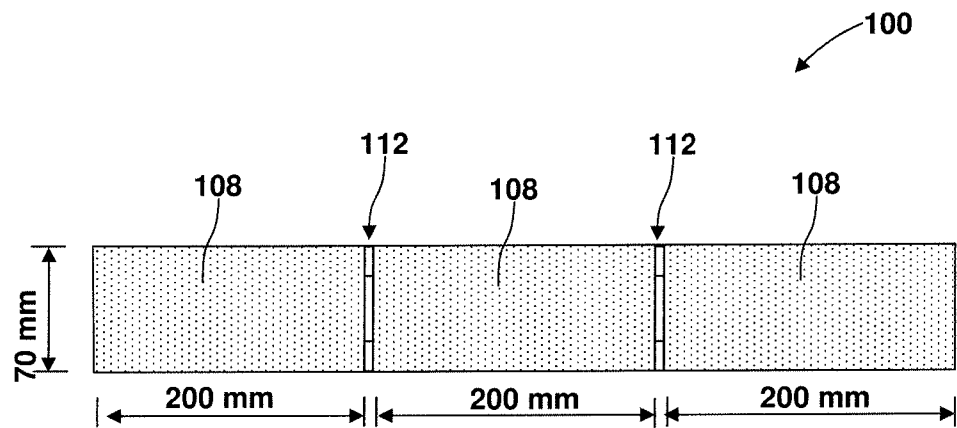


FIG. 3A

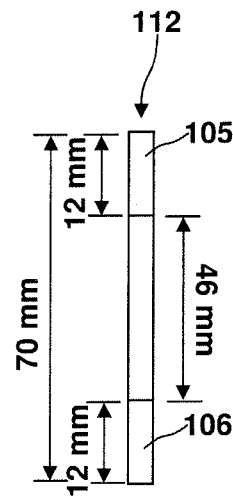


FIG. 3B

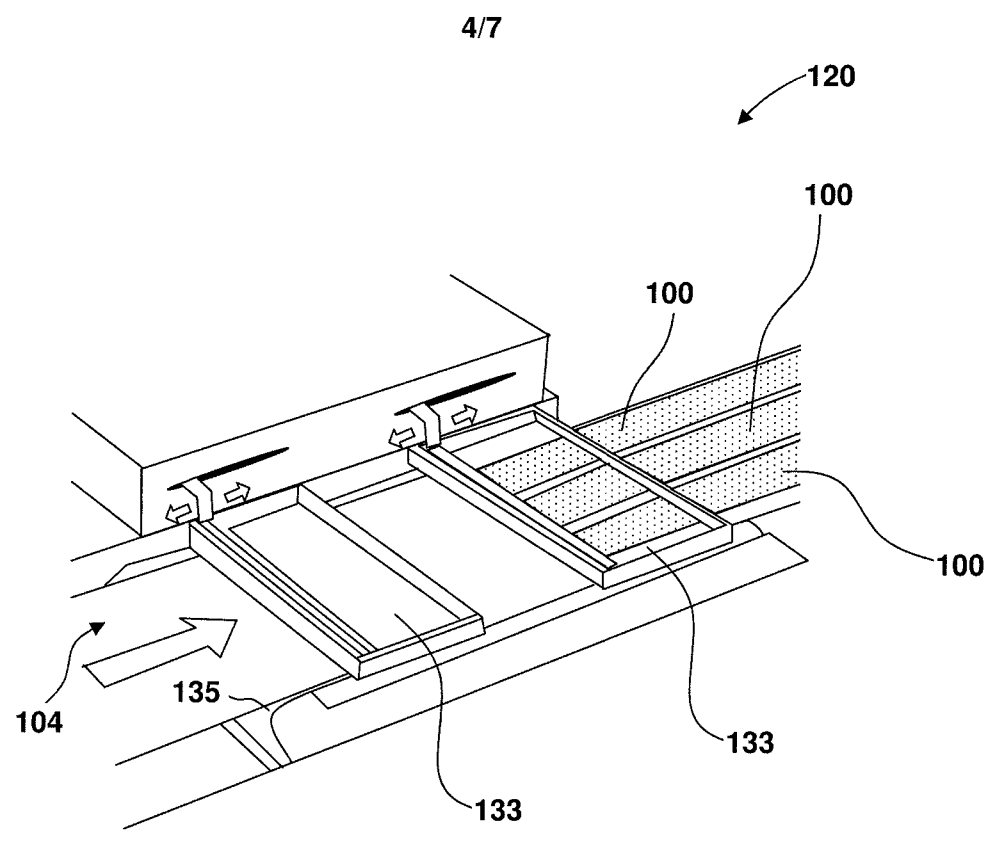


