(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
16 June 2022 (16.06.2022)

WIPO | PCT

(10) **International Publication Number**
WO 2022/122774 A1

(51) **International Patent Classification:**
C09J 7/10 (2018.01) *C09J 7/38* (2018.01)

(21) **International Application Number:**
PCT/EP2021/084674

(22) **International Filing Date:**
07 December 2021 (07.12.2021)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
202011436447.5 07 December 2020 (07.12.2020) CN

(71) **Applicant: TESA SE** [DE/DE]; Hugo-Kirchberg-Str. 1, 22848 Norderstedt (DE).

(72) **Inventors: LIU, Lei**; No. 65 Bei Xie Yu Street, Tian, Suzhou, Jiangsu 131-202 (CN). **CHENG, Xiao**; No. 688 Huajinggang road, (Wuzhong district), Suzhou, Jiangsu 23-802 (CN). **MAATZ, Gero**; Augsburger Str. 19, 40597 Düsseldorf (DE).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title:** LASER-ASSISTED ADHESIVE TAPE AND SEALING STRUCTURE CONTAINING THE ADHESIVE TAPE

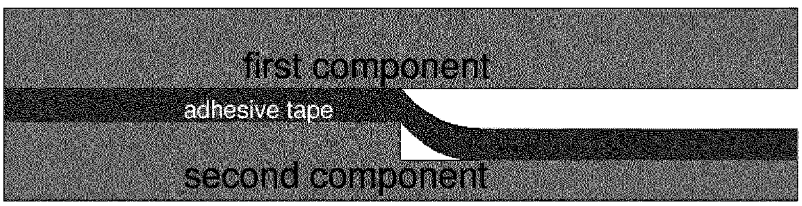

Fig 15

(57) **Abstract:** The invention relates to a laser-assisted adhesive tape and a sealing structure comprising the adhesive tape. Specifically, under the action of a laser, the adhesive tape can be foamed and expanded directionally and quantitatively to fill the gaps between the components adhered by the adhesive tape. The adhesive tape is particularly suitable for filling irregular gaps.

WO 2022/122774 A1

LASER-ASSISTED ADHESIVE TAPE AND SEALING STRUCTURE CONTAINING THE ADHESIVE TAPE

TECHNICAL FIELD

The invention relates to the field of materials, in particular to a laser-assisted adhesive tape and a sealing structure comprising the adhesive tape.

BACKGROUND ART

In the mobile phone or related electronic industry such as tablet computers, wearable devices and so on, more and more devices front shell or back cover transition from flat surface to curved surface. For example, almost all flagship mobile phone terminal brands use curved back cover design, which is often called 3D back cover. These 3D back covers may be made of glass, plastic or even ceramics and other materials, and the corresponding middle frame is also curved. In the production process of mobile phones, it is necessary to bond the curved back cover with the curved middle frame (as shown in Figures 1 and 2). However, due to the limitation of the prior art level, there will always be a relatively large clearance tolerance when the two are matched, which may be in the cross-sectional direction or along the edge of the back cover. Mobile phone manufacturers need to fill this gap and the corresponding gap tolerance with tape.

At present, the main solution adopted is to use thicker foam tape (such as 250-400 μ m), and use greater pressure to fill this gap tolerance when bonding and assembling (as shown in Figure 2), but it cannot fully realize the bending filling of the gap.

Whether the gap is tightly fitted or not is very important for the waterproof, dustproof and chemical entry prevention of mobile phones, as well as the reliability of mobile phones when they are used (such as falling). Therefore, it is urgent to develop a solution that can completely fill irregular gaps in this field.

SUMMARY OF THE INVENTION

The purpose of the invention is to provide a laser-assisted adhesive tape and a sealing structure comprising the adhesive tape. Under the action of laser, the adhesive tape can rapidly, directionally and controllably expand to realize full bonding among irregular components, which has important significance for improving curved surface bonding performance of electronic products such as mobile phones.

In the first aspect of the invention, it provides a laser-assisted adhesive tape comprising at least one expandable tape layer,

the expandable tape layer comprises pressure-sensitive adhesive and unfoamed microspheres and/or partially foamed microspheres distributed in the pressure-sensitive adhesive;

the unfoamed microspheres and/or the partially foamed microspheres can undergo directional and quantitative on-site foaming under the action of a laser.

In another preferred embodiment, by the total weight of one expandable tape layer, the weight content of the unfoamed microspheres in the expandable tape layer is 0.1-15.0 wt%; and/or

the weight content of the partially foamed microspheres in the expandable tape layer is 0.1-5.0 wt%.

In another preferred embodiment, the thickness of the expandable tape layer before laser treatment is t0, and the thickness of the expandable tape layer after laser treatment is t1, and t1/t0 = 1.01 -5.

In another preferred embodiment, the adhesive tape comprises a reinforcing layer and two expandable tape layers adhered to two main surfaces of the reinforcing layer.

In another preferred embodiment, the adhesive tape comprises a reinforcing layer, a first adhesive layer without microspheres adhered to one main surface of the reinforcing layer, and an expandable tape layer adhered to the other main surface of the reinforcing layer.

In another preferred embodiment, the adhesive tape comprises an expandable tape layer and two adhesive layers without microspheres adhered to the two main surfaces of the expandable tape layer.

In the second aspect of the invention, it provides a sealing structure comprising from the outside to the inside in order: a first component, the adhesive tape according to the first aspect of the invention, and a second component, wherein:

the first component is an outer layer, and the first component is laser-transparent or laser-heatable;

the adhesive tape is an intermediate layer, and the adhesive tape is used for bonding and sealing the first component and the second component;

the second component is an inner layer.

In another preferred embodiment, the material of the first component and the material of the second component are the same or different, and are each independently selected from the group consisting of glass, ceramic, plastic, coating or combinations thereof.

In another preferred embodiment, the shape of the first component and the shape of the second component do not match.

In another preferred embodiment, an irregular gap exists in an area formed between the first component and the second component, and the irregular gap has at least two different heights.

It should be understood that in the present invention, any of the technical features specifically described above and below (such as in the Examples) can be combined with each other, which will not redundantly be described one by one herein.

DESCRIPTION OF FIGURES

Fig. 1 is a schematic diagram of component shape change and assembly results of electronic products such as mobile phones.

Fig. 2 is a schematic diagram of the existing tape bonding gap.

Fig. 3 is a schematic diagram of the adhesive tape in form 1 of the present invention before and after foaming.

Fig. 4 is a schematic diagram of the adhesive tape in form 2 of the present invention before and after foaming.

Fig. 5 is a schematic diagram of the adhesive tape in form 3 of the present invention before and after foaming.

Fig. 6 is a schematic diagram of the adhesive tape in form 4 of the present invention before and after foaming.

Fig. 7 is a schematic diagram of the adhesive tape in form 5 of the present invention before and after foaming.

Fig. 8 is a schematic diagram of laser treated tape.

Fig. 9 shows the thickness test results of the tape after laser treatment.

Fig. 10 is a schematic diagram of gap filling performance test.

Fig. 11 is a gap test diagram of No.1 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after being stored at room temperature for 24 hours after lamination.

Fig. 12 is a gap test diagram of No.2 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after being stored at room temperature for 24 hours after lamination.

Fig. 13 is a gap test diagram of No.3 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after lamination and stored at room temperature for 4 hours after laser processing the edge of the ink.

Fig. 14 is a gap test diagram of No.4 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after lamination and stored at room temperature for 4 hours after laser processing the edge of the ink.

Fig. 15 illustrates the sealing structure of the present invention.

Fig. 16 illustrates the sealing structure of the present invention after laser treatment.

Fig. 17 is the infrared processing gap test diagram of No.3 adhesive tape.

Fig. 18 is the infrared processing gap test diagram of No.4 adhesive tape.

DETAILED DESCRIPTION OF THE INVENTION

After long-term and in-depth research, the inventor realizes efficient filling of gaps during bonding of curved surface components by adopting an expandable tape layer containing unfoamed microspheres and/or partially foamed microspheres and laser-assisted technology, and significantly improves bonding performance between curved surface components. On this basis, the inventors have completed the present invention.

