

METHOD OF MAKING AN INLAY FOR A CHIP CARD OR DOCUMENT

Technical Field

5 The present invention relates generally to the field of chip\card and document inlays, and more specifically to a method of making such inlays.

Prior Art

10 EP3311339A1 relates to a security document comprising at least an antenna and a chip connected to the antenna. The security document further comprises at least one transparent window arranged such that at least a part of said antenna is visible in said window, thereby forming a visible security feature.

15 It is an object of the invention to provide an improved method of making inlays for chipcards and documents.

This object is solved by the subject matter of the independent claims. Further developments are given by the subject matter of the dependent claims.

20 The application provides an enhanced Incorporation of a transparent window feature into inlays, by a transparent window that is incorporated in an inlay.

There is disclosed a method of making an inlay wherein an inlay is a material placed within a different material in the form of an add-on for a card or a document, comprising: providing a core layer having a first side and a second side, wherein the core layer comprises a substrate in the form of an underlying layer, and is configured to accommodate an electronic component, such as a discrete device in an electronic system. There is a step of placing a first overlay layer on the first side of the transparent core layer, the first overlay layer having at least one pre-fabricated window, and placing a second overlay layer on the second side of the core layer, the second overlay layer having at least one pre-fabricated window. There is a step of arranging a first insert within the window, wherein a window can be a transparent area in an otherwise opaque material of the first overlay layer. The insert is configured to prevent distortion in the form of an optical phenomenon resulting from the failure of an optical component

to produce a good image. In a transitional region between the first insert and the first overlay layer, there is interlacing between the material of the first insert and the material of the first overlay layer, providing a hot joining. Hot joining is a joining technique used in the manufacture and repair, between the first insert and the first overlay layer, by submitting both the insert and the overlay layer to heat such that they both melt and their molten materials penetrate into each other and then lock mechanically to each other after hardening, and the insert and the overlay layer undercut each other locally, similar to a micro back taper connection. This is achieved without applying any additional glue material between the inserts and the overlay layers, through a hot lamination under pressure by heating the substrates and/or the inlays over their softening points. "Hot joining" is sometimes also called "adhesive bonding", and this is done without adding additional glue materials into the joint between the two joined materials. That adds extra stability to the chip card.

The first overlay layer and the second overlay layer can comprise a high-opaque material configured to cover visibility, wherein visibility is the capability of providing an unobstructed view, of the electronic component,

The electronic component comprises a chip module in the of a contactless chip module and an embedded antenna that is integrated into the core layer using wire embedding.

In a development, the application provides an assembly, i.e. a unit comprising components that have been fitted together.

Embodiments of the invention are associated with various advantages and/or technical effects.

There is disclosed a method of making an inlay for a card or document, comprising:

- providing a core layer having a first side and a second side, wherein the core layer comprises a substrate and is configured to accommodate an electronic component;
- placing a first overlay layer on the first side of the transparent core layer, the first overlay layer having at least one pre-fabricated window;
- placing a second overlay layer on the second side of the core layer, the second overlay layer having at least one pre-fabricated window;

- arranging a first insert within the window of the first overlay layer, wherein the insert is configured to prevent distortion of the window during lamination;
- integrating an electronic component within the core layer.

According to the application, there is a transitional region between the first insert and the first overlay layer, there is interlacing between the material of the first insert and the material of the first overlay layer. That interlacing provides a hot joining between the insert and the first overlay layer, by submitting both the insert and the overlay layer to heat such that they both melt and their molten materials penetrate into each other and then lock mechanically to each other after hardening and the overlay layer undercut each other locally in order, similar to a micro back taper connection.

Utilizing an insert to prevent distortion during lamination increases the accuracy of the placement of the pre-fabricated window, ensuring that the electronic component and optical variable material are properly aligned.

Integrating the electronic component within the core layer makes it more difficult to create unauthorized copies of the inlay and the chip card.

Undercutting the overlay layers locally creates a stronger and more secure connection between the various layers of the inlay, preventing tampering and increasing its overall effectiveness as a security measure.

In a development:

- the insert comprises an optical variable material configured to provide a security feature,
- the core layer comprises an optical variable material configured to provide a security feature, and
- the first overlay layer and the second overlay layer comprise a high-opaque material configured to cover the visibility of the electronic component, wherein the optical variable material provides unique characteristics such as color shift, UV strong fluorescence, or a holographic or diffractive pattern.

The electronic component comprises a chip module in the form of a contactless chip module and an embedded antenna that is integrated into the core layer using wire embedding.

- 5 The use of an optical variable material in the insert and core layer provides a unique and difficult-to-replicate security feature that can be easily recognized by authorized parties.

10 The integration of a contactless chip module and embedded antenna within the core layer ensures that the electronic component is protected from external damage and provides a more seamless user experience.

15 The hot joining created by the interlacing of the insert and overlay layer materials creates a strong and reliable connection that is less likely to delaminate or fail during use.

