

importance in order to provide for competitiveness of such substrates.

For example, frequently metal components, such as metal pads, and the like are added to the card base material so as to impart increased weight or superior outer appearance to card-type substrates. In still other approaches respective card-type information substrates are formed on the basis of a metal base material, thereby achieving heavy weight and a specific outer appearance, which may result in conveying presence of superior value of the corresponding payment card. Typically, such metal-based payment cards are designed for contact-based coupling to a corresponding reader device, thereby, however, significantly restricting usable lifetime due to wear and tear of the contacts and also limiting user experience due to the lack of wireless connectivity.

In view of the situation described above, it is an object of the present invention to allow superior external appearance and/or weight of a card-type information substrate while at the same time increasing flexibility with respect to wireless connectivity capabilities of the card-type information substrate.

Summary

In view of the situation described above the present invention is generally based on the technical concept that additional weight and/or superior appearance may be imparted to card-type information substrates by providing a frame, which is made of a different material as a card base material in order to add at least additional weight to the card, without changing the specified outer dimensions of the card-type substrate. Moreover, the card-type information substrate may still be provided with wireless connectivity capabilities irrespective of the type of material used in the card frame. In illustrative embodiments, one or more heavy components, such as metal containing plates or slugs, may be additionally incorporated so as to enhance the weight and/or optical effects that may be achieved on the basis of the frame made of heavy material.

In an aspect, the present disclosure refers to a pre-form (690) of a card-type information substrate, comprising

a frame (610) formed around a perimeter of a base material (691), a material of said frame (610) having a higher specific weight compared to the base material (691) in the form of plastic and thus imparting increased weight to said pre-form (690);

a metal containing plate (680) provided within an outline of said frame (610) and imparting additional weight to said pre-form (690); and

an antenna (630) positioned within said outline of said frame (610) and configured to enable wireless communication;

characterized in that

said pre-form further comprises:

a first disconnecting layer (692) covering, said frame (610), said base material (691), said metal containing plate (680) and said antenna (630) and forming a first surface of said pre-form (690),

wherein said first disconnecting layer (692) comprises a rigid material which does not soften or flow onto or into respective steps formed by thickness differences of the materials of said frame (610), said base material (691), said metal containing plate (680) or said antenna (630) during lamination of further components to said pre-form (690).

In an aspect, the present disclosure refers to a card-type information substrate (100, 200, 300, 400, 500, 700, 800), comprising

a substrate material made of plastic (140, 240, 340, 440, 540);

an electronic module (120, 220, 320, 420, 520) provided in said substrate material (140, 240, 340, 440, 540); and

a pre-form (690) according to the above aspect attached to said substrate material (140, 240, 340, 440, 540), wherein said antenna (130, 230, 330, 430, 530, 630) of said pre-form (690) is operatively connected to said electronic module (120, 220, 320, 420, 520) to perform wireless communication.

In an aspect, the present disclosure refers to a method of forming a pre-form of a card-type information substrate (100, 200, 300, 400, 500, 700, 800) comprising:

- selecting a substrate material (140, 240, 340, 440, 540);
- providing a frame (110, 210, 310, 410, 510, 610) around a perimeter of a base material (140, 240, 340, 440, 540), wherein said frame material (110, 210, 310, 410, 510) has a higher specific weight compared to said base material (691) in the form of plastic, thus imparting increased weight to said pre-form (690);
- providing said substrate material (140, 240, 340, 440, 540) with an electronic module (120, 220, 320, 420, 520);
- providing said substrate material (140, 240, 340, 440, 540) with an antenna (130, 230, 330, 430, 530);
- providing said substrate material (140, 240, 340, 440, 540) with a metal containing plate (680);

characterized in that

said method further comprises

- providing a first disconnecting layer (692) covering said frame (610), said base material (691), said metal containing plate (680) and said antenna (630) and forming a first surface of said pre-form (690),

wherein said first disconnecting layer (692) comprises a rigid material which does not soften or flow onto or into respective steps formed by thickness differences of the materials of said frame (610), said base material (691), said metal containing plate (680) or said antenna (630) during lamination of further components to said pre-form (690).

