ANTENNA STRUCTURE AND PAYMENT DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202520304516.9, filed with the China National Intellectual Property Administration on February 25, 2025 and entitled "ANTENNA STRUCTURE AND PAYMENT DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] One or more implementations of this specification relate to the field of electronic payment technologies, and in particular, to an antenna structure and a payment device.

BACKGROUND

[0003] Near field communication (NFC) is a short-range high-frequency radio technology that enables contactless identification and interconnection by transmitting or receiving electromagnetic signals through an NFC antenna.

[0004] NFC technology-based payment devices are relatively small in volume and more lightweight and convenient to use. However, because antenna costs are relatively high, costs of promoting such payment devices also increase, which limits population of the payment devices.

SUMMARY

[0005] To reduce application costs of near field communication-based payment scenarios, one or more implementations of this specification provide an antenna structure and a payment device.

[0006] According to a first aspect, one or more implementations of this specification provide an antenna structure. The antenna structure includes a flexible insulating film. A first winding is etched on a front surface of the flexible insulating film, a second winding is etched on a back surface of the flexible insulating film, and the first winding and the second winding are connected

in series to form a first conductor. The first conductor is wound from the inside out or from the outside in for a plurality of turns to form a first antenna coil. A first conductive element is added on an end pin of the first antenna coil, and is configured to connect to an external main control board.

[0007] In a possible implementation, a third winding is further etched on the front surface of the flexible insulating film, a fourth winding is further etched on the back surface of the flexible insulating film, and the third winding and the fourth winding are connected in series to form a second conductor; the second conductor is wound from the inside out or from the outside in for a plurality of turns to form a second antenna coil; a second conductive element is added on an end pin of the second antenna coil, and is configured to connect to the main control board; and the second antenna coil is wound on an inner side of the first antenna coil.

[0008] In a possible implementation, both the first conductive element and the second conductive element are carbon paste screen-printed on corresponding end pins.

[0009] In a possible implementation, both the first conductive element and the second conductive element are wiring terminals riveted onto corresponding end pins.

[0010] In a possible implementation, both the first conductive element and the second conductive element are metal coatings applied onto corresponding end pins.

[0011] In a possible implementation, both the first conductive element and the second conductive element are positioned directly opposite to and in close contact with corresponding end pins, respectively, and completely cover the corresponding end pins.

[0012] In a possible implementation, the first winding and the second winding are conductively connected in series by riveting, and the third winding and the fourth winding are conductively connected in series by riveting.

[0013] In a possible implementation, the antenna structure further includes a conductive spring plate, a first connection end of the conductive spring plate is configured to connect to the end pin on which the first conductive element is disposed, a second connection end of the conductive spring plate is configured to connect to the end pin on which the second conductive element is added, and a third connection end of the conductive spring plate is configured to connect to the main control board.

[0014] In a possible implementation, insulation reinforcement films are adhered to a back surface of the end pin of the first antenna coil and a back surface of the end pin of the second

antenna coil.

[0015] According to a second aspect, one or more implementations of this specification provide an antenna structure. The antenna structure includes a flexible insulating film. A first winding is etched on a front surface of the flexible insulating film, a second winding is etched on a back surface of the flexible insulating film, and the first winding and the second winding are connected in series to form a first conductor. The first conductor is wound from the inside out or from the outside in for a plurality of turns to form a first antenna coil. A tuning capacitor is disposed at a position near an end pin of the first antenna coil. The tuning capacitor is conductively connected in series to the first antenna coil by using conductive silver adhesive.

[0016] According to a third aspect, one or more implementations of this specification provide a payment device, and the payment device includes the antenna structure according to the first aspect or the second aspect.

[0017] In summary, according to the antenna structure provided in one or more implementations of this specification, metal windings are etched on a front surface and a back surface of a flexible insulating film based on a winding shape of an antenna coil, and the metal windings are connected in series to form a conductor for constructing an antenna coil. This significantly reduces metal usage and effectively reduces costs of an antenna. When applied to a payment device, the antenna structure can also significantly reduce costs of the payment device, making it easier to promote and use the payment device, thereby enriching users' payment experience.