In a development, an inlay for a card or document comprises:

- a core layer having a first side and a second side, and the core layer is configured to accommodate an electronic component
- 20 - a first overlay layer disposed on a first side of the transparent core layer, the first overlay layer having at least one pre-fabricated, e.g. by pre-punching, window
- a second overlay layer disposed on a second side of the core layer, the second overlay layer having at least one pre-fabricated window,
- a first insert arranged within the window of the first overlay layer, wherein the insert
- 25 is configured to prevent distortion of the window during lamination, and
- an electronic component integrated within the core layer.

30 In a transitional region between the first insert and the first overlay layer, there is interlacing between the material of the first insert and the material of the first overlay layer providing a hot joining between the first insert and the first overlay layer.

The transparent or opaque nature of at least one layer of the inlay allows for greater customization and functionality depending on the intended use.

The use of a PC film, a PVC film, or a PETG film as the substrate for the core layer provides a strong and durable material that is resistant to damage and less susceptible to warping or distortion.

- 5 Using PC film, a PVC film, or a PETG film for the overlay layers provides a high level of opacity, increasing the security of the inlay by preventing unauthorized parties from viewing the electronic component or optical variable material.

- 10 In a development, at least one of the core layer, the first overlay layer, or the second overlay layer is transparent or opaque.

Utilizing an insert to prevent distortion during lamination creates a more precise and accurate inlay, reducing waste and increasing manufacturing efficiency.

- 15 Integrating the electronic component within the core layer provides a more streamlined and efficient manufacturing process, reducing the number of individual components that need to be assembled.

- 20 The hot joining created by the interlacing of the insert and overlay layer materials provides a more secure and reliable inlay, reducing the risk of defects or failures during use.

- 25 In a development, the substrate of the core layer comprises a PC film, a PVC film, or a PETG film.

The use of an optical variable material in the insert and core layer provides a unique and easily identifiable security feature that is difficult to replicate, increasing the overall effectiveness of the inlay as a security measure.

- 30 The integration of a contactless chip module and embedded antenna within the core layer provides a more durable and secure electronic component that is less likely to be damaged or fail during use.

The hot joining created by the interlacing of the insert and overlay layer materials creates a strong and reliable connection that is less likely to delaminate or fail during use, increasing the overall longevity of the inlay.

- 5 In a development, the first overlay layer and/or the second overlay layer comprise a PC film, a PVC film, or a PETG film.

The use of a polycarbonate (= PC) film, a PVC film, or a PETG film as the substrate for the core layer provides a strong and durable material that is resistant to damage and wear, increasing the overall longevity of the inlay.

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Using PC film, a PVC film, or a PETG film for the overlay layers provides a high level of opacity, increasing the security of the inlay by preventing unauthorized parties from viewing the electronic component or optical variable material.

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The hot joining created by the interlacing of the insert and overlay layer materials provides a strong and reliable connection that is less likely to delaminate or fail during use, increasing the overall effectiveness of the inlay as a security measure.

- 20 In a development, the insert comprises a PC film, a PVC film, or a PETG film.

The use of a PC film, a PVC film, or a PETG film as the insert provides increased durability and resistance to wear and tear.

- 25 The PC film, a PVC film, or a PETG film insert can be easily customized with different security features for enhanced protection against counterfeiting.

The transparency of the PC film, a PVC film, or a PETG film insert allows for easy visibility and inspection of the underlying electronic component.

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In a development, the insert comprises an optical variable material configured to provide a security feature.

The optical variable material insert provides a high level of security against counterfeiting due to its unique visual characteristics.

5 The optical variable material insert can be customized to create a range of different security features, including color-shifting, UV-reactive, and holographic patterns.

Optical variable material inserts can be easily integrated into existing manufacturing processes for electronic components, making them a cost-effective security solution.

10 In a development, the core layer comprises an optical variable material configured to provide a security feature.

15 Incorporating an optical variable material into the core layer of the electronic component provides a higher level of security compared to surface-level security features.

The optical variable material can be easily customized to create unique security features that are difficult to replicate.

20 By integrating the security feature into the core layer, the electronic component remains protected even if the surface level security features are compromised.

25 In a development, the first opaque overlay layer and the second opaque overlay layer comprise a high-opaque material configured to cover visibility of the electronic component.

The use of high-opaque materials in the first and second overlay layers ensures complete visibility is covered, preventing unauthorized access and tampering.

30 High-opaque materials can be easily customized to match the design requirements of the electronic component without compromising security.

High-opaque materials provide an additional layer of protection against environmental factors such as moisture or heat.

In a development, the transparent inserts are made from an optical variable material, providing unique characteristics such as color shift, UV strong fluorescence, and other security features.

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The use of optical variable material in transparent inserts provides a cost-effective solution to creating unique visual characteristics for enhanced security.

