Method for the bonding and debonding of substrates

The present invention relates to a method for bonding a product substrate via a connection layer to a carrier substrate as well as to a method for debonding a product substrate from a carrier substrate bonded via a connection layer to the product substrate and to a product-substrate-to-carrier-substrate bond.

A number of methods for debonding/separating two substrates (product substrate and carrier substrate) are known from the state of the art. Most methods use so-called bonding adhesives for achieving a temporary bond between two substrates, which can be easily undone. The bonding adhesives are normally polymers, in particular thermoplastics.

A first method for the temporary bonding consists in coating the entire surface of a substrate. The second substrate is connected to the first substrate by a bonding operation. Separation, i.e. debonding of the two substrates is effected by a shearing process at a raised temperature. This temperature preferably lies above the glass transition temperature of the bonding adhesive. Due to the shearing force applied it is possible to move both substrates relative to each other in a very slow process and thus to separate them from each other.

A second method for temporary bonding consists in treating specific surface areas of the carrier substrate in such a way that the adhesive effect between these surface areas and the bonding adhesive is minimal, in particular completely disappears. Apart from these specifically treated surface areas a very small surface area remains, which is left untreated. This highly adhesive surface area is normally a peripheral circular ring a few millimetres thick. Following this specific treatment the carrier substrate is coated full-surface with the bonding adhesive. Then follows a normal bonding operation. The debonding operation is usually carried out by chemical means in that the rim zone of the bonding adhesive is debonded, thereby reducing the adhesive power between the bonding adhesive and the carrier substrate. Thereafter the carrier substrate can be very easily lifted off the product substrate.

A further method for separating two substrates from each other consists in applying a special soluble layer onto, in particular, a transparent carrier substrate, before the bonding adhesive is applied. Because the carrier substrate is transparent to a specific electromagnetic radiation, the photons are allowed unhindered access to the soluble layer. The photons cause a change in the soluble layer, reducing the adhesive power to the bonding adhesive. Such a method has been described in WO2014058601A1, in which a UV laser is fired onto a soluble layer on the inside of a carrier substrate in order to obtain a reaction there, which causes the bonding adhesive to separate from the carrier substrate and thus causes the carrier substrate to separate from the product substrate.

Embodiments of the invention propose a method and a device, with which an optimised process of bonding and debonding/separating is achieved and with which subsequent method steps are simplified.

According to a first aspect of the present invention, there is provided a method for bonding a product substrate via a connection layer to a carrier substrate, the method including: applying the connection layer to the carrier substrate, wherein the connection layer comprises a bonding adhesive; applying a soluble layer comprising a material selected from the group comprising polymers, metals, non-metals and metal alloys between the connection layer and the product substrate; and irradiating the soluble layer with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation, wherein the connection layer and the carrier substrate are at least predominantly transparent to the electromagnetic radiation.

According to a second aspect of the present invention, there is provided a method for debonding a product substrate from a carrier substrate bonded to the product substrate via a connection layer, wherein a soluble layer is applied between the connection layer and the product substrate, the method including: dissolving the soluble layer by irradiating the soluble layer with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation, wherein the connection layer and the carrier substrate are at least predominantly transparent to the electromagnetic radiation.

According to a third aspect of the present invention, there is provided a product-substrate-to-carrier-substrate bond with a product substrate, which is bonded to a carrier substrate via a connection layer, wherein a soluble layer is arranged between the connection layer and the product substrate, and wherein a) irradiating the soluble layer with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation, and b) the connection layer and the carrier substrate are both at least predominantly transparent to the electromagnetic radiation transmitted through the connection layer.

The scope of the invention also encompasses all combinations of at least two characteristics indicated in the description, the claims and/or the figures. Where value ranges are indicated, values falling within the cited limits shall be considered to be disclosed as threshold values and to be claimable in any random combination.

Embodiments of the invention are based on the idea of proposing a method and a device, with which a product-substrate-to-carrier-substrate bond can be

CLAIMS

1. A method for bonding a product substrate (2) via a connection layer (4) to a carrier substrate (5), the method comprising:

applying the connection layer (4) to the carrier substrate, wherein the connection layer (4) comprises a bonding adhesive;

applying a soluble layer (3) comprising a material selected from the group comprising polymers, metals, non-metals and metal alloys between the connection layer (4) and the product substrate (2); and

irradiating the soluble layer (3) with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation,

wherein the connection layer (4) and the carrier substrate (5) are at least predominantly transparent to the electromagnetic radiation.