In an aspect, the present disclosure refers to a method for forming a card-type information substrate (100, 200, 300, 400, 500) comprising:

- forming a pre-form of a card-type information substrate according to the method of the above aspect;
- providing a substrate material made of plastic (140, 240, 340, 440, 540);
- providing an electronic module (120, 220, 320, 420, 520) provided in said substrate material (140, 240, 340, 540);
- laminating said pre-form, said substrate material (140, 240, 340, 440, 540) and said electronic module (120, 220, 320, 420, 520).

In one example therefore the above-specified technical object is solved by a card-type information substrate. The card-type information substrate includes a substrate material made of plastic and an electronic module that is embedded in the substrate material. Furthermore, the card-type information substrate includes a frame that is formed around the perimeter of the substrate material, wherein the frame imparts increased weight and/or superior appearance to the card-type information substrate. Additionally, the card-type information substrate includes an antenna that is positioned within an outline of the

frame and that is operatively connected to the electronic module to perform wireless communication.

It should be noted that the frame may be connected to the substrate material by direct connection or by means of any intermediate agent.

According to this example the dimension, shape and the material composition of the frame may be selected so as to achieve increased weight and/or superior appearance, which may be accomplished by using an appropriate type of material or materials and incorporating the material(s) into the card base material on the basis of an appropriately selected configuration.

In this respect it should be appreciated that increased weight is to be understood as a difference in weight of the inventive card-type substrate having formed therein the frame compared to a substantially identical card-type substrate, in which the frame would be replaced by the base material of the remainder of the card-type substrate. That is, the volume occupied by the frame material has a greater weight compared to the substrate material made of plastic for otherwise identical overall dimensions of the card-type substrate. To this end, any appropriate materials may be used, which may have basically a higher specific weight compared to the substrate material in the form of plastic, wherein typically many of such appropriate frame materials may additionally impart superior mechanical robustness to the card-type information substrate compared to the situation, in which the substrate material in the form of plastic would be used throughout the entire card.

Furthermore, it is to be appreciated that the term "frame" is to be understood as a component that encloses at least a significant portion of the substrate material, while still leaving a significant central area that is not covered by the frame material. For example, a width of the frame, although in some embodiments it may vary along the circumferential direction, may be restricted to approximately 3 to 25% of the total extension of the smaller one of the two orthogonal lateral dimensions of the card-type substrate. For example, for a card-type substrate having a length, as the greater one of the two lateral dimensions, of approximately 85.6 mm and a width, as the smaller one of the two lateral dimensions, of approximately 54.0 mm, the width of the frame may be in the range of approximately 2 mm to 13.5 mm.

Consequently, by applying the concept of providing a frame for the card-type substrate respective desired characteristics of any such appropriate frame material may be taken advantage of while still providing sufficient area for implementing the electronic module and

the antenna within the outline of the frame. That is, upon selecting an appropriate geometric configuration of the frame in combination with providing a desired frame material the overall size of the inner area enclosed by the frame may appropriately be designed so as to accommodate the electronic module and the antenna having the required RF characteristics. For example, when maximizing the card internal area enclosed by the frame the dimensions of the antenna may be appropriately adapted, thereby providing sufficient area for an antenna design that results in sufficient RF performance of the antenna.

In a further illustrative example the card-type information substrate includes an eddy current restriction component that is configured and arranged to restrict eddy currents in the frame. In this example, the characteristics of many types of materials are taken into consideration with respect to their RF performance hampering behaviour. For example, certain materials of even low conductivity may exhibit a tendency for creating eddy currents when exposed to an electromagnetic field of a certain frequency range. For instance, many standardised payment cards may operate in a frequency range of approximately 11 to 20 MHz, which may result in respective eddy currents generated in the frame material, which in turn may negatively affect the radio frequency performance of the antenna.

In this respect it should be appreciated that the term eddy current is to be understood as having the meaning of including any physical mechanism resulting in losses of electromagnetic radiation emitted or received by the antenna due to the presence of the frame material. Consequently, by taking into consideration the possibility of the creation of eddy currents in the frame material the eddy current restriction component may appropriately be adapted so as to avoid or at least restrict the amount of dampening and thus the magnitude of eddy currents to an acceptable level.