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The optical variable material provides a high level of customization, allowing for a range of security features to be easily incorporated.

The transparent nature of the inserts allows for easy visibility and inspection of the underlying electronic component.

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In a development, the optical variable material further comprises a holographic or diffractive pattern.

Incorporating holographic or diffractive patterns into the optical variable material provides an additional layer of security against counterfeiting.

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Holographic or diffractive patterns are difficult to replicate, making them an effective security feature against tampering or fraud.

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The use of holographic or diffractive patterns can be easily integrated into existing manufacturing processes for electronic components, making them a cost-effective security solution.

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In a development, the electronic component comprises a chip module and an embedded antenna.

The use of a contactless chip module eliminates the need for physical contact, reducing wear and tear on the chip and extending its lifespan.

The use of wire embedding technology to integrate the antenna into the core layer provides a more efficient and reliable antenna², improving the overall performance of the electronic component.

- 5 The transparent windows and inlays allow for easy visibility and customization, making the assembly suitable for a variety of applications across industries.

In a development, the chip module is a contactless chip module.

- 10 The use of a wireless charging system eliminates the need for cords and cables, reducing clutter and simplifying the charging process.

The high efficiency of the wireless charging system allows for faster charging times and energy savings compared to traditional charging methods.

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The compact design of the wireless charging system makes it suitable for use in a variety of portable and stationary electronic devices.

- 20 In a development, the embedded antenna is integrated into the core layer using wire embedding.

- 25 In a development, the application provides An assembly, comprising: transparent core layer white/opaque layer 2 insert chip module embedded antenna transparent window inlay inlays transparent windows core layer core layers windows window chip cards 8 cards 8 opaque overlays 9 overlays 9 overlay layers chip antenna² .

The use of a multi-layered construction provides a strong and durable material suitable for use in a variety of applications across industries.

- 30 The ability to customize the color and transparency of each layer allows for a high degree of flexibility in the design and production process.

The use of a UV-resistant material in the construction provides long-lasting protection against sun damage, making the material suitable for outdoor use.

The term "core layer" is used herein to refer to a layer comprising one or more layers of the core layer. The term "transparent core layer" is used herein to refer to a layer comprising at least one layer of transparent or opaque plastic.

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A "transparent windows core layer" designates: the term transparent windows core layer refers to a window in the core layer that is transparent to light that is transmitted through the core layer.

10 The term "white/opaque layer" is used herein to refer to a layer that has a relatively low translucence.

An "insert" designates an element that is inserted or is to be inserted into a window.

15 The term "chip module" as used herein refers to a device that comprises an electronic component, such as a microcontroller.

The term "embedded antenna" is used herein to refer to an electronic component that is embedded within a layer of a chip card or other document.

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The term "transparent window" is used herein to refer to a transparent void.

A "window" designates a transparent area in an otherwise opaque material.

25 An "inlay" designates a component that is placed in a chipcard or document blank in order to provide a functional assembly.

The term "chip cards" or "cards" is used herein to refer to any type of electronic chip card.

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The term "opaque overlay" is used herein to refer to a layer that has a reduced translucence. The term "overlay layer" is used herein to refer to a layer that is configured to provide an overlay for an electronic component, such as a chip module or an antenna.

An "antenna" designates: an electrical device that sends or receives radio or television signals.

- 5 The term "overlay layer" is used herein to refer to a layer that is configured to provide an overlay for a core layer of a chipcard or a document.

Short Description of the Figures

- 10 Figure 1 shows a material flow during hot lamination,
Figure 2A shows a transparent window 6 shape before lamination,
Figure 2B shows a transparent window 6 shape after lamination, without an insert 3 according to the application,
Figure 3 shows a flowing behavior of material comparing between with vs without
15 inserts 3,
Figure 4 shows an inlay design with transparent windows 6,
Figure 5 shows an inlay design with pre-cut windows 6,
Figure 6 shows an inlay construction with inserts 3 filling,
Figure 7 shows an inlay design with high opaque overlay,
20 Figure 8 shows an inlay design with optical variable material Inserts 3,
Figure 9 shows an inlay design with optical variable material core layer,
Figure 10 shows an inlay design with transparent windows 6,
Figure 11 shows an inlay design with pre-cut windows 6, and
Figure 12 shows an inlay design with inserts 3 filling.

- 25 The present disclosure is illustrated by way of example and not limited in the accompanying figures in which like reference numerals indicate similar elements. Embodiments of the application will now be described with reference to the attached drawings

- 30 The application describes product design and processes of how the transparent window 6 feature can be created and incorporated into inlays 7 in a better appearance. The feature will then be used for displaying security elements that are embedded in chip cards 8 that are made with the inlay 7 according to the application.

An inlay 7 with transparent windows 6 comprises the inserts 3 and multi-layered substrates such as PC. The core layer 1 or core layers 1 are transparent, where copper wire antennas and chip 11 modules are embedded and covered by white or opaque overlays 9 or overlay layers 10 on both top and bottom.