BRIEF DESCRIPTION OF DRAWINGS

[0018] To describe the technical solutions in one or more implementations of this specification, the following briefly describes the accompanying drawings needed for describing the implementations. Clearly, the accompanying drawings in the following description merely show some implementations recorded in one or more implementations of this specification, and a person of ordinary skill in the art can still derive other drawings from these accompanying drawings without creative efforts.

[0019] FIG. 1 is a schematic diagram illustrating a front surface of an antenna structure, according to one or more implementations of this specification;

[0020] FIG. 2 is a schematic diagram illustrating a back surface of the antenna structure shown in FIG. 1;

[0021] FIG. 3 is a schematic diagram illustrating a front surface of another antenna structure, according to one or more implementations of this specification;

[0022] FIG. 4 is a schematic diagram illustrating a back surface of the antenna structure shown in FIG. 3; and

[0023] FIG. 5 is a schematic diagram illustrating an application scenario, according to one or more implementations of this specification.

DESCRIPTION OF EMBODIMENTS

[0024] The following further describes one or more implementations of this specification in detail by using the accompanying drawings and implementations. With these descriptions, the features and advantages of one or more implementations of this specification will become clearer.

[0025] The term "exemplary" specially used here means "as an example, implementation, or illustrative". Any implementation described here as "exemplary" should not be construed as being superior to or better than other implementations. Although various aspects of the implementations are shown in the accompanying drawings, the accompanying drawings are not necessarily drawn to scale, unless otherwise indicated.

[0026] In addition, the technical features described below in different implementations of this specification can be mutually combined as long as they do not constitute a conflict with each other.

[0027] With the development of NFC technologies, NFC technology-based payment devices have gradually entered people's daily lives. During payment, a user only needs to bring a mobile phone close to the payment device to complete payment quickly, making the payment more convenient. However, because antenna costs of NFC technology-based payment devices are relatively high during manufacturing, population of the payment devices imposes considerable cost pressure on service providers, thereby limiting the popularization of the payment devices to some extent.

[0028] To reduce promotion costs of NFC technology-based payment devices and increase a popularization rate of the payment devices, one or more implementations of this specification provide an antenna structure and a payment device, to reduce antenna costs and costs of the

payment device, making it easier to promote and populate NFC technology-based payment devices. This, in turn, enriches users' payment options, offering greater diversity and convenience in payment experience to users and improving payment experience of users.

[0029] FIG. 1 is a schematic diagram illustrating a front surface of an antenna structure, according to one or more implementations of this specification. FIG. 2 is a schematic diagram illustrating a back surface of the antenna structure in FIG. 1.

[0030] It can be seen from FIG. 1 and FIG. 2 that in an optional implementation of this specification, the antenna structure can include a flexible insulating film 10. For example, the flexible insulating film 10 can be a polyethylene terephthalate (PET) film. The PET film exhibits good mechanical properties, good toughness, high tensile strength, and favorable durability. In addition, the PET film has good corrosion resistance and insulating performance. In this implementation of this specification, the PET film is used as the flexible insulating film on which the antenna coil is etched, which can improve the durability of an antenna and prolong a service life of the antenna. It should be understood that the flexible insulating film 10 included in the antenna structure can alternatively be a film made of another flexible material. Implementations are not limited in this specification.

[0031] A first winding 21 is etched on a front surface of the flexible insulating film 10, a second winding 22 is etched on a back surface of the flexible insulating film 10, and the first winding 21 and the second winding 22 are connected in series to form a first conductor. On a plane parallel to the flexible insulating film 10, the first conductor is wound from the inside out or from the outside in for a plurality of turns to form an antenna coil, which is denoted as a first antenna coil 20.