In one illustrative example at least a portion of the frame is formed of a conductive material. As already discussed in the introductory part of the description metal materials are frequently used in conventional payment cards so as to increase weight and enhance appearance of such cards. Consequently, by using a metal material or materials at least in one portion of the frame may therefore provide for the possibility of appropriately designing the weight and/or the outer appearance of the card-type substrate, wherein, however, any negative influence of the metal material(s) on the RF performance of the antenna may be taken into consideration by design and/or other mechanisms, such as the eddy current restriction components discussed above.

In a further illustrative example, the frame is formed of a non-conductive material, which,

in one illustrative example, may be provided in the form of ceramic. In this manner, the desired features of a frame in accordance with the present invention may be obtained, such as increasing weight and/or enhancing appearance of the card-type substrate, while substantially not negatively affecting the RF performance of the antenna. In one illustrative example, the frame may be completely made of ceramic or any other appropriate non-conductive material without any intermediate conductive or metallic portions, thereby minimizing an influence on the RF performance of the antenna.

In a further illustrative example the eddy current restriction component, discussed above, includes a slit that is formed in the frame. That is, in this illustrative example the frame may be "interrupted" by a slit, but may otherwise completely enclose the substrate material of the card-type substrate. In this case, it has been recognized that even for conductive frame materials respective dampening mechanisms, i.e. eddy currents, may sufficiently be restricted so as to still provide for a required RF performance of the antenna. A width of the slit, i.e., the dimension of the slit along a circumferential direction of the frame, may be selected so as to obtain the required eddy current restricting functionality, while still achieving the desired optical and mechanical behaviour of the frame.

In a further illustrative example the eddy current restriction component, as discussed above, includes a resistive portion that is connected to the frame and that has a lower specific conductivity compared to the conductivity of a base material of the frame. That is, the resistive portion may physically and/or electrically be connected to the frame so as to reduce the overall conductivity of the frame, which in turn may result in a reduction of any dampening mechanisms, i.e. eddy currents that may otherwise be generated in the frame in significant amounts during operation of the antenna.

In one illustrative example, the resistive portion may include a slit in combination with a fill material that exhibits reduced conductivity. In this manner, the resistive portion is provided as portion physically connected to the frame and thus representing a part of the frame, while nevertheless reducing overall conductivity of the frame, even if the remaining portion of the frame may be formed of a metal or any other conductive material. In this manner, a substantially closed loop may be provided in the form of the frame based on any appropriate frame base material, while nevertheless the resistive portion(s) provide(s) for reduced losses upon operating the antenna. As already indicated, therefore the resistive portion(s) may represent a part of the frame, which in turn may thus be provided as a closed loop, thereby increasing overall mechanical robustness and also providing for superior outer appearance of the frame.

In other illustrative examples the frame is at least partially conductive and has a total conductivity that corresponds to a conductivity of 50 S/m (Siemens per meter) or less. As discussed above, using conductive materials as a base for the frame may be advantageous in some respects, for instance in terms of creating additional weight with a reduced amount of frame material and/or achieving a desired appearance of the frame by using certain alloys, and the like providing specific optical effects, while nevertheless the overall conductivity may be controlled to the above-specified value range in order to maintain the loss mechanisms at a low level so as to still achieve the required RF performance of the antenna. For example, the frame may be made of a base material having a conductivity of 50 S/m or less without requiring any other materials of reduced conductivity, thereby achieving consistent material characteristics along the entire circumferential extension of the frame, while still ensuring appropriate RF performance of the antenna.

In still other illustrative examples the frame is, in total, conductive and includes at least one portion of reduced conductivity so as to obtain the desired total conductivity as specified above. In this manner, a high degree of flexibility is provided in establishing a desired total conductivity while on the other hand enabling the usage of a number of conductive materials i.e. of materials of increased conductivity, while adjustment of the total conductivity may still be reliably insured by providing the at least one portion of reduced conductivity.

In one illustrative example the at least one portion of reduced conductivity includes a region of reduced material thickness. In this manner, a desired total conductivity may readily be adjusted for many types of conductive materials, while a consistent optical appearance may be maintained at least at one surface of the frame.