Unfoamed microspheres/partially foamed microspheres

Unfoamed microspheres usable in the present invention include, but are not limited to, expandable polymer microspheres, they contain a polymer shell and the gas enclosed in them, when heated to a temperature (e.g. 80-200 °C or above, preferably 95-110 °C, more preferably 130-160 °C), the polymer shell, which is a thermoplastic material, softens and the gas in the shell expands, resulting in a rapid increase in the volume of the microspheres.

Generally, the particle size of the polymer microspheres is generally 5-40 μm (preferably 8-38 μm) without foaming, and after foaming, the particle size can be increased to 1.01-5 times (preferably 1.1-3 times) depending on the heat absorbed.

Materials forming the polymer shell include, but are not limited to, polyacrylonitrile, polypropylene, or combinations thereof.

Generally, the polymer shell has a thickness of 1-5 μm, preferably 2-3 μm when it is unfoamed.

Typically, unfoamed microspheres and/or partially foamed microspheres used in the present invention include, but are not limited to, Expancel 551 WU40, Expancel 920 DU120, Expancel 093 DU120, Expancel 031 DU40, Expancel 053 DU40, or combinations thereof.

It should be understood that in the present invention, "foaming agent", "unfoamed microsphere", "unfoamed polymer microsphere" and "expandable polymer microsphere" are used interchangeably.

It should be understood that "partially foamed microspheres" as described herein refer to microspheres between unfoamed microspheres and fully foamed microspheres.

Expandable tape layer (also known as foam tape or expandable tape)

The expandable adhesive tape layer used in the invention is mainly composed of pressure sensitive adhesive, unfoamed polymer microspheres and/or partially foamed microspheres, and the expandable adhesive tape layer is obtained by conventional coating, drying, slitting and die-cutting of the mixture of the two or the three.

It should be understood that the above-mentioned coating, drying, slitting and die-cutting can all be performed by the processes commonly used in pressure-sensitive adhesive tapes, which are very familiar to those skilled in the art and will not be repeated here.

The pressure sensitive adhesive is selected from the group consisting of acrylate, rubber, silica gel, polyurethane, or a combination thereof.

It should be understood that, for convenience, the embodiment of the invention adopts the pressure-sensitive adhesive developed by the applicant, but it must be noted that the pressure-sensitive adhesive of the above-mentioned category sold in the market is also suitable for the technical solution of the invention, and the related technical effect will not be obviously changed due to the adoption of the pressure-sensitive adhesive sold in the market (i.e., considerable technical effect can be obtained by adopting the pressure-sensitive adhesive sold in the market).

The weight content of the unfoamed polymer microspheres in one expandable tape layer is about 0.1-15wt%, preferably 0.3-10wt%, preferably 0.5-8wt%, based on the total weight of the expandable tape layer.

The weight content of the partially foamed microspheres in one expandable tape layer is about 0.1-5 wt%, preferably 0.1-3.5 wt%, preferably 0.1-2.5 wt%, based on the total weight of the expandable tape layer.

The thickness t0 of the expandable tape layer before laser treatment (i.e. unfoamed or partially foamed) is generally 30-500 μm, preferably 50-300 μm.

After laser heating (i.e. after laser foaming), the thickness t1 of the expandable tape layer is generally 32-800 μm, preferably 50-500 μm.

Before and after laser treatment, t1/t0=1.01-5, preferably 1.05-3, more preferably 1.1-2.5, most preferably 1.2-2.

It should be understood that the expandable tape layer of the present invention does not require further crosslinking reaction during subsequent use, and the entire subsequent expansion bonding process has the advantage of safety and controllability.

In the present invention, the laser intensity acted by the laser is 0.01%-20% of the rated power, preferably 0.01%-10% of the rated power, and more preferably 0.01%-5% of the rated power. The rated power of laser is 100W.

In the present invention, the laser processing time of the laser treatment is 0.5 s - 20 s, preferably 0.5 s -15 s, and more preferably 0.5 s -10 s.

It should be understood that in order to realize directional and quantitative foaming, the adjustment accuracy of laser intensity acted by the above laser should be 0.01% - 0.1% of rated power, and the adjustment accuracy of laser processing time acted by the above laser should be 0.1s - 1s, so as to realize the most ideal adjustment.

Adhesive tape

The structure of the adhesive tape of the invention includes but is not limited to the following five forms:

Form 1: as shown in Fig. 3, the adhesive tape comprises only one expandable tape layer and two release layers optionally located on either side of the expandable tape layer. Preferably, the thickness of the expandable tape layer before expansion is 30-500 μm, preferably 100-400 μm, more preferably 200-350 μm. After laser heating, the microsphere expands to increase the volume of the adhesive tape, and the thickness of the expandable tape layer is 31-700 μm, preferably 50-500 μm.

The thickness change of the expandable tape layer varies from 1 to 500%, preferably from 5 to 300%, before and after the laser action. For example, an expandable tape layer with a thickness of 100 μm can be changed to 101-500 μm, preferably 105-300 μm under the action of laser.

Form 2: as shown in Fig. 4, the adhesive tape comprises a reinforcing layer and expandable tape layers located on two main surfaces of the reinforcing layer; the reinforcing layer is a material including, but not limited to, the following group: polyolefin, polyester, polyimide, polyurethane, rubber, or combinations thereof; the thickness of the reinforcing layer is less than or equal to 150 μm, preferably less than or equal to 100 μm, preferably less than or equal to 50 μm (e.g. 5-50 μm, preferably 10-20 μm); the thickness of one-side expandable tape layer is 30-200 μm (preferably 50-150 μm); after laser heating, the volume of tape is increased by the expansion of microspheres, and the thickness of expandable tape layer on one side is expanded to 31-1000 μm (preferably 32-600 μ m); preferably, the reinforcing layer is laser-transparent; preferably, the ratio of the thickness of one-sided expandable tape layer to the thickness of the reinforcing layer before laser treatment is 0.5-100 (preferably 5-75).

The polyester includes, but is not limited to, the following materials: polyethylene terephthalate, polybutylene terephthalate, polycarbonate, polymethyl methacrylate, or combinations thereof.

It should be understood that the presence of a reinforcing layer in the adhesive tape of the present invention not only significantly enhances the mechanical strength of the adhesive tape, but also greatly facilitates the removal and reworking of the adhesive tape.

Form 3: as shown in Fig. 5, same as form 2, the difference is the upper side of the reinforcing layer is an adhesive layer (without unfoamed microspheres) and the lower side is an expandable tape layer, the thickness of the adhesive layer (without unfoamed microspheres) before and after expansion is 30-200 μm (preferably 50-150 μm), the thickness of the expandable tape layer before expansion is 50-300 μm (preferably 50-200 μm), and the thickness of the expandable tape layer after expansion is 51-1500 μm (preferably 53-600 μm); preferably, the adhesive layer is laser-transparent or laser-heatable;

Form 4: as shown in Fig. 6, same as form 2, the difference is that the upper side of the reinforcing layer is an expandable tape layer, the lower side is an adhesive layer (without unfoamed microspheres), the thickness of the adhesive layer before and after expansion is 30-200 μm (preferably 50-150 μm), the thickness of the expandable adhesive tape layer before expansion is 50-300 μm (preferably 50-200 μm), and the thickness of the expandable adhesive tape layer after expansion is 51-1500 μm (preferably 53-600 μm);

Form 5: as shown in Fig. 7, the adhesive tape comprises an expandable adhesive tape layer, an adhesive layer 1 and an adhesive layer 2 located on two main surfaces of the expandable adhesive tape layer, the thickness of the expandable adhesive tape layer before expansion is 30-500 μm (preferably 100-350 μm), the expandable adhesive tape layer has a thickness of 31-2500 μm (preferably 105-1050 μm) after expansion, the adhesive layer is a material including but not limited to the following group: acrylate, rubber, silica gel, or a combination thereof, and the thickness of one adhesive layer is 5-100 μm (preferably 20-70 μm), and the microsphere expands to increase the volume of the adhesive tape after laser heating. Preferably, the adhesive layer is laser-transparent or laser-heatable.

Laser assisted technology

Laser has the characteristics of good orientation, high brightness, pure color and great energy.