[0032] During manufacturing of an antenna, a metal layer can be attached to each of the front surface and the back surface of the flexible insulating film 10. For example, an aluminum foil layer can be adhered to each of the front surface and the back surface of the flexible insulating film 10. Then, based on a shape of the first antenna coil 20, that is, a shape of winding from the inside out for a plurality of turns or winding from the outside in for a plurality of turns, etching is performed to obtain the first winding 21 on the front surface of the flexible insulating film 10 and the second winding 22 on the back surface of the flexible insulating film 10. Then, the first winding 21 on the front surface of the flexible insulating film and the second winding 22 on the back surface of the flexible insulating film are conductively connected in series to form a complete conductor, which

is denoted as the first conductor. A coil formed by winding the first conductor is the first antenna coil 20.

[0033] Optionally, the widths of the first winding 21 and the second winding 22 obtained by etching can be set based on a requirement of an actual application scenario. For example, the width of the first winding 21 can be 0.25 millimeters (mm).

[0034] Optionally, the first winding 21 can include one segment of conductor, or the first winding 21 can include a plurality of segments of conductors. Similarly, the second winding 22 can include one segment of conductor, or the second winding 22 can include a plurality of segments of conductors. Implementations are not limited in this specification. It should be understood that all conductors included in the first winding 21 and all conductors included in the second winding 22 are conductively connected in series to each other to form the first conductor.

[0035] Optionally, the first winding 21 on the front surface of the flexible insulating film and the second winding 22 on the back surface of the flexible insulating film can be conductively connected in series by riveting. As shown in FIG. 1 and FIG. 2, the first winding 21 and the second winding 22 can be conductively riveted at a first riveting point 23 shown in the figures.

[0036] Optionally, the first conductor obtained by conductively connecting the first winding 21 and the second winding 22 in series can be wound in an arc shape, a rectangle shape, or other irregular shapes. Based on this, the first antenna coil 20 can be formed by winding the first conductor into a plurality of arc-shaped coils, a plurality of rectangular coils, or a plurality of coils of other irregular shapes. Implementations are not limited in this specification.

[0037] Optionally, portions of the conductor on the first antenna coil 20 that are located near both ends—namely, a portion of the conductor near a starting end of winding and a portion of the conductor near a terminating end of winding—both extend to an outer side of a wound portion of the first antenna coil to serve as an end pin 24 of the first antenna coil, which is subsequently referred to as a first end pin 24 for short, for connecting to an external main control board. For example, the antenna structure can be used as an NFC antenna, and is applied to a payment device. The first end pin 24 can be configured to connect to a main control board of the payment device. In this way, the payment device can communicate with an external device via the antenna structure, and perform NFC technology-based payment.

[0038] Optionally, a portion of the conductor on the first antenna coil 20 that extends to the outer side of the wound portion can be located on the same plane as a coil of the wound portion.

Optionally, to facilitate application of the antenna structure to a device with a relatively small volume, the portion of the conductor on the first antenna coil 20 that extends to the outer side of the wound portion can also form an angle with a plane on which the coil of the wound portion is located. A magnitude of the angle is determined based on a requirement of an application scenario. Implementations are not limited in this specification.

[0039] Because a metal layer, such as aluminum foil, is prone to oxidation, an electrical connection between the antenna structure and the main control board is affected, and consequently, communication efficiency of the device is affected. To protect the first end pin 24 of the antenna structure from oxidation and enhance conductivity of the first end pin 24, in the antenna structure provided in this implementation of this specification, a first conductive element (not shown in the figure) is added on the first end pin 24 of the first antenna coil 20. In this case, the first conductive element can protect the first end pin 24 of the first antenna coil 20 from oxidation. When the first end pin 24 on which the first conductive element is added is connected to the main control board, conductivity is better.