In illustrative examples the antenna is a planar antenna formed of metal traces, which are formed on a carrier material. In this manner, established manufacturing techniques may be applied so as to obtain a desired type of overall antenna configuration for a planar architecture. For example, techniques for selectively depositing material, non-selective deposition techniques in combination with lithography processes and etch techniques, and the like may be used, thereby enabling the generation of even highly complex antenna geometries on the basis of cost-efficient manufacturing techniques that insure minimal process variations and, thus, result in reproducible RF behaviour.

In still other illustrative examples the antenna is formed of a wire that is embedded in a carrier material. Consequently, any such "wire embedded" configurations for an antenna may

also efficiently be implemented into the card-type information substrate, since the RF behaviour may be adjusted on the basis of techniques as discussed above by adapting frame configuration to the specific antenna design.

In further illustrative examples the operative coupling between the electronic module and the antenna is established by a direct electrical, i.e. a wired, connection between the antenna and the electronic module. That is, in these examples a wired connection is established between the electronic module and the antenna, thereby contributing to reduced overall losses of the entire system composed of the electronic module and the antenna provided within the outline of the frame. Consequently, electronic modules without having incorporated therein a module internal coupling antenna may be used, which may per se provide for superior overall RF performance of a module-antenna system established for wireless information exchange with an external reader device.

In still other illustrative examples the operative coupling between the electronic module and the antenna is established by inductive coupling between the antenna and the electronic module. In this manner, well-established electronic modules having incorporated therein the coil for inductive coupling may be used, while the required RF performance of the antenna for communicating with an external reader device may still be achieved based on the techniques as discussed above, even though the antenna is provided within the outline of the frame.

In further illustrative examples of the present invention the card-type information substrate has two opposing long sides, wherein the antenna is arranged symmetrically with respect to the two opposing long sides. Thus, by a corresponding design, in which symmetry with respect to the long sides of the card is taken into consideration, generally the influence of the frame on the antenna may be reduced, even if the frame contains conductive materials, such as metals. In this respect, the symmetry of the antenna with respect to the long sides of the substrate is to be understood as referring to a configuration, in which the distances of the respective antenna long sides to the respective adjacent long sides of the substrate are equal. That is, the antenna is centred with respect along the width dimension of the substrate.

In one illustrative example, a distance of the antenna from the two opposing long sides is at least 6 mm. It has been recognized by the inventors that when applying standard dimensions in the lateral and thickness dimensions for the card-type information substrate, as are typically used for payment cards and the like, a distance of at least 6 mm may result in

a significant improvement of the RF performance of the antenna. Consequently, by appropriately adapting the dimensions of the frame, as already discussed above, the available area of the card that is enclosed by the frame may be adjusted such that for a given lateral size of the antenna the distance as specified above may be obtained.

In illustrative examples disclosed herein, the card-type information substrate is a payment card having standard dimensions. That is, in these illustrative examples the frame may advantageously be implemented in a standard payment card, while still ensuring efficient wireless information exchange capability with an external reader device, for instance by complying with established RF standards for wireless communication in the field of payment cards.

It should be appreciated, however, that the principles disclosed herein may also be used in combination with other card-type substrates with differing dimensions when the implementation of any such differing lateral dimensions and/or thickness dimensions may become necessary in certain applications.

According to another example, the above-referenced technical object is solved by a pre-form of a card-type information substrate. The pre-form includes a frame formed around the perimeter of a base material, wherein the frame imparts increased weight to the pre-form. Furthermore, the pre-form includes at least one metal containing plate that is provided within an outline of the frame. Moreover, the pre-form includes an antenna that is positioned within the outline of the frame and is configured to enable wireless communication.

According to this concept the present disclosure provides for a pre-form of a card-type information substrate, which includes, in addition to a weight-increasing frame, an additional component made of a heavy material, thereby increasing the overall effect on the final card-type information substrate. By providing respective heavy components for a card-type information substrate as a pre-form, which may have to still undergo specific manufacturing processes, such as laminating one or more additional material layers, significant advantages may be gained, since the pre-form enables a substantially standard manufacturing procedure for the completion of the card-type information substrate without requiring specifically designed manufacturing processes. Furthermore, as also discussed above and as will be discussed in the following, the heavy components such as the frame and the at least one metal containing plate or slug may be designed and arranged such that a desired performance for wireless communication on the basis of the antenna may be achieved.