The application takes advantage of the opaque overlays 9 to create white plain inlay 7 surface, this would also cover visibility of wire-embedded antennas and chip 11 modules. With the pre-punched windows 6 in specific area on both sides of opaque overlays 9, it creates see-through function on inlays 7. The inserts 3 are used to fill in the gaps, keeping control of the windows 6 shape and their size to remain in defined dimensions.

The application aims at the following matters:

1. How to create a transparent windows 6 feature at inlays 7 and
2. How to control transparent windows 6 shrinkage.

The transparent windows 6 of the application are built into the chip cards 8 during cards 8 production. The process is easy. One way to achieve this is already integrate into inlays 7 prior to making cards 8, using these inlays 7. The feature can be developed and incorporated into inlays 7.

Basically, the transparent windows 6 can be simply created by having pre-punched windows 6 on the opaque overlays 9. But with this current method, there is always a difficulty to keep control of window 6 shrinkage after lamination, as the consequence the size and shape of the windows 6 will alter and not in accordance with the defined dimensions anymore.

Therefore the application will not only aim to offer inlay 7 solution with transparent windows 6 feature but will also incorporate an enhanced and industrialized methods to better keep the windows 6 within the defined shape and dimensions by using the inserts 3 to fill in the gap.

The inserts 3 will function as a brick, preventing the core layers 1 and overlay layers 10 from freely and uncontrollably flowing into the gaps when being melted, causing a distortion of the transparent windows 6.

5 Step 4 – Novel Aspects of the Invention:

As previously mentioned in above paragraphs, there are among others two concerns that this application tries to resolve.

10 Firstly the incorporation of the transparent windows 6 into inlays 7, this can be achieved by using white or opaque overlays 9 with pre-punched windows 6 on both sides.

The others would focus on how the transparent windows 6 can be created but the
15 problem still remains as the size and shape of the windows 6 cannot be controlled, or that the size and shape get melted, distorted and do not remain in the defined dimensions anymore.

Detailed description

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Figure 1 explains the overlay and core layers 1 behavior when being melted and move during lamination, flowing into the gaps.

Figure 2 illustrates how the transparent windows 6 mostly look like after lamination.

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This application will intentionally focus on how to overcome a material shrinkage and distortion problem, the inserts 3 that are prepared in accordance with the size and shape of the pre-punched windows 6 of the opaque overlays 9 are used to fill in the gaps. And they would technically block or prevent the overlay and transparent core
30 layers 1 from moving during lamination into the gaps, altering windows 6 shape and size.

The inserts 3 would prevent the material from moving freely into the gaps and help keep the transparent window 6 remain in the defined shape and size.

Figure 3 describes the different flowing behavior of the substrate when being melted during lamination, comparing between the product with and without the inserts 3.

- 5 Figure 3 also describes a method for creating an inlay 7 for a card or document. The method involves providing a core layer 1 with two sides, designed to hold an electronic component. A first or upper overlay layer with a pre-fabricated window 6 is placed on one upper side of the core layer 1, while a second overlay layer with a pre-fabricated window 6 is placed on the other side. A first insert 3 is arranged within the window 6 of the first overlay layer to prevent distortion during lamination. An electronic component is integrated into the core layer 1. In a transitional region between the first insert 3 and the first overlay layer, the materials of the insert 3 and overlay layer interlace, creating a secure adhesive bond. This bond is achieved by applying heat, allowing the materials to melt, penetrate into each other, and mechanically lock together after hardening, forming a snug fit.

Step 5 – Conceptual Model:

- Figure 4, it illustrates inlay 7 structure with transparent window 6 feature, consisting of 5 main components which are.

Transparent core layer 1:

- can be any substrate such as PC film, a PVC film, or a PETG film.
- single or multi layers.
- 25 - transparent color, can be standard film, laserable and/or optical variable material .
- thickness can vary, mainly depending on chip module 4 thickness.
- the layer where antenna 12 and chip module 4 are embedded.

White/opaque layer 2:

- 30 - can be any substrate such as PC film, a PVC film, or a PETG film.
- single or multi layers.
- "White/opaque" means that it can have white or opaque color.
- thickness variable.

the layer where transparent windows 6 can be incorporated.

Insert 3

- can be any substrate such as PC film, a PVC film, or a PETG film.
- transparent color, can be standard film, laserable and/or optical variable material .

5 chip module 4

contactless chip module 4.

- can be memory and/or controller chip 11 where the data is stored.
 - communication with reader is done wireless through electromagnetic induction, using
- 10 radio frequency, via embedded antenna 5 which is connected to the chip module 4.

Embedded antenna 5

- copper based wire.
 - integrated into core layer 1 using wire embedding.
- 15 - connected to chip module 4 using thermocompression.