In the invention, after the adhesive tape is adhered to the component, according to the position of the gap, the adhesive tape can be treated by laser with high directivity, and the adhesive tape can be expanded at fixed point and quantitatively to fill the gap according to the demand.

In order for the laser energy to be efficiently transmitted to the adhesive tape, the energy can be transmitted in the following methods:

method A: during the formation of the expandable tape layer, a first substance including (but not limited to) carbon black, dye, or a combination thereof is added to the mixture to assist heat absorption; the weight ratio of the first substance to the microspheres is 1-10, preferably 1.5-5;

method B: coating an ink layer and other materials that are easy to absorb heat (i.e., forming a heat absorbing material layer) inside the component on a part of the area (such as the edge area of the tape) or all the areas near the interaction surface between the component on the outside of the final product (such as mobile phone, etc.) and the tape; the thickness of the heat absorbing material layer is 10-60 μm, preferably 20-50 μm.

In the present invention, the laser intensity acted by the laser is 0.01%-20% of the rated power, preferably 0.01%-10% of the rated power, and more preferably 0.01%-5% of the rated power.

Sealing structure (or bonded sealing structure)

The invention provides a sealing structure which comprises a first component, an adhesive tape and a second component in turn from outside to inside,

the first component is located on the outer layer, and the first component is laser-transparent or laser-heatable;

the adhesive tape is located in the middle layer, and the adhesive tape is used for bonding and sealing the first component and the second component;

the second component is located in the inner layer.

In another preferred embodiment, the second component is laser-transparent or laser-heatable.

In another preferred embodiment, the shape of the first component and the shape of the second component do not match. The "do not match" means that when the first component and the second component are assembled, there is an irregular gap between them.

In another preferred embodiment, the material of the first component and the material of the second component are the same or different, each independently selected from the group consisting of glass, ceramic, plastic, coating, metal, or a combination thereof.

In another preferred embodiment, the coating material is selected from the group consisting of acrylate, polyurethane, silicone, or combinations thereof.

In another preferred embodiment, the first component is a curved back cover of an electronic product.

In another preferred embodiment, the second component is a curved middle frame or a planar middle frame of an electronic product.

In another preferred embodiment, the shape of the first component is irregular.

In another preferred embodiment, the shape of the second component is irregular.

In another preferred embodiment, the thickness of the adhesive tape is 50-500 μm, preferably 100-450 μm, more preferably 150-400um, most preferably 200-400um.

In the present invention, after the sealing structure is provided, to achieve complete filling, bonding and sealing of the irregular gap between the first component and the second component, the adhesive tape can be fixed-point expanded to fill, bond and seal the irregular gap by laser orientation and positioning acting on the adhesive tape through the first component (or heating the first component), thereby realizing complete adhesive sealing of the first component and the second component.

By way of example, the irregular gap means that there are at least two (e.g. 2-100, 5-80, or 10-60) height values in the gap. The more the height value of the gap exists, the more irregular the shape of the gap is, and the adhesive advantage of the adhesive tape of the invention will be more prominent and obvious.

It should be understood that the adhesive tape of the present invention is particularly suitable for bonding and filling the irregular assembly gaps between the first component and the second component, which are difficult to fully fill, bond and seal by existing physical size fixed tapes.

When the sealing structure is part of an electronic product such as a mobile phone, since the electronic component of the electronic product cannot withstand the temperature exceeding 80 °C, after assembly, the laser heating action can be limited to the target area through the high directional action of the laser, and the non-target area can be completely unaffected by the laser heating.

Fig. 15 illustrates the sealing structure for ease of understanding. It can be seen that the directly bonded seal structure has a significant gap between the first component and the second component due to the mismatch between the first component and the second component.

Fig. 16 illustrates the sealing structure after laser treatment. It can be seen that the adhesive tape is positioning expanded after laser orientation and positioning treatment of the adhesive tape in the area containing the void, thereby realizing complete bonding of the first component and the second component.

Compared with the existing structure, the adhesive tape in the sealing structure of the invention can be positioned and quantitatively expanded according to the actual filling and bonding requirements by adjusting the acting power, the acting time and the acting position of the laser, so as to realize excellent filling and bonding of irregular gaps and excellent filling, bonding and sealing effects. The high directivity of the laser enables the laser action to accurately act on the target area without affecting the surrounding area. The high energy of laser can realize rapid action and greatly improve the assembly efficiency.

The sealing structure of the invention can carry out on-site conformal under the action of laser, and is particularly suitable for bonding and sealing between irregular shape components.

Through the use of the laser-assisted adhesive tape, after the laser-assisted expansion, the waterproof and dustproof performance of the electronic equipment as a whole can be significantly improved, and the buffering and anti-seismic performance of the equipment can be significantly improved.

Bonding device

In order to cooperate with the laser heating expansion, bonding and sealing of the adhesive tape in the sealing structure, the invention also provides a bonding device, the bonding device comprising:

1) a processing chamber used for laser processing of the adhesive tape in the sealing structure;

2) a laser acting unit for providing directional and quantitative laser required for heating and expanding the adhesive tape in the sealing structure;

3) a control unit used to control the laser heating process and the operation of the whole equipment.

Generally, the control unit controls the laser heating process through a temperature control mode or a power control mode.

Compared with the prior art, the present invention has the following main advantages:

(1) laser processing can make the expandable adhesive tape layer in the sealing structure expand at fixed point and quantitatively with high selectivity and precision, so as to fully fill the irregular gap;

(2) because of the high accuracy of laser processing, its action area can be limited to the tape area that needs to be expanded, and other heat-related adverse effects will not be produced on other parts of electronic products;

(3) the expansion accuracy of the laser treatment can be controlled at the micron level (e.g. 1-5μm);

(4) the laser treatment can be directly added into the original processing technology of electronic products, and the adaptability is very good;

(5) because laser processing has extremely high directional processing ability, the processing method is especially suitable for situations with complex gap shapes, such as stepped gaps or other irregular gaps.

The present invention will be further illustrated below with reference to the specific examples. It should be understood that these examples are only to illustrate the invention but not to limit the scope of the invention. The experimental methods with no specific conditions described in the following examples are generally performed under the conventional conditions, or according to the manufacture's instructions. Unless indicated otherwise, parts and percentage are calculated by weight.

Unless otherwise defined, all professional and scientific terminology used in the text have the same meanings as known to the skilled in the art. In addition, any methods and materials similar or equal with the record content can apply to the methods of the invention. The method of the preferred embodiment described herein and the material are only for demonstration purposes.

Raw materials

Name	manufacturer	physical and chemical properties
Expancel 053 DU40	from Akzo Nobel	Polymer Material: Polyacrylonitrile foaming starting temperature: 96-103 °C before foaming: the particle size is 10-16 μm, and the thickness of polymer shell is about 2-5 μm after foaming: the particle size is 30-45 μm, and the thickness of polymer shell is 0.1-0.5 μm
Expancel 920 DU120	from Akzo Nobel	Polymer Material: Polyacrylonitrile foaming starting temperature: 122-132℃ before foaming: the particle size is 28-38 μm, and the thickness of polymer shell is about 2-5 μ m after foaming: the particle size is 80-120 μm, and the thickness of polymer shell is 0.1-0.5 μm
Acrylate pressure sensitive adhesive 1	self-developed pressure sensitive adhesive by Tesa	pressure sensitive adhesive type: modified acrylate, modified by resin tackification, brand tesa33 Pressure sensitive adhesive characteristics: high adhesion, high cohesion, excellent anti-warping ability, excellent performance stability; Pressure sensitive adhesive color: black
Acrylate pressure sensitive adhesive 2	self-developed pressure sensitive adhesive by Tesa	pressure sensitive adhesive type: modified acrylate, modified by resin tackification, brand tesa34 Pressure sensitive adhesive characteristics: high adhesion, high cohesion, excellent anti-warping ability, excellent performance stability; pressure sensitive adhesive color: transparent

EXAMPLE 1 adhesive tape 1

As shown in Fig. 3, the adhesive tape 1 comprises only an expandable tape layer 1 made from a mixture containing an acrylate pressure-sensitive adhesive 1 and Expancel 053 DU40 by coating, drying, slitting and die-cutting.