In an illustrative example, the frame contains a metal material, thereby also achieving similar effects as already discussed above. For example, by including a metal material into at least some portions of the frame the pre-form may be endowed with superior stability and/or optical appearance and/or weight and/or haptic characteristics, thereby achieving, in combination with the metal containing plate, a respective desired final configuration.

In a further illustrative example the pre-form further includes a first disconnecting layer that covers, at a first surface of the pre-form, the frame, the base material, the at least one metal containing plate and the antenna. Therefore, the disconnecting layer may result in improved surface appearance, since different components in the body of the final card-type substrate will not be visible due to different heat dissipation of components. Moreover, the first disconnecting layer may provide for a larger process window for production of the card-type substrate, since, for example, heat during card manufacturing (lamination process) will have less effect on the surface quality. A further effect of the first disconnecting layer is improved card haptic, since, for instance, when using e.g. epoxy glass tape, the card, that is, the final card-type information substrate, will have higher flexibility (spring back effect) when bended and the bending is not plastic (destructive), whereas otherwise, when just having the frame made of SST, the frame will stay warped / bent. Similarly, the card-type substrate itself may remain deformed, when the card-type substrate is bent during handling.

Furthermore, the first disconnecting layer may act as kind of "heat blocker" to protect outer layers still to be made from plastic during card production when e.g. milling the card at the metal during card production (card singulation process). Milling generates heat. That is, the disconnecting layer may thus provide for appropriate surface characteristics of the pre-form in order to account for differences of different materials and different material properties in the pre-form during the further manufacturing processes, which may be required for completing the card-type information substrate. In this sense, the disconnecting layer may basically "decouple" the pre-form from the remaining components still to be attached to the pre-form so as to obtain the desired card-type information substrate. As a consequence, the disconnecting layer may enable the further processing of the pre-form on the basis of substantially standardised lamination processes, i.e. processes for attaching one or more material layers or material sheets by applying increased pressure and elevated temperatures without substantially being affected by the "core" materials of the pre-form.

The disconnecting layer may be attached to the "core" components of the pre-form by means of a first adhesive layer, thereby providing for a robust physical connection between the core components and the first disconnecting layer.

In a further illustrative example the pre-form includes a second disconnecting layer that covers, at a second surface of the pre-form opposite to the first surface, the frame, the base material and the at least one metal containing plate. Consequently, by providing the second disconnecting layer similar advantages may be achieved at the opposite surface of the pre-form with respect to the further processing of the pre-form, as discussed above in the context of the first disconnecting layer.

Also in this case, the second disconnecting layer may be attached by means of a second adhesive layer.

Moreover, in further illustrative examples the pre-form may have similar features and configurations with respect to adaptation to RF performance, as is also discussed above in the context of the frame of the card-type information substrate. That is, the frame of the pre-form is, in some examples, at least partially formed of a conductive material, such as stainless steel, thereby providing the effects and advantages, as discussed above.

Similarly, the frame of the pre-form is, in some illustrative examples, formed of a non-conductive material, such as ceramic, so as to contribute to increased overall weight of the pre-form, while affecting the RF performance in a less pronounced manner.

Moreover, as discussed above, an eddy current restriction component is provided in the pre-form according to illustrative examples, wherein the eddy current restriction component is configured and arranged so as to restrict eddy currents in the frame and/or the metal containing plate. Consequently, in this manner eddy currents may be reduced in the frame and/or the metal containing plate, thereby also reducing RF losses of the antenna of the pre-form, in a similar manner as discussed above in the context of the frame of the card-type information substrate.

In illustrative examples, the eddy current restriction component includes one or more slits formed in the frame and/or the metal containing plate. In this manner, the occurrence of eddy currents and, thus, the occurrence of undue RF losses may be reduced without substantially affecting the overall appearance, size and shape of the frame and/or the metal containing plate.