The terms “chip module 4” and “copper wire”, and “embedded antenna 5” are used as a reference to electronic component parts in general, and the product design with the transparent window 6 feature can be applied using other chip 11 form factors and

20 antenna 12 form factors, for instance bare die using flip chip 11 technology on a substrate where the antenna 12 is done by different technology and material such as printing or etching.

How the transparent windows 6 can be created and achieved. The opaque overlay

25 layers 10 are to be prepared with pre-cut windows 6 in defined size and shape which are freely adaptable.

Fig. 4 describes a method that expands on Fig. 3, where a second overlay layer with at least one pre-punched window 6 is placed on the second or lower side of the core layer 1. A second insert 3 is arranged within the lower window 6 of the second overlay

30 layer to prevent distortion during lamination. In a transitional region between the second insert 3 and the second overlay layer, the materials interlace to create an adhesive bond, achieved by applying heat, allowing the materials to melt, penetrate into each other, and mechanically lock together after hardening.

Transparent core layer 1 which can be a single or multi layers and where the electronic components such as chip module 4 and antenna 12 are located, will be sandwiched by the opaque overlays 9 with pre-cut windows 6 on both sides. The opaque overlays 9 will create white plain inlay 7 surface, leaving the pre-cut areas seen through but key is to ensure that the pre-cuts are aligned on both sides during the layers collation process, Figure 5.

Technically the inlays 7 which are produced using the conceptual model in Figure 5 could already create transparent windows 6 but due to the fact that the inlays 7 in general are hot-laminated in high temperature and pressure under a certain period, Using the subject matter of the application, the material is prevented from getting melted and shrunk, specifically in the pre-cut areas, and from flowing freely and uncontrollably into the gaps. As the consequence, the shape and size of the windows 6 will not alter and stay in accordance with the defined dimensions.

Figure 6 describes how the inserts 3 are used. As technically described shrinkage behavior of the material when being melted, the inserts 3 relevant to this application.

The inserts 3 can be standard transparent film, laserable and/or optical variable material . Their shape and size are freely adaptable which is in accordance with the pre-cuts of the opaque overlays 9.

The inserts 3 are not meant to change the shrinkage behavior of the material during hot lamination as it cannot be but in fact it will be specifically used to fill in to the pre-cuts, eliminating the gaps and preventing the overlay and core layers 1 from being melted into.

Therefore the combination of using opaque overlays 9 with pre-cuts together with the inserts 3 filling techniques, it will not only be able to incorporate the transparent windows 6 into inlays 7 but also to offer an enhanced method to limit uncontrolled shrinkage and flowing behavior which cause a distortion to the windows 6 shape and size.

Step 6 – Optional Features:

Optional feature : High opaque overlay

- 5 To be more specific on the material to be used as overlay, the idea behind is not to just use standard white/opaque color but to use high opaque. The advantage of high opaque material is that it will create solid white plain on the inlay 7 surface which covers visibility of chip module 4 and copper wire antenna 12. This will accommodate the customer to comfortably select transparent layers to be added during cards 8
10 production, Figure 7.

Optional feature : optical variable material inserts 3

- 15 The inserts 3 in general is standard transparent film but we can optionally replace it with optical variable material, Figure 8. The optical variable material is a colored transparent film which has characteristics such as color shift, UV strong fluorescence and etc. With the optical variable material as the inserts 3, it would introduce a more secured product.

- 20 With optical variable material, the color of the clear window 6 can switch between two colors depending on a bright or dark background. Integrated in transparent PC films used for clear window 6 applications, it is compatible with existing production processes. The optical variable material enables clear windows 6 in identification documents with a visual effect in security. A typical thickness of the optical variable
25 material is about 100 μm . Under the flashlight of a smartphone or other conventional white light source, the insert 3 can turn into a second colour such as green, while it is in a shadow it remains in a first colour such as pink. The optical variable material can be provided according to the instructions given in the WO2011064162.

- 30 Optional feature: optical variable material core layer 1

Core layer 1 where the chip module 4 and antenna 12 are located, it is basically a standard transparent film but we can optionally replace it with optical variable material, Figure 9. This will provide a more secured product and its unique characteristics of the

optical variable material such as secondary color and strong fluorescence can be entirely seen on the edges.

Step 7 – Final Product:

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Figure 10 illustrates an inlay 7 structure with a transparent window 6 feature, consisting of 5 main components which are.

Transparent core layer 1

- 10
- can be any substrate such as PC film, a PVC film, or a PETG film.
 - single or multi layers.
 - transparent color, can be standard film, laserable and/or optical variable material .
 - thickness can vary, mainly depending on chip module 4 thickness.
 - the layer where antenna 12 and chip module 4 are embedded.

15

White/opaque layer 2

- can be any substrate such as PC film, a PVC film, or a PETG film.
 - single or multi layers.
 - white/opaque color.
- 20
- thickness variable.
 - the layer where transparent windows 6 can be incorporated.