FIG. 4

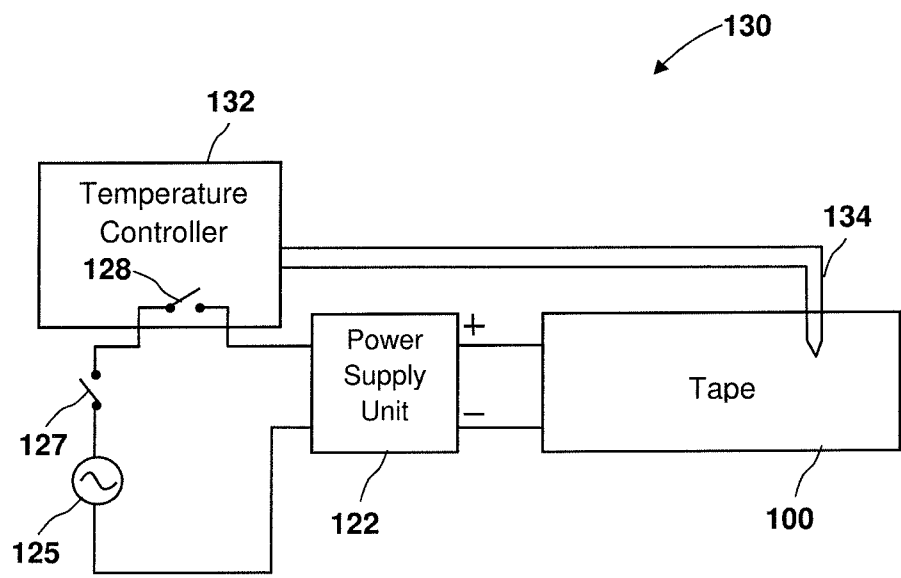


FIG. 5

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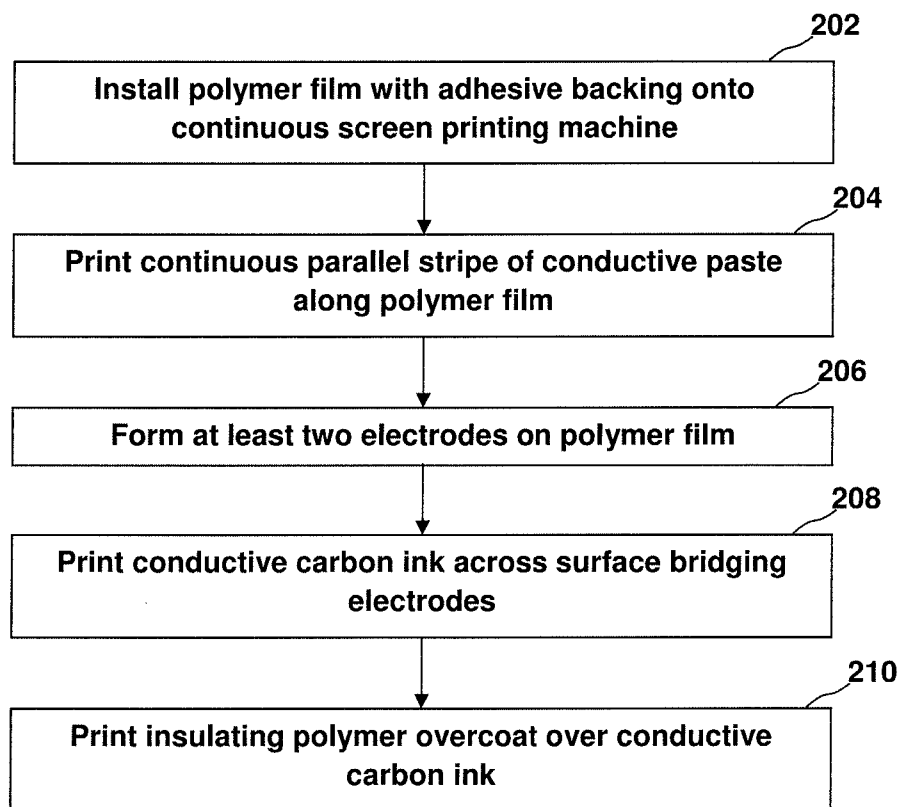