In one illustrative example the eddy current restriction component includes a resistive portion connected to the frame and/or the metal containing plate that has a lower specific

conductivity compared to a conductivity of a remaining material of the frame and/or the metal containing plate. As a consequence, by providing the resistive portion a reliable mechanism is implemented for reducing eddy currents and, thus, RF losses without substantially affecting the overall configuration of the frame and/or the metal containing plate. For example, the resistive portion may be implemented on the basis of one or more slits and a fill material of reduced conductivity, thereby enabling the provision of the frame and/or the metal containing plate as a mechanical single component, while nevertheless significantly reducing eddy currents.

According to some illustrative examples, the resistive portion is provided as part of the frame and/or the metal containing plate so as to allow the provision of the frame and/or the metal containing plate as a single component having already incorporated therein the resistive portion.

In other illustrative examples, the frame forms a closed loop, thereby providing a highly mechanically stable edge of the pre-form prior to being processed into a respective card-type information substrate.

In other illustrative examples, the metal containing plate is a continuous single piece of material. In this manner, the process of manufacturing the pre-form is simplified, since the metal containing plate as a single component may readily be produced in a separate fabrication process and may be incorporated into the pre-form, for instance by being laterally attached to the base material, and the like.

In other illustrative examples, the metal containing plate includes two or more metal containing plates. In these embodiments the two or more metal containing plates may be arranged side-by-side so as to implement a reduced contact surface or avoid any direct contact at all, thereby also significantly contributing to reduced overall conductivity and thus reduced eddy currents.

In further illustrative examples, the frame and/or the metal containing plate are conductive and include at least one portion of reduced conductivity. Also in this case, respective RF losses may be reduced due to providing for increased resistance for any eddy currents induced by RF radiation.

In one illustrative example, the at least one portion of reduced conductivity includes a region of reduced material thickness. In this manner, a desired overall conductivity of the

frame and/or the metal containing plate may be readily adjusted by selecting the reduced material thickness, the size and the shape of the portion of reduced material thickness. For example, material may be removed from the frame and/or the metal containing plate by grinding, drilling, etching, and the like, so as to locally obtain a reduced material thickness.

In some illustrative examples, the metal containing plate contains tungsten as a metal, thereby contributing to a significant weight increase due to the high weight of tungsten.

Generally, in some illustrative examples the design and the characteristics of the frame, the metal containing plate(s) and the antenna may be tuned so as to achieve a required minimum RF performance that is sufficient for a desired performance of wireless communication with an external reader device, while any further modifications, such as described above, may not be required.

According to a further example the above-referenced object is solved by a card-type information substrate that comprises a substrate material made of plastic and an electronic module that is provided in the substrate material. Additionally, the card-type information substrate includes a pre-form, as discussed above or as will be discussed later on in the detailed description, wherein the pre-form is attached to the substrate material and the antenna of the pre-form is operatively connected to the electronic module in order to perform wireless communication.

The above-referenced technical object is also solved by a method of forming a card-type information substrate. The substrate comprises a frame, an antenna for wireless communication and an electronic module that is operatively connected to the antenna. The method includes determining at least one metric that represents a desired radio frequency performance of the antenna. Moreover, the method includes selecting a total conductivity of the frame and/or a position of the antenna within an outline of the frame and/or performance of the electronic module on the basis of the at least one metric so as to achieve the desired radio frequency performance.

In this example the presence of the frame in the card-Information substrate may be estimated by determining the metric representing the radio frequency performance of the antenna. That is, the influence of the frame on the radio performance may be assessed on the basis of at least one metric or parameter value that specifies radio frequency performance in the presence of the frame. Based on the required radio frequency performance appropriate measures may be taken so as to tune the actual radio frequency

In this manner, having established representative parameters for a number of influences on the RF performance, desired design criteria may be set in advance that have to be met, while the remaining parameters may provide for sufficient flexibility in appropriately adapting other design aspects in order to arrive at the desired RF performance. For instance, if weight and/or external appearance criteria may be set in advance, then other aspects may be selected in accordance with the pre-established parameter values, such as overall conductivity of the metal frame possibly in combination with overall RF performance of the electronic module, possibly in combination with design, configuration and position of the antenna in order to achieve the required RF performance.