In the mixture, the weight ratio of pressure sensitive adhesive and foaming agent is 98: 2.

The thickness of the expandable tape layer 1 is 100 μm.

EXAMPLE 2 adhesive tape 2

As shown in Fig. 4, the adhesive tape 2 comprises, from top to bottom, a first expandable tape layer made from a mixture of an acrylate pressure sensitive adhesive 1 and Expancel 920 DU120 in a weight ratio of 98: 2, having a thickness of 100 μm;

a reinforcing layer made from polyethylene terephthalate and has a thickness of 12 μm;

a second expandable tape layer made from a mixture of an acrylate pressure sensitive adhesive 1 and Expancel 920 DU120 in a weight ratio of 97: 3 and has a thickness of 100 μm.

EXAMPLE 3 adhesive tape 3

As shown in Fig. 5, the adhesive tape 3 comprises, from top to bottom, a first adhesive layer made from acrylate pressure sensitive adhesive 2, with a thickness of 100 μm;

a reinforcing layer made from polyethylene terephthalate and has a thickness of 12 μm;

an expandable tape layer made from a mixture of acrylate pressure sensitive adhesive 1 and Expancel 920 DU120 in a weight ratio of 97: 3, with a thickness of 100 μm.

EXAMPLE 4 adhesive tape 4

As shown in Fig. 6, the adhesive tape 4 comprises, from top to bottom, an expandable tape layer made from a mixture of an acrylate pressure sensitive adhesive 1 and Expancel 920 DU120 in a weight ratio of 97: 3, with a thickness of 100 μm;

a reinforcing layer made from polyethylene terephthalate and has a thickness of 12 μm;

a first adhesive layer made from acrylate pressure sensitive adhesive 2, with a thickness of 100 μm.

EXAMPLE 5 adhesive tape 5

As shown in Fig. 7, the adhesive tape 5 comprises, from top to bottom, a first adhesive layer made from acrylate pressure sensitive adhesive 2, with a thickness of 50 μm;

an expandable adhesive tape layer made from a mixture of an acrylate pressure sensitive adhesive 1 and Expancel 920 DU120 in a weight ratio of 97: 3, with a thickness of 100 μm;

a second adhesive layer made from acrylate pressure sensitive adhesive 2, with a thickness of 50 μm.

EXAMPLE 6 adhesive tape 6

The same as Example 1, the difference is that Expancel 920 DU120 is used instead of Expancel 053 DU40 as the unfoamed microspheres.

The thickness of the expandable adhesive tape layer in the adhesive tape 6 is 100 μm.

EXAMPLE 7 laser treatment

Taking the adhesive tape 1 of Example 1 as an example, the adhesive tape 1 was irradiated with a laser intensity of 0.5% of the rated power (the rated power of the laser is 100W) for 10s, and the thickness of the laser acting area of the adhesive tape was changed from 100 μm to 135 μm.

Fig. 8 is a schematic diagram of the laser-treated adhesive tape, and Fig. 9 is a thickness test result of the laser-treated adhesive tape.

The thickness of the adhesive tape in the invention is measured as follows:

At room temperature, the sample was placed on a microscope platform, and the foamed and unfoamed areas were highly scanned by 3D laser scanning microscope (instrument model Keyence VK-X200K), and the height change of the sample surface during scanning was recorded by computer. And the required area on the obtained height change curve was selected, and the software will automatically calculate the height difference of the selected area.

EXAMPLE 8 Gap Filling Performance Test

<u>Test method</u>

Attach the test tape and glass plate with 40 μm thick printing ink, then attach it to another flat glass (as shown in Fig. 10), observe the phenomenon of bubbles and bright lines caused by ink steps, treat the edge area of printing ink with laser for samples 3 and 4, and then observe the improvement of bubbles and bright lines, and compare with samples 1 and 2.

Among them, samples 1-4 are shown in the following table:

Sample number	sample description
1	100 μm acrylic foam tape 75410
2	150 μm acrylic foam tape 75415
3	100 μm adhesive tape 1 (foaming agent 053DU40)
4	100 μm adhesive tape 6 (foaming agent 920DU120)

Fig. 11 is a gap test diagram of No.1 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after being stored at room temperature for 24 hours after lamination.

It can be seen from Fig. 11 that after storing for 24 hours after lamination, there are still bright lines and bubbles that are not completely attached to the edge of the ink.

Fig. 12 is a gap test diagram of No.2 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after being stored at room temperature for 24 hours after lamination.

It can be seen from Fig. 12 that after storing for 24 hours after lamination, there are still bright lines and bubbles that are not completely attached to the edge of the ink.

Fig. 13 is a gap test diagram of No.3 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after lamination and stored at room temperature for 4 hours after laser treatment (treatment power 1%, treatment time 15s) the edge of the ink.

It can be seen from Fig. 13 that after laser treatment, the bright lines and bubbles on the edge of ink basically disappear.

Fig. 14 is a gap test diagram of No.4 adhesive tape, wherein a and b are photos taken after lamination, and c and d are photos taken after lamination and stored at room temperature for 4 hours after laser treatment (treatment power 1%, treatment time 10s) the edge of the ink.

It can be seen from Fig. 14 that after laser treatment, the bright lines and bubbles on the edge of ink basically disappear.

Comparative example 1 infrared treatment

The same as in Example 8, the samples laminated with No.3 and No.4 adhesive tapes were subjected to infrared treatment with a treatment power of 100W and a treatment time of 10s.

Fig. 17 is the infrared processing gap test diagram of No.3 adhesive tape.

Fig. 18 is the infrared processing gap test diagram of No.4 adhesive tape.

From Fig. 17 and Fig. 18, it can be seen that after infrared treatment, the thickness of expandable tape layer has not changed obviously, and the bright lines and bubbles existing at the edge of ink have not disappeared obviously, so it is impossible to realize the role of caulking, and of course it is impossible to realize the role of full adhesion and sealing. At the same time, infrared can not achieve accurate positioning and quantitative treatment.

All literatures mentioned in the present invention are incorporated by reference herein, as though individually incorporated by reference. Additionally, it should be understood that after reading the above teaching, many variations and modifications may be made by the skilled in the art, and these equivalents also fall within the scope as defined by the appended claims.

Claims

1. A laser-assisted adhesive tape, characterized in that the adhesive tape includes at least one expandable tape layer,

the expandable tape layer comprises pressure-sensitive adhesive and unfoamed microspheres and/or partially foamed microspheres distributed in the pressure-sensitive adhesive;

the unfoamed microspheres and/or the partially foamed microspheres can undergo directional and quantitative on-site foaming under the action of a laser.

2. The adhesive tape according to claim 1, wherein by the total weight of one expandable tape layer, the weight content of the unfoamed microspheres in the expandable tape layer is 0.1-15.0 wt%; and/or

the weight content of the partially foamed microspheres in the expandable tape layer is 0.1-5.0 wt%.

3. The adhesive tape according to claim 1, wherein the thickness of the expandable tape layer before laser treatment is t0, and the thickness of the expandable tape layer after laser treatment is t1, t1/t0 = 1.01 -5.

4. The adhesive tape according to claim 1, wherein the adhesive tape comprises a reinforcing layer and two expandable tape layers adhered to two main surfaces of the reinforcing layer.

5. The adhesive tape according to claim 1, wherein the adhesive tape comprises a reinforcing layer, a first adhesive layer without microspheres adhered to one main surface of the reinforcing layer, and an expandable tape layer adhered to the other main surface of the reinforcing layer.

6. The adhesive tape according to claim 1, wherein the adhesive tape comprises an expandable tape layer and two adhesive layers without microspheres adhered to the two main surfaces of the expandable tape layer.

7. A sealing structure, characterized in that the sealing structure comprises from the outside to the inside in order: a first component, the adhesive tape according to claim 1, and a second component, wherein:

the first component is an outer layer, and the first component is laser-transparent or laser-heatable;

the adhesive tape is an intermediate layer, and the adhesive tape is used for bonding and sealing the first component and the second component;

the second component is an inner layer.