2. A method for debonding a product substrate (2) from a carrier substrate (5) bonded to the product substrate (2) via a connection layer (4), wherein a soluble layer (3) is applied between the connection layer (4) and the product substrate (2), the method comprising:

dissolving the soluble layer (3) by irradiating the soluble layer with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation, wherein the connection layer (4) and the carrier substrate (5) are at least predominantly transparent to the electromagnetic radiation.

3. The method according to claim 1 or 2, wherein the physical and/or chemical properties of the soluble layer, with respect to the electromagnetic radiation, are chosen to complement the corresponding physical and/or chemical properties of the connection layer (4) and/or the carrier substrate (5).

4. The method according to any one of the preceding claims, wherein an absorption of photons of the electromagnetic radiation in the connection layer (4) is less than 50 %.

5. The method according to any one of claims 1 to 3, where the absorption of photons of the electromagnetic radiation in the connection layer (4) is less than 25 %.

6. The method according to any one of claims 1 to 3, where the absorption of photons of the electromagnetic radiation in the connection layer (4) is less than 10 %.

7. The method according to any one of claims 1 to 3, where the absorption of photons of the electromagnetic radiation in the connection layer (4) is less than 1 %.

8. The method according to any one of claims 1 to 3, where the absorption of photons of the electromagnetic radiation in the connection layer (4) is less than 0.1 %.

9. The method according to any one of the preceding claims, wherein an absorption of photons of the electromagnetic radiation in the soluble layer (3) is more than 50 %.

10. The method according to any one of claims 1 to 8, wherein the absorption of photons of the electromagnetic radiation in the soluble layer (3) is more than 75 %.

11. The method according to any one of claims 1 to 8, wherein the absorption of photons of the electromagnetic radiation in the soluble layer (3) is more than 90 %.

12. The method according to any one of claims 1 to 8, wherein the absorption of photons of the electromagnetic radiation in the soluble layer (3) is more than 99 %.

13. The method according to any one of claims 1 to 8, wherein the absorption of photons of the electromagnetic radiation in the soluble layer (3) is more than 99.9 %.

14. The method according to any one of the preceding claims, wherein the electromagnetic radiation interacts with the connection layer (4) to change the temperature of the connection layer (4) by less than 50 °C.

15. The method according to any one of claims 1 to 13, wherein the electromagnetic radiation interacts with the connection layer (4) to change the temperature of the connection layer (4) by less than 25 °C, more preferably by less than 10 °C, most preferably by less than 1 °C, at the very most preferably less than 0.1 °C.

16. The method according to any one of claims 1 to 13, wherein the electromagnetic radiation interacts with the connection layer (4) to change the temperature of the connection layer (4) by less than 10 °C.

17. The method according to any one of claims 1 to 13, wherein the electromagnetic radiation interacts with the connection layer (4) to change the temperature of the connection layer (4) by less than 1 °C.

18. The method according to any one of claims 1 to 13, wherein the electromagnetic radiation interacts with the connection layer (4) to change the temperature of the connection layer (4) by less than 0.1 °C.

19. The method according to any one of the preceding claims, wherein the soluble layer (3) is configured or applied with a layer thickness smaller than 10 μm.

20. The method according to any one of claims 1 to 18, wherein the soluble layer (3) is configured or applied with a layer thickness smaller than 1 μm.

21. The method according to any one of claims 1 to 18, wherein the soluble layer (3) is configured or applied with a layer thickness smaller than 100 nm.

22. The method according to any one of claims 1 to 18, wherein the soluble layer (3) is configured or applied with a layer thickness smaller than 10 nm.

23. The method according to any one of claims 1 to 18, wherein the soluble layer (3) is configured or applied with a layer thickness smaller than 1 nm.

24. A product-substrate-to-carrier-substrate bond with a product substrate (2), which is bonded to a carrier substrate (5) via a connection layer (4), wherein a soluble layer (3) is arranged between the connection layer (4) and the product substrate (2), and wherein

a) irradiating the soluble layer (3) with an electromagnetic radiation of a radiation source whereby the radiation leads to lowering of adhesion, wherein the electromagnetic radiation comprising radiation selected from the group comprising microwaves, infrared light, visible light, ultraviolet light and X-ray radiation, and

b) the connection layer (4) and the carrier substrate (5) are both at least predominantly transparent to the electromagnetic radiation transmitted through the connection layer (4)

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