In illustrative examples, any such parameter matching process may be implemented in a computer device on the basis of an appropriately designed instruction set, wherein respective parameters representing RF relevant features of the card-type information substrate may be stored in a respective database that may be accessed by the respective program instructions. Generally, the respective database may continuously be updated on the basis of experiments, simulations and data obtained from actual cards operated under real life conditions. In this manner the overall process of developing and producing frame-based card-type substrates may be “automated” to a certain degree, thereby increasing reproducibility and thus yield of the manufacturing process.

Brief description of the drawings

Further illustrative embodiments and other aspects of the present invention will be described in more detail in the following specification, while also referring to the accompanying drawings, in which

Fig. 1A schematically illustrates a top view of a card-type information substrate according to an illustrative embodiment;

Fig. 1B schematically illustrates a cross-sectional view of the card-type information substrate of Fig. 1A according to one illustrative embodiment;

Figs. 2A and 2B schematically illustrate top views of configurations with different placement of an antenna with respect to a frame of a card-type information substrate according to illustrative embodiments;

Fig. 2C schematically illustrates a table of parameters or metrics representing the RF

Claims

1. A pre-form (690) of a card-type information substrate, comprising

a frame (610) formed around a perimeter of a base material (691), a material of said frame (610) having a higher specific weight compared to the base material (691) in the form of plastic and thus imparting increased weight to said pre-form (690);

a metal containing plate (680) provided within an outline of said frame (610) and imparting additional weight to said pre-form (690); and

an antenna (630) positioned within said outline of said frame (610) and configured to enable wireless communication;

characterized in that

said pre-form further comprises:

a first disconnecting layer (692) covering, said frame (610), said base material (691), said metal containing plate (680) and said antenna (630) and forming a first surface of said pre-form (690),

wherein said first disconnecting layer (692) comprises a rigid material which does not soften or flow onto or into respective steps formed by thickness differences of the materials of said frame (610), said base material (691), said metal containing plate (680) or said antenna (630) during lamination of further components to said pre-form (690).

2. The pre-form (690) of claim 1, wherein said frame (610) contains a metal material.

3. The pre-form (690) of claim 2, wherein said first disconnecting layer (692) is attached by a first adhesive layer.

4. The pre-form (690) of any of previous claims, further comprising a second disconnecting layer (695) covering, at a second surface of said pre-form (690) opposite to said first surface, said frame (610), said base material (691) and said metal containing plate (680).

5. The pre-form (690) of claim 4, wherein said second disconnecting layer (695) is attached by a second adhesive layer.

6. The pre-form (690) of any of claims 1 to 5, wherein at least a portion of said frame (610) is formed of a conductive material, in particular stainless steel.
7. The pre-form (690) of any of claims 1 to 5, wherein said frame (610) is formed of a non-conductive material.
8. The pre-form (690) of any of claims 1 to 6, further comprising an eddy current restriction component configured and arranged so as to restrict eddy currents in at least one of said frame (610) and said metal containing plate (680).
9. The pre-form (690) of claim 8, wherein said eddy current restriction component comprises one or more slits formed in at least one of said frame (610) and said metal containing plate (680).
10. The pre-form (690) of claim of any of claims 8 or 9, wherein said eddy current restriction component comprises a resistive portion connected to at least one of said frame (610) and said metal containing plate (680) and having a lower specific conductivity compared to a conductivity of a remaining material of said at least one of the frame (610) and the metal containing plate (680).
11. The pre-form (690) of claim 10, wherein said resistive portion comprises a slit and a fill material of reduced conductivity.
12. The pre-form (690) of claim 10, wherein said resistive portion is provided as part of said at least one of the frame (610) and the metal containing plate (680).
13. The pre-form (690) of any of claims 1 to 12, wherein said frame (610) forms a closed loop.
14. The pre-form (690) of any of claims 1 to 13, wherein said metal containing plate (680) is a continuous single piece of material.
15. The pre-form (690) of any of claims 1 to 13, wherein said metal containing plate (680) comprises two or more metal containing plates.
16. The pre-form (690) of any of claims 1 to 6, or 8 to 15, wherein at least one of said frame (610) and said metal containing plate (680) is conductive and includes at least one portion of reduced conductivity.
17. The pre-form (690) of claim 16, wherein said at least one portion of reduced conductivity includes a region of reduced material thickness.