8. The sealing structure according to claim 7, wherein the material of the first component and the material of the second component are the same or different, and are each independently selected from the group consisting of glass, ceramic, plastic, coating or combinations thereof.

9. The sealing structure according to claim 7, wherein the shape of the first component and the shape of the second component do not match.

10. The sealing structure according to claim 7, wherein an irregular gap exists in an area formed between the first component and the second component, and the irregular gap has at least two different heights.

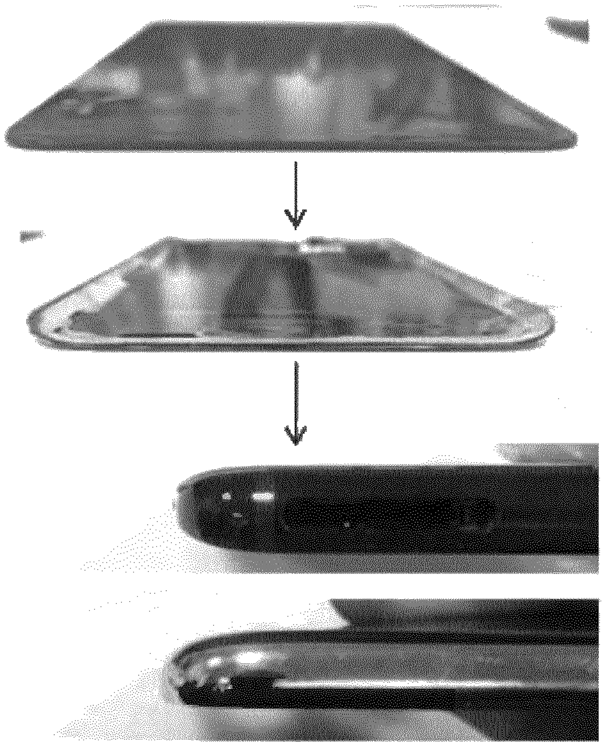

Fig 1

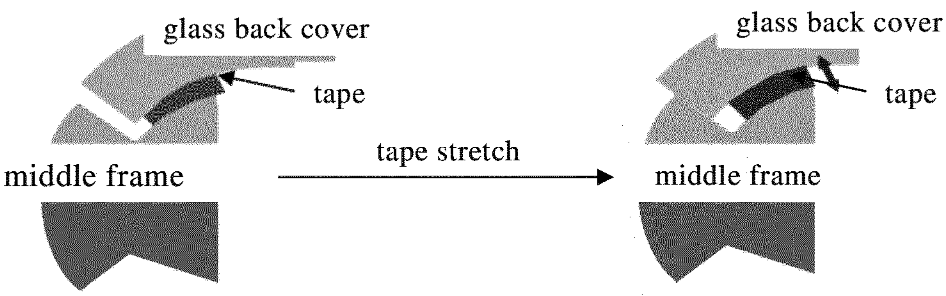

Fig 2

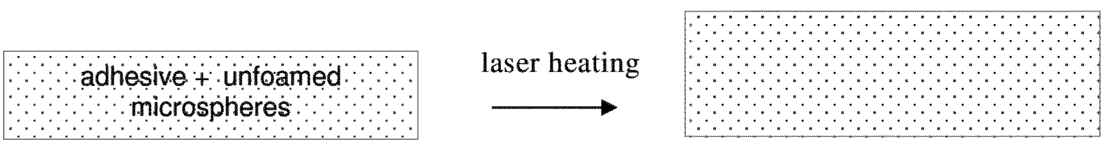

Fig 3

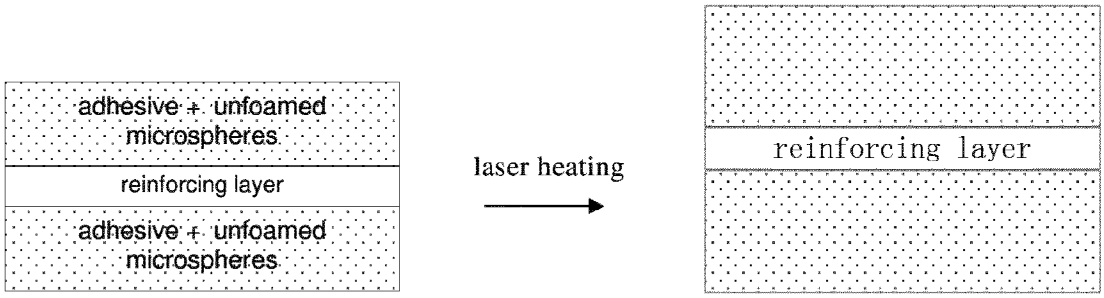

Fig 4

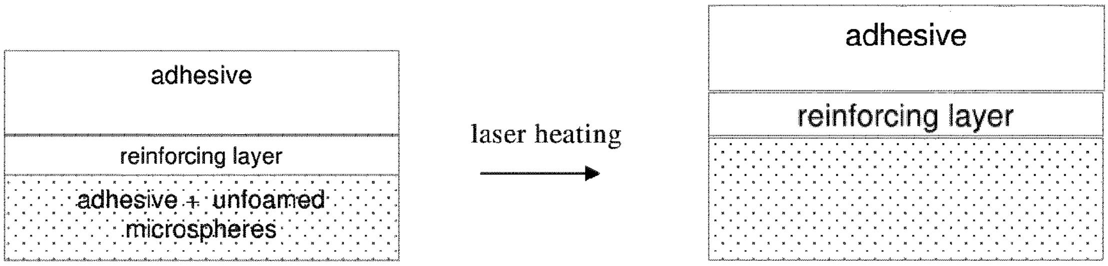

Fig 5

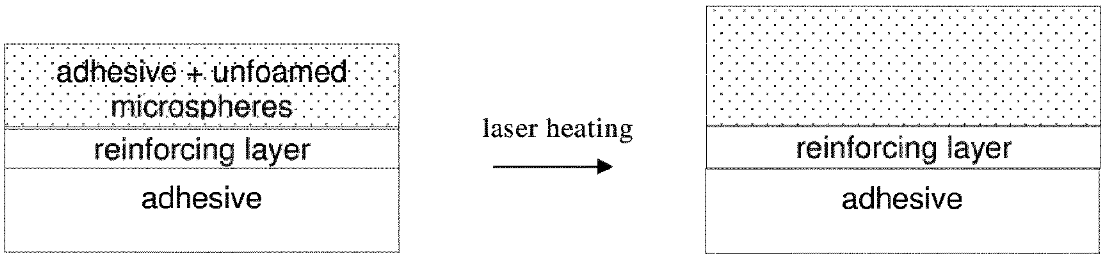