Inserts 3

- can be any substrate such as PC film, a PVC film, or a PETG film.
- 25
- transparent color, can be standard film, laserable and/or optical variable material .

chip module 4

- contactless chip module 4.
 - can be memory and/or controller chip 11 where the data is stored.
 - communication with reader is done wireless through electromagnetic induction, using
- 30
- radio frequency, via embedded antenna 5 which is connected to the chip module 4.

Embedded antenna 5

- copper based wire.
- integrated into core layer 1 using wire embedding.

- connected to chip module 4 using thermocompression.

The term "chip module 4" 4 and "copper wire embedded antenna 5" 5 are used as reference to electronic component parts in general, and the product design with the transparent window 6 feature can be applied using other chip 11 form factors and antenna 12 form factors, for instance bare die using flip chip 11 technology on a substrate where the antenna 12 is produced by different technology and material, such as printing or etching.

How the transparent windows 6 can be created and achieved: The opaque overlay layers 10 are to be prepared with pre-cut windows 6 in defined sizes and shapes which are freely adaptable.

Transparent core layer 1 which can be a single or multi layers and where the electronic components such as chip module 4 and antenna 12 are located, will be sandwiched by the opaque overlays 9 with pre-cut windows 6 on both sides. The opaque overlays 9 will create white plain inlay 7 surface, leaving the pre-cut areas seen through. In the next step, it is ensured that the pre-cuts are aligned on both sides during layers collation process, see Figure 11.

Technically, the inlays 7 which are produced using the conceptual model in figure 5 can be seen as transparent windows 6 and because the inlays 7 in general are hot-laminated in high temperature and pressure during a certain period, the material gets melted and shrunk. Specifically in the pre-cut areas, creating gaps, the material could flow in freely and uncontrollably. As the consequence, the shape and size of the windows 6 would alter and stay not in accordance with the defined dimensions anymore.

Figure 12 describes how the inserts 3 are used. As technically described shrinkage behavior of the material when being melted, the inserts 3 according to this application are provided

The inserts 3 can be standard transparent film, laserable and/or optical variable material. Their shape and size are freely adaptable which is in accordance with the pre-cuts of the opaque overlays 9.

- 5 The inserts 3 are not meant to change the shrinkage behavior of the material during hot lamination as it cannot be and in fact they are specifically used to fill in to the pre-cuts, eliminating the gaps and preventing the overlay and core layers 1 from being melted into to.
- 10 Therefore the combination of using opaque overlays 9 with pre-cuts together with the inserts 3 filling techniques, it will not only be able to incorporate the transparent windows 6 into inlays 7 but also to offer an enhanced method to limit uncontrolled shrinkage and flowing behavior which cause a distortion to the windows 6 shape and size.

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The present application relates to a method for bonding a plastic overlay layer, which includes a pre-punched window (6), to a plastic insert (3) positioned in the window (6). Specifically, the bonding occurs at a transitional area between the overlay layer and the insert (3), after submitting both the overlay layer and the insert (3) to a lamination

20 process. The lamination process causes the plastic of the insert (3) and the plastic of the overlay layer to start melting, resulting in adhesion between the insert (3) and the overlay layer.

Physical absorption is an important mechanism for achieving adhesion between the

25 surfaces of the insert (3) and the overlay layer. This mechanism involves weak attractive forces, known as van der Waals forces, operating between the adhesive and adherend. These forces are of two types: the weaker dispersion forces and the stronger polar forces. Because van der Waals forces occur between any two molecules in contact, they contribute to all adhesive bonds. To obtain good absorption,

30 the distance between the molecules of adhesive and adherend must converge toward molecular intervals such that van der Waals interaction takes place. The lamination process provides that the adhesion occurs over a large part or the entire surface between the overlay layer and the insert (3).

Chemical bonding can also be employed to achieve higher bond strength. This involves the formation of covalent, ionic, or hydrogen bonds across the interface. The introduction of molecular bonding between the adhesive and the adherend can be obtained by reactions at the surfaces, using proper surface treatments or additional coupling agents at the surfaces between the overlay layer and the insert (3).

Diffusion is another mechanism of bonding that is specific to polymers. The lamination process provides that the molecular chains of the polymers can interpenetrate at the interface between the surfaces of the insert (3) and the overlay layer, resulting in the two surfaces becoming interlocked at a molecular level, and therefore becoming one.

Electrostatic adhesion is based on the difference in electronegativities of the adhering materials. The adhesion forces between the adherend and adhesive layer are applied by contact or transfer potentials. These transfer potentials cause the buildup of an electric double layer at the adhesive-adherend boundary, resulting in corresponding Coulomb attraction forces between the surfaces of the insert (3) and the overlay layer.