18. The pre-form (690) of any of claims 1 to 17, wherein said metal containing plate (680) contains tungsten.

19. A card-type information substrate (100, 200, 300, 400, 500, 700, 800), comprising

a substrate material made of plastic (140, 240, 340, 440, 540);

an electronic module (120, 220, 320, 420, 520) provided in said substrate material (140, 240, 340, 440, 540); and

a pre-form (690) according to any of claims 1 to 18 attached to said substrate material (140, 240, 340, 440, 540), wherein said antenna (130, 230, 330, 430, 530, 630) of said pre-form (690) is operatively connected to said electronic module (120, 220, 320, 420, 520) to perform wireless communication.

20. A card-type information substrate (100, 200, 300, 400, 500, 700, 800) according to claim 19, wherein said frame (110, 210, 310, 410, 510, 610) of said pre-form (690) is formed around the perimeter of said substrate material (140, 240, 340, 440, 540), wherein a thickness of said frame (110, 210, 310, 410, 510, 610) corresponds to a total thickness of said card-type information substrate (100, 200, 300, 400, 500) and said frame material (110, 210, 310, 410, 510) has a higher specific weight compared to the base material (691) in the form of plastic, so that said frame (110, 210, 310, 410, 510, 610) imparts at least one of increased weight and superior optical appearance to said card-type information substrate (100, 200, 300, 400, 500, 700, 800) .

21. A method of forming a pre-form of a card-type information substrate (100, 200, 300, 400, 500, 700, 800) comprising:

- selecting a substrate material (140, 240, 340, 440, 540);
- providing a frame (110, 210, 310, 410, 510, 610) around a perimeter of a base material (140, 240, 340, 440, 540), wherein said frame material (110, 210, 310, 410, 510) has a higher specific weight compared to said base material (691) in the form of plastic, thus imparting increased weight to said pre-form (690);
- providing said substrate material (140, 240, 340, 440, 540) with an electronic module (120, 220, 320, 420, 520);
- providing said substrate material (140, 240, 340, 440, 540) with an antenna (130, 230, 330, 430, 530);
- providing said substrate material (140, 240, 340, 440, 540) with a metal containing plate (680);

characterized in that

said method further comprises

- providing a first disconnecting layer (692) covering said frame (610), said base material (691), said metal containing plate (680) and said antenna (630) and forming a first surface of said pre-form (690),

wherein said first disconnecting layer (692) comprises a rigid material which does not soften or flow onto or into respective steps formed by thickness differences of the materials of said frame (610), said base material (691), said metal containing plate (680) or said antenna (630) during lamination of further components to said pre-form (690).

22. A method for forming a card-type information substrate (100, 200, 300, 400, 500) comprising:

- forming a pre-form of a card-type information substrate according to the method of claim 21;
- providing a substrate material made of plastic (140, 240, 340, 440, 540);
- providing an electronic module (120, 220, 320, 420, 520) provided in said substrate material (140, 240, 340, 540);
- laminating said pre-form, said substrate material (140, 240, 340, 440, 540) and said electronic module (120, 220, 320, 420, 520).

23. The method according to claim 22, further comprising the following steps:

determining at least one metric that represents a desired radio frequency performance of said antenna (130, 230, 330, 430, 530, 630);

selecting at least one of a total conductivity of said frame (110, 210, 310, 410, 510, 610), a position of said antenna (130, 230, 330, 430, 530, 630) within an outline of said frame (110, 210, 310, 410, 510, 610) and a performance of said electronic module (120, 220, 320, 420, 520) on the basis of said at least one metric so as to achieve said desired radio frequency performance; and

selecting at least one of a size and a shape of a metal containing plate (680) to be provided with the outline of said frame (110, 210, 310, 410, 510, 610) so as to achieve said desired radio frequency performance.