Fig 6

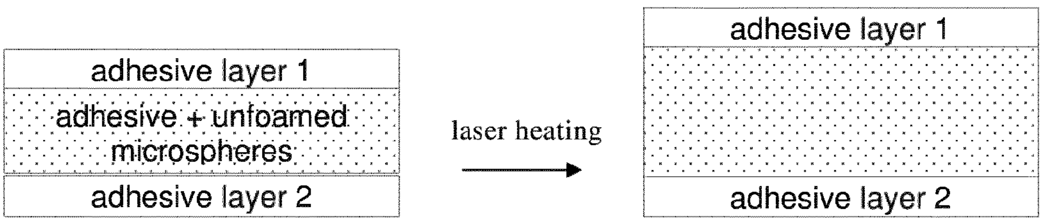

Fig 7

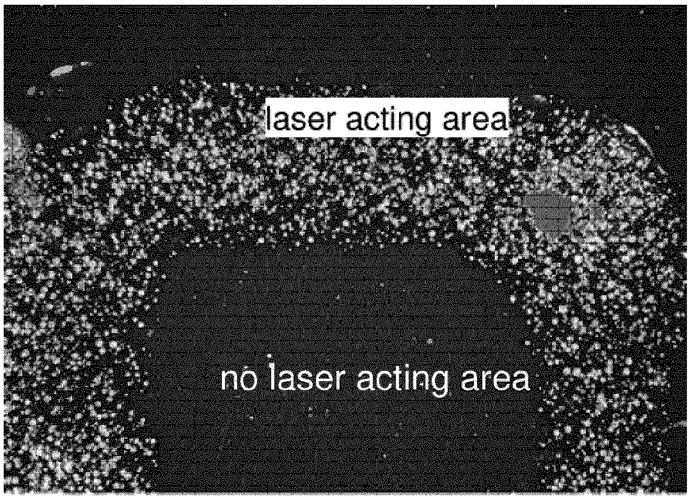

Fig 8

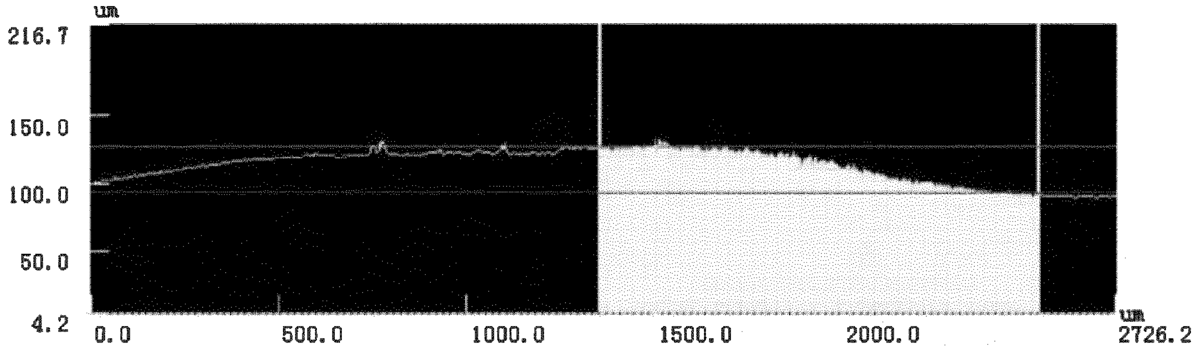

Fig 9

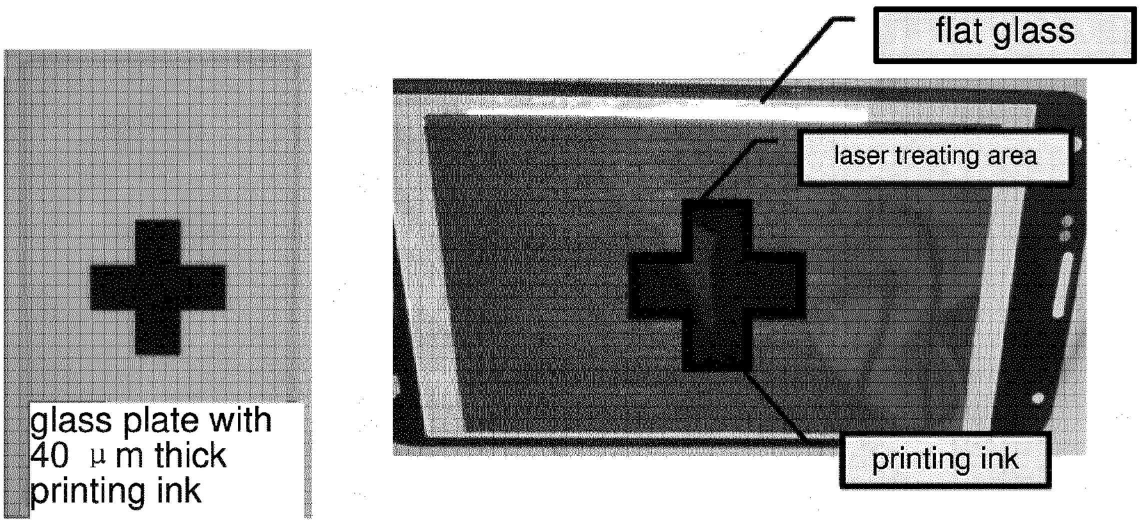

Fig 10

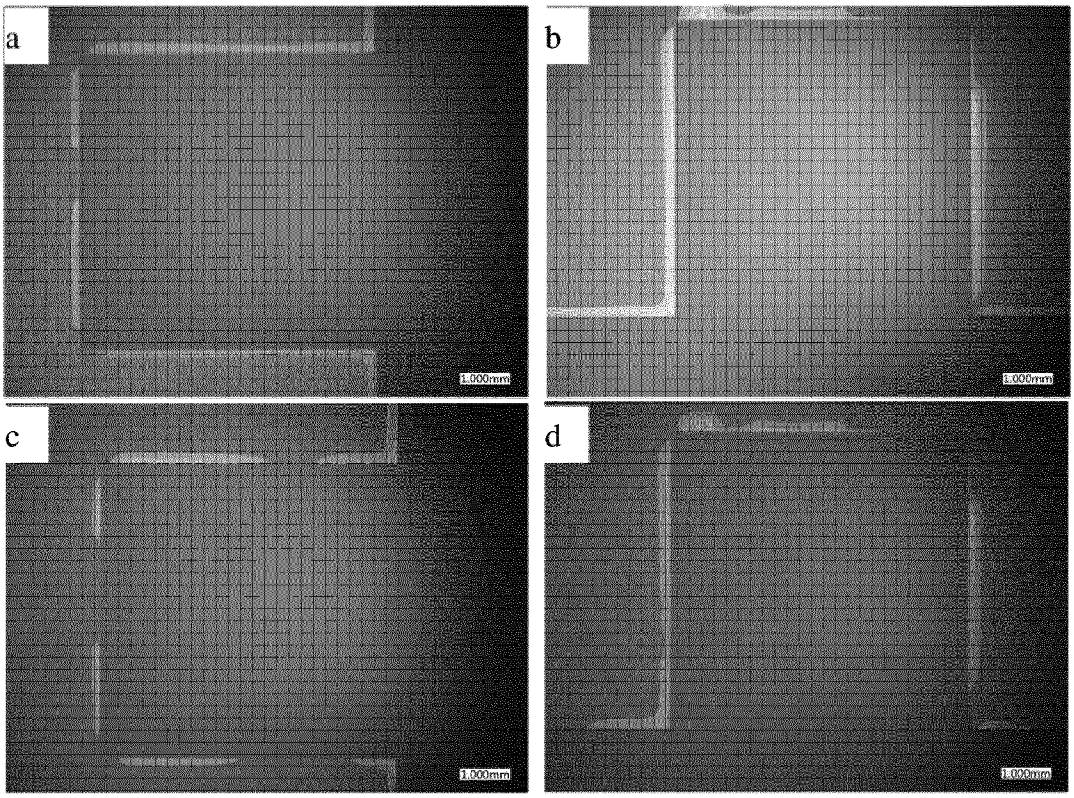
a
b
c
d
1.000mm
1.000mm
1.000mm
1.000mm

Fig 11

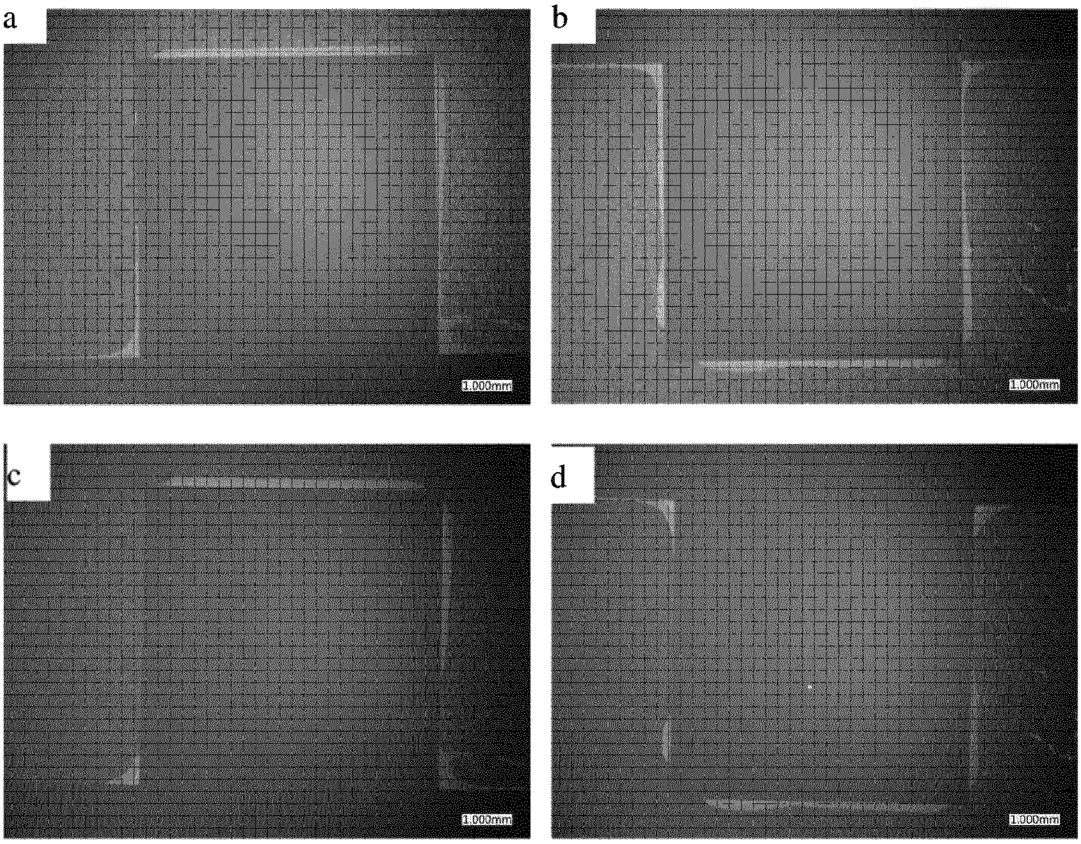
a
b
c
d
1.000mm
1.000mm
1.000mm
1.000mm

Fig 12

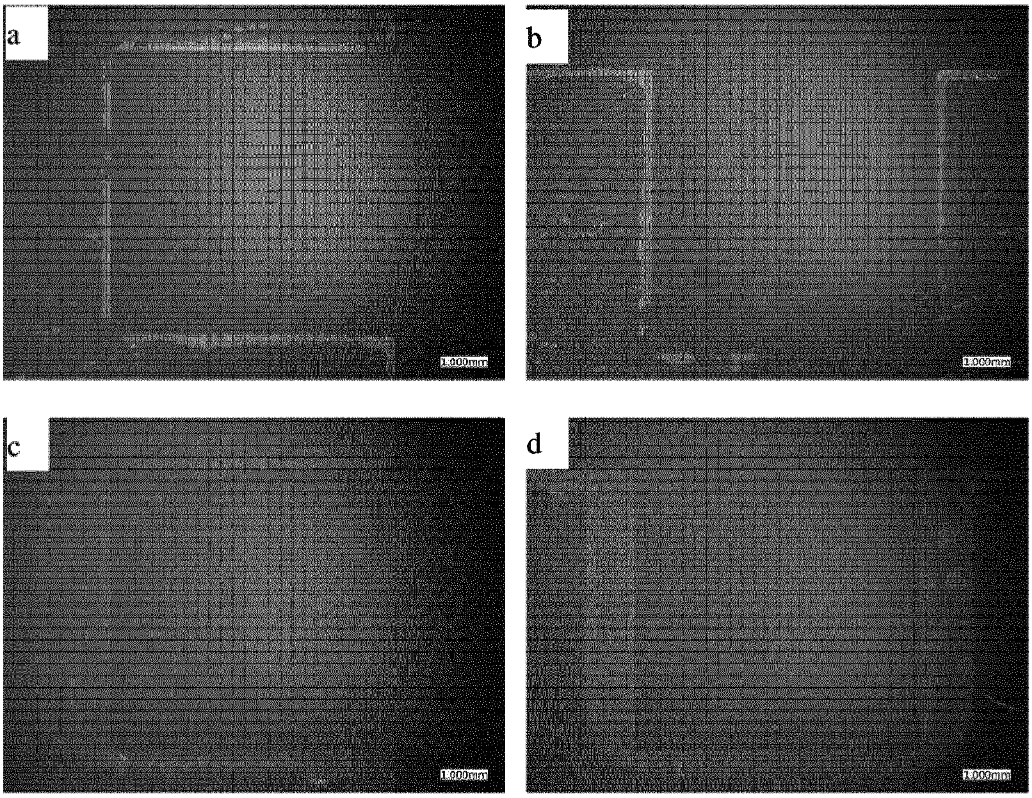

Fig 13

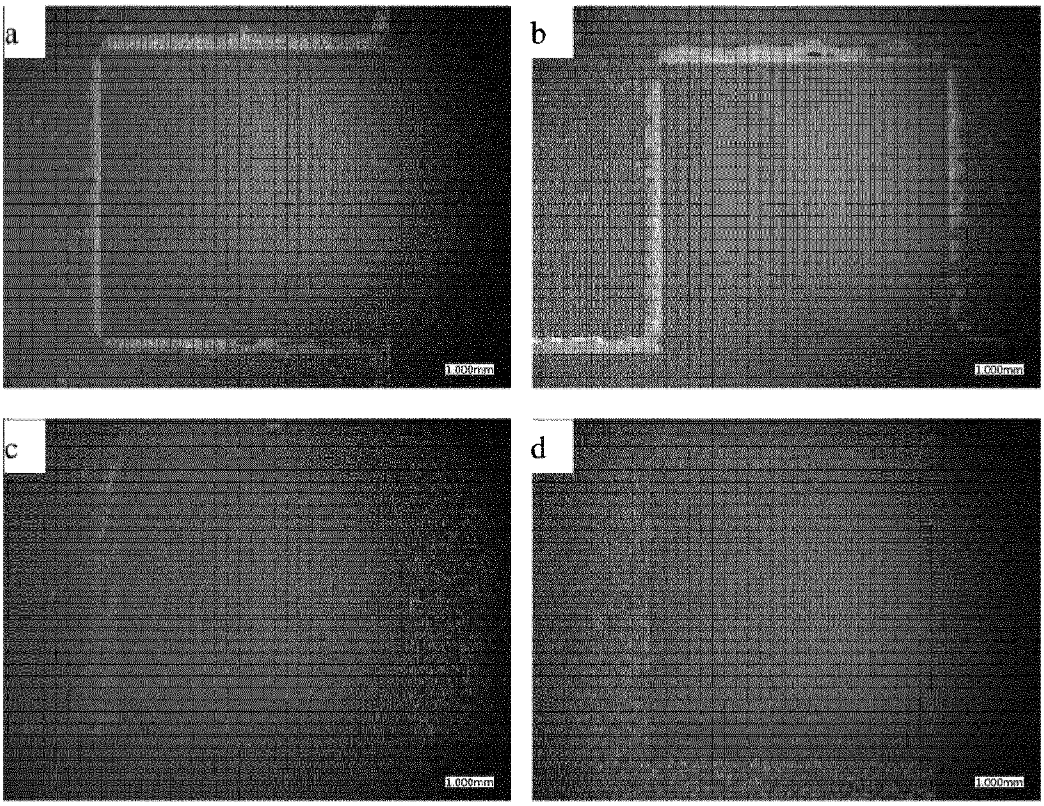

Fig 14

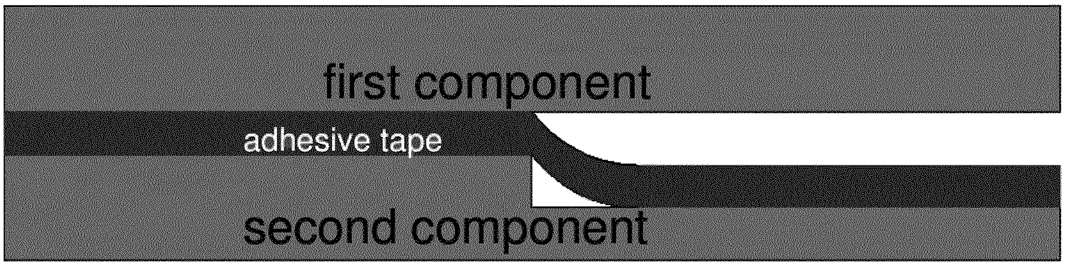

Fig 15

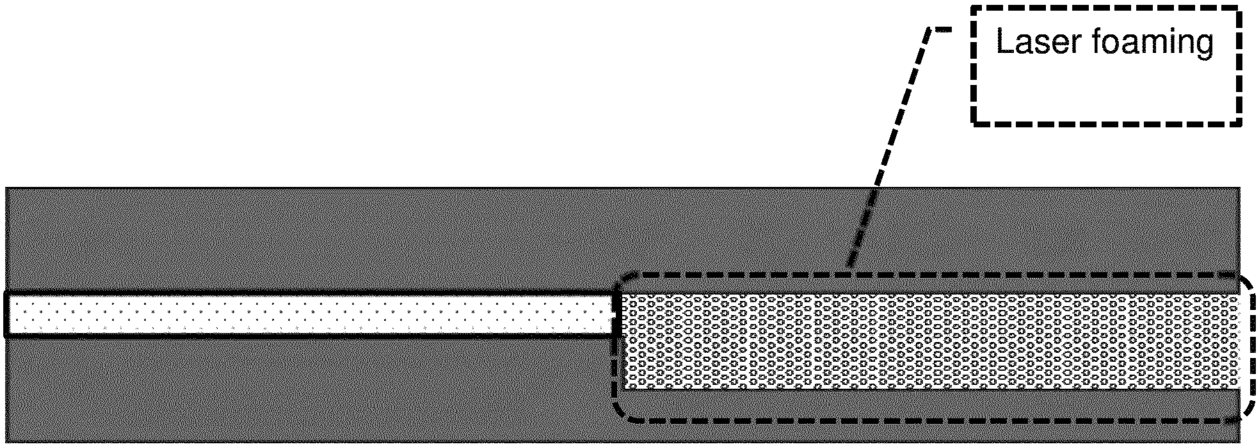

Fig 16

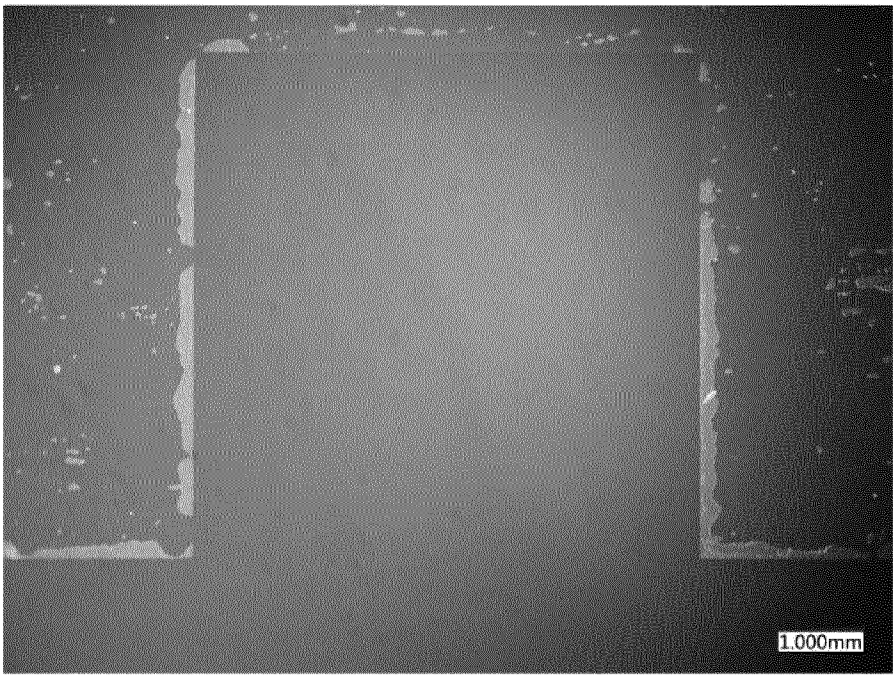

Fig 17

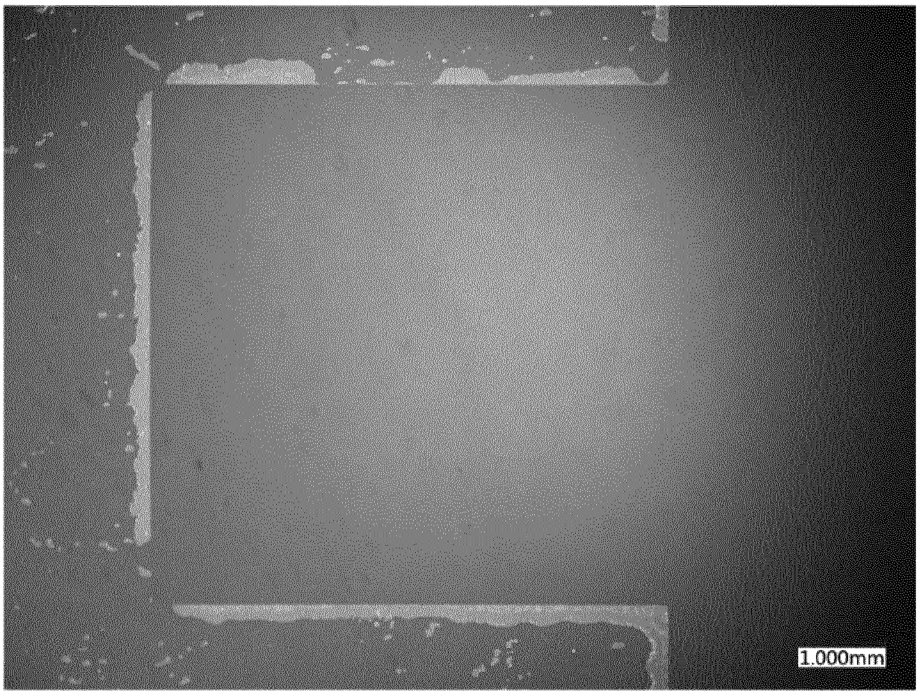

Fig 18

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/084674

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09J7/10 C09J7/38
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)
C09J C08K