Although chemical bonds are a significant contributor to the adhesion bond, an important force behind the adhesion is mechanical interlocking. By submitting both the insert (3) and the overlay layer to heat, they both melt such that their molten materials can penetrate into each other and then lock mechanically to the adherend after hardening. That and the increased surface at the transitional area between the two result in a mechanical bond that significantly contributes to the overall strength of the bond between the plastic overlay layer and the plastic insert (3).

In summary, the method of bonding a plastic overlay layer with a pre-punched window (6) to a plastic insert (3) involves a lamination process that melts the plastic of both components, allowing for adhesion between the surfaces of the insert (3) and the overlay layer.

Any one of the presently described embodiments can be advantageously combined with any other one.

It is suggested to combine described embodiments, or combinations thereof, with one or more of the following techniques or technologies or concepts or ideas or paradigms or states or the like:

- 5 Embodiments not shown here provide a method that builds upon Fig. 3 or 4, incorporating optical variable material (O.V.M) in the insert 3 and core layer 1 to provide a security feature, and using high-opaque material in the first and second overlay layers 10 to cover the visibility of the electronic component.
- 10 The O.V.M exhibits unique characteristics such as color shift, UV strong fluorescence, or holographic or diffractive patterns. The electronic component consists of a contactless chip module 4 and an embedded antenna 5 integrated into the core layer 1 using wire embedding.
- 15 Other embodiments have an inlay 7 for a card or document that features a core layer 1 with a first and second side, configured to accommodate an electronic component. A first overlay layer with at least one pre-fabricated window 6 is placed on the first side of the core layer 1, while a second overlay layer with at least one pre-fabricated window 6 is placed on the second side. A first insert 3 is arranged within the window
20 6 of the first overlay layer, preventing distortion during lamination. The electronic component is integrated within the core layer 1. In a transitional region between the first insert 3 and the first overlay layer, the materials interlace, providing an adhesive bond between the first insert 3 and the first overlay layer.
- 25 Other embodiments have an inlay 7 which includes a second overlay layer with at least one pre-punched window 6 on the second side of the core layer 1. A second insert 3 is arranged within the window 6 of the second overlay layer to prevent distortion during lamination. In a transitional region between the second insert 3 and the second overlay layer, the materials interlace to create an adhesive bond between them.
- 30 In further embodiments, at least one of the core layer 1, the first overlay layer, or the second overlay layer has varying levels of transparency or opacity, especially where the substrate of the core layer 1 is made of a PC film, a PVC film, or a PETG film.

Either the first overlay layer, the second overlay layer, or both can be composed of a PC film, a PVC film, or a PETG film, and also the insert 3 can be made of a PC film, a PVC film, or a PETG film.

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The insert 3 can include an optical variable material (O.V.M) that provides a security feature and also the inlay 7 and the core layer 1 can include a optical variable material (O.V.M) designed to provide a security feature.

10 The first and second opaque overlay layers 10 can be made of high-opaque material to conceal the electronic component. Transparent inserts 3 can be made from an optical variable material (O.V.M) that provides unique characteristics such as color shift, UV strong fluorescence, and additional security features. The optical variable material (O.V.M) can also include a holographic or diffractive pattern.

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In other embodiments, the electronic component can comprise a chip module 4 and an embedded antenna 5, wherein the chip module 4 can be a contactless chip module 4.

20 The inlay 7 can have an embedded antenna 5 is integrated into the core layer 1 using wire embedding.

Reference Numeral List

- 1 transparent core layer
- 1 core layers
- 5 1 transparent windows core layer
- 2 white/opaque layer
- 3 insert
- 3 inserts
- 4 chip module
- 10 5 embedded antenna
- 6 transparent window
- 6 transparent windows
- 6 window
- 6 windows
- 15 7 inlay
- 7 inlays
- 8 chip cards
- 8 cards
- 9 opaque overlays
- 20 9 overlays
- 10 overlay layers
- 11 chip
- 12 antenna

Claims

1. A method of making an inlay (7) for a card or document, comprising:

- providing a core layer (1) having a first side and a second side, wherein the core layer (1) comprises a substrate and is configured to accommodate an electronic component;
 - placing a first overlay layer (10) on the first side of the transparent core layer (1), the first overlay layer (10) having at least one pre-fabricated window (6);
 - placing a second overlay layer (10) on the second side of the core layer (1), the second overlay layer (10) having at least one pre-fabricated window (6);
 - arranging a first insert (3) within the (at least one pre-punched) window (6) of the first overlay layer (10), wherein the insert (3) is configured to prevent distortion of the window (6) during lamination;
 - integrating an electronic component within the core layer (1),
- wherein in a transitional region between the first insert (3) and the first overlay layer (10), there is interlacing between the material of the first insert (3) and the material of the first overlay layer (10), providing a hot joining between the first insert (3) and the first overlay layer (10), by submitting both the insert (3) and the overlay layer (10) to heat such that they both melt and their molten materials penetrate into each other and then lock mechanically to each other after hardening, without adding additional glue materials into the joint between the insert (3) and the first overlay layer (10).