FIG. 6

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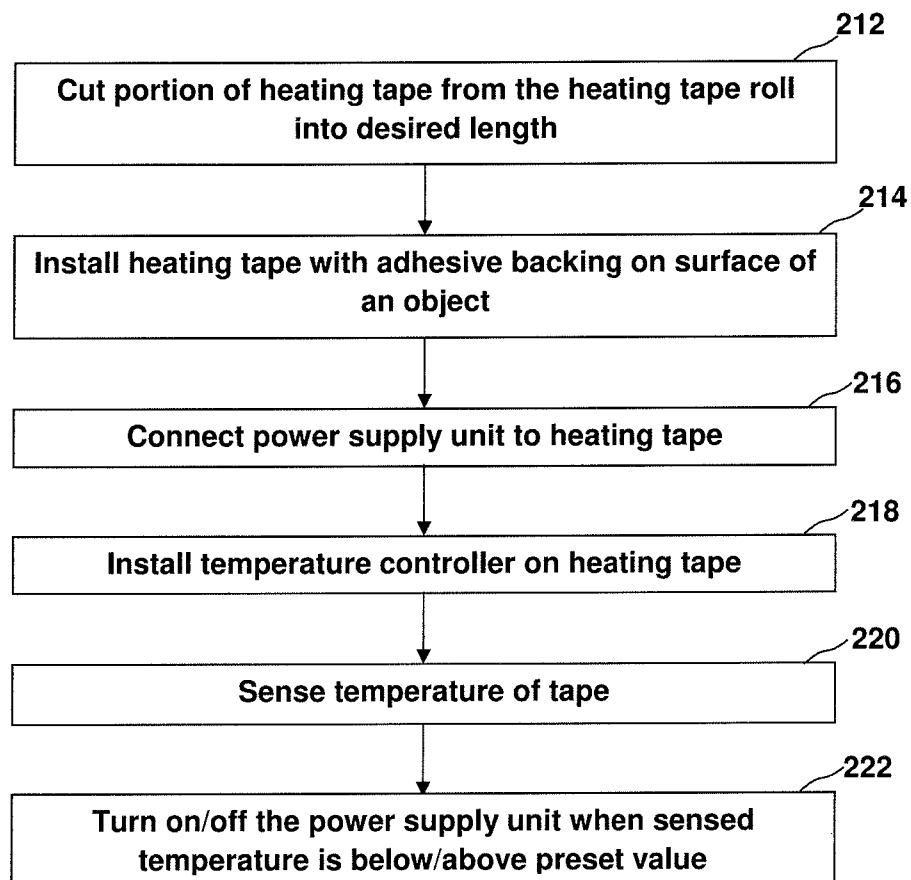


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/SG2016/050168

A. CLASSIFICATION OF SUBJECT MATTER  
INV. H05B3/56 H05B3/34  
ADD.

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)  
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                         | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | WO 2010/081035 A2 (PROTECTO WRAP COMPANY [US]; HOPKINS JOHN [US]; SCHETTLER TIMOTHY [US]) 15 July 2010 (2010-07-15)<br>abstract; figures 1-8<br>page 3, lines 3-9<br>page 8, lines 19-23; claim 1<br>----- | 1-13                  |
| X         | US 9 297 541 B1 (MCGILLYCUDDY EUGENE B [US]) 29 March 2016 (2016-03-29)<br>abstract; claims 1-3; figures 1-6<br>column 4, line 45 - column 5, line 19<br>-----                                             | 1-13                  |
| A         | US 4 656 339 A (GRISE FREDERICK G J [US])<br>7 April 1987 (1987-04-07)<br>abstract; figures 1-11<br>-----<br>-/-                                                                                           | 1                     |



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

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Date of the actual completion of the international search

7 December 2016

Date of mailing of the international search report

15/12/2016

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European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Garcia, Jesus

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International application No

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| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                   |                       |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category*                                            | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                | Relevant to claim No. |
| A                                                    | EP 2 884 818 A2 (CENTI CT DE<br>NANOTECNOLOGIA E MATERIAIS TECNICOS<br>FUNCIONAIS E INTELIGEN)<br>17 June 2015 (2015-06-17)<br>abstract; figures 1-3<br>paragraph [0056]<br>----- | 1                     |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SG2016/050168

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
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|                                           |                     |                            | WO 2010081035 A2 15-07-2010 |
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| US 4656339                                | A                   | 07-04-1987                 | NONE                        |
| EP 2884818                                | A2                  | 17-06-2015                 | NONE                        |