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	EP 2 626 395 A2 (NITTO DENKO CORP [JP]) 14 August 2013 (2013-08-14) abstract paragraphs [0031], [0032], [0047], [0048], [0093] paragraph [0131]; claims 1,4,7; example 1 -----	1-10
X	WO 2019/076652 A1 (TESA SE [DE]) 25 April 2019 (2019-04-25) abstract page 16, line 20 - line 35 page 21, line 4 - line 19 page 28, line 9 - line 25 page 29, line 13 - line 19 page 30, line 13 - page 34, line 5 page 51, line 25 - line 33; claims 1,3-5; examples 1,4,5,9,10,14-18; table 1 -----	1-10

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 April 2022	25/04/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Meier, Stefan

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 644 669 A1 (NITTO DENKO CORP [JP]) 2 October 2013 (2013-10-02) abstract paragraphs [0001], [0009], [0013], [0022]; claim 1; example 1 -----	1-10
X	EP 3 567 086 A1 (TESA SE [DE]) 13 November 2019 (2019-11-13) abstract paragraphs [0079], [0149] - paragraphs [0153], [0179] paragraph [0191] - paragraph [0193]; claims 1,7-9,21; example 1 -----	1-10

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2021/084674

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 2626395	A2	14-08-2013	CN	103242752	A	14-08-2013
			EP	2626395	A2	14-08-2013
			JP	2013159743	A	19-08-2013
			KR	20130091262	A	16-08-2013
			TW	201335304	A	01-09-2013
			US	2013199732	A1	08-08-2013
WO 2019076652	A1	25-04-2019	CN	111247221	A	05-06-2020
			DE	102018200957	A1	18-04-2019
			EP	3697861	A1	26-08-2020
			KR	20190105140	A	11-09-2019
			TW	201922997	A	16-06-2019
			WO	2019076652	A1	25-04-2019
EP 2644669	A1	02-10-2013	CN	103360964	A	23-10-2013
			EP	2644669	A1	02-10-2013
			JP	5921927	B2	24-05-2016
			JP	2013203799	A	07-10-2013
			KR	20130110067	A	08-10-2013
			TW	201348391	A	01-12-2013
			US	2013260120	A1	03-10-2013
EP 3567086	A1	13-11-2019	NONE			