2. The method of claim 1, further comprising:

- placing a second overlay layer (10) on the second side of the core layer (1), the second overlay layer (10) having at least one pre-fabricated window (6);
 - arranging a second insert (3) within the at least one pre-punched window (6) of the second overlay layer (10), wherein the insert (3) is configured to prevent distortion of the window (6) during lamination;
- wherein in a transitional region between the second insert (3) and the second overlay layer (10), there is interlacing between the material of the second insert (3) and the material of the second overlay layer (10), providing a hot joining between the second insert (3) and the second overlay layer (10), by submitting both the insert (3) and the overlay layer (10) to heat such that they both melt and their molten materials penetrate into each other and then lock mechanically to each other after hardening, without

adding additional glue materials into the joint between the insert (3) and the second overlay layer (10).

3. The method of claim 2, wherein:

- 5 - the insert (3) comprises an optical variable material configured to provide a security feature,
 - the core layer (1) comprises an optical variable material configured to provide a security feature, and
 - the first overlay layer (10) and the second overlay layer (10) comprise a high-opaque
 - 10 material configured to cover visibility of the electronic component,
- wherein the optical variable material, providing unique characteristics such as color shift, UV strong fluorescence, or a holographic or diffractive pattern,
- wherein the electronic component comprises a chip module (4) in the form of a contactless chip module (4) and an embedded antenna (5) that is integrated into the
- 15 core layer (1) using wire embedding.

4. An inlay (7) for a card or document, comprising:

- a core layer (1) having a first side and a second side, wherein the core layer (1) is configured to accommodate an electronic component;
 - 20 - a first overlay layer (10) disposed on a first side of the transparent core layer (1), the first overlay layer (10) having at least one pre-fabricated window (6);
 - a second overlay layer (10) disposed on a second side, opposite of the first side of the core layer (1), of the core layer (1), the second overlay layer (10) having at least one pre-fabricated window (6);
 - 25 - a first insert (3) arranged within the window (6) of the first overlay layer (10), wherein the insert (3) is configured to prevent distortion of the window (6) during lamination; and
 - an electronic component integrated within the core layer (1),
- wherein in a transitional region between the first insert (3) and the first overlay layer
- 30 (10), there is interlacing between the material of the first insert (3) and the material of the first overlay layer (10) providing a hot joining between the first insert (3) and the first overlay layer (10).

5. The inlay (7) of claim 4, comprising

- a second overlay layer (10) disposed on a second side opposite of the first side of the core layer (1) of the core layer (1), the second overlay layer (10) having at least one (pre-punched) window (6);
wherein a second insert (3) is arranged within the window (6) of the second overlay layer (10), wherein the insert (3) is configured to prevent distortion of the window (6) during lamination,
and wherein in a transitional region between the second insert (3) and the second overlay layer (10), there is interlacing between the material of the second insert (3) and the material of the second overlay layer (10) providing a hot joining between the second insert (3) and the second overlay layer (10).
6. The inlay (7) of one claims 4 or 5, wherein at least one of the core layer (1), the first overlay layer (10), or the second overlay layer (10) is transparent or opaque.
7. The inlay (7) according to one of the claims 4 to 6, wherein the substrate of the core layer (1) comprises a PC film, a PVC film, or a PETG film.
8. The inlay (7) according to one of the claims 4 to 7, wherein the first overlay layer (10) and/or the second overlay layer (10) comprise a PC film, a PVC film, or a PETG film.
9. The inlay (7) according to one of the claims 4 to 8, wherein the insert (3) comprises a PC film, a PVC film, or a PETG film.
10. The inlay (7) according to one of the claims 4 to 9, wherein the insert (3) comprises an optical variable material configured to provide a security feature.
11. The inlay (7) according to one of the claims 4 to 10, wherein the core layer (1) comprises an optical variable material configured to provide a security feature.
12. The inlay (7) according to one of the claims 4 to 11, wherein the first opaque overlay layer (10) and the second opaque overlay layer (10) comprise a high-opaque material configured to cover visibility of the electronic component.

13. The inlay (7) according to one of the claims 4 to 12, wherein said transparent inserts (3) are made from an optical variable material, providing unique characteristics such as color shift, UV strong fluorescence, and other security features.

5 14. The inlay (7) according to claim 13, wherein said optical variable material further comprises a holographic or diffractive pattern.

15. The inlay (7) according to one of the claims 4 to 14, wherein the electronic component comprises a chip module (4) and an embedded antenna (5).

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16. The inlay (7) according to claim 15, wherein the chip module (4) is a contactless chip module (4).

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17. The inlay (7) according to one of the claims 4 to 16, wherein the embedded antenna (5) is integrated into the core layer (1) using wire embedding, printing, or etching.

18. A chip card with an inlay (7) according to one of the claims 4 to 17.