[0040] Optionally, the first conductive element can be carbon paste screen-printed on the first end pin 24 of the first antenna coil 20. In other words, the carbon paste can be screen-printed on the first end pin 24 of the first antenna coil 20 through screen-printing. In a process of screen-printing the carbon paste, the carbon paste exhibits strong adhesion to an etched aluminum foil after the carbon paste is baked, so that conductivity and corrosion resistance of the first end pin 24 of the first antenna coil 20 are both good, and performance is significantly improved. It should be understood that another conductive material can alternatively be screen-printed on the first end pin 24 of the first antenna coil 20. For example, silver paste can be screen-printed on the first end pin 24 of the first antenna coil 20. Implementations are not limited in this specification.

[0041] Optionally, the first conductive element can alternatively be a wiring terminal riveted onto the first end pin 24 of the first antenna coil 20. In other words, the wiring terminal can be riveted onto the first end pin 24 of the first antenna coil 20 by riveting, and the first end pin 24 of the first antenna coil 20 is covered by the wiring terminal. As such, the first end pin 24 of the first antenna coil 20 can also be prevented from being oxidized and corroded, and conductivity of the first end pin 24 of the first antenna coil 20 can be enhanced.

[0042] Optionally, the first conductive element can alternatively be a metal coating applied onto the first end pin 24 of the first antenna coil 20. In other words, a metal layer can be plated

onto the first end pin 24 of the first antenna coil 20. For example, nickel or gold can be plated onto the first end pin 24 of the first antenna coil 20. As such, the first end pin 24 of the first antenna coil 20 can be prevented from being oxidized and corroded, and conductivity of the first end pin 24 of the first antenna coil 20 can be enhanced. It should be understood that other metals can also be plated onto the first end pin 24 of the first antenna coil 20. Implementations are not limited in this specification.

[0043] Optionally, when the first conductive element is added on the first end pin 24 of the first antenna coil 20, the added first conductive element is positioned directly opposite to and in close contact with the first end pin 24 of the first antenna coil 20, and a coverage area of the first conductive element is greater than a range of the first end pin 24 of the first antenna coil 20. It should be understood that the coverage area of the first conductive element only needs to be slightly greater than the range of the first end pin 24 of the first antenna coil 20. As such, the first conductive element can cover the entire first end pin 24 of the first antenna coil 20 to prevent the first end pin from being corroded, while avoiding excessive extension beyond the range of the first end pin 24 of the first antenna coil 20, thereby preventing a problem of large misalignment that could affect conductivity.

[0044] Optionally, the flexible insulating film 10 and the first antenna coil 20 obtained by etching are made of relatively soft materials. Even if the first conductive element is added on the first end pin 24 of the first antenna coil 20, the first end pin 24 is still relatively soft, which makes it inconvenient to connect the first end pin 24 of the first antenna coil 20 to the external main control board. To improve the convenience of antenna connection, an insulation reinforcement film can further be adhered to a back surface of the first end pin 24 of the first antenna coil 20, so as to improve hardness and strength of the first end pin 24 of the first antenna coil 20, thereby making it more convenient to connect the antenna structure to the external main control board.

[0045] Optionally, the insulation reinforcement film can be a polyimide (PI) film or a PET film. It should be understood that the insulation reinforcement film can alternatively be other insulating films. Implementations are not limited in this specification.

[0046] Optionally, a shape of the flexible insulating film 10 used to etch the first antenna coil 20 can be set based on a shape of the first antenna coil 20. In other words, the shape of the flexible insulating film 10 matches the shape of the first antenna coil 20. It should be understood that an area of the flexible insulating film 10 is greater than an area occupied by the first antenna coil 20,

so that the entire first antenna coil 20 can be etched onto the flexible insulating film 10. For example, as shown in FIG. 1 and FIG. 2, if the first antenna coil 20 is formed by winding a plurality of arc-shaped coils, the flexible insulating film 10 can be an annular hollow insulating film. It should be understood that the flexible insulating film 10 further includes an extended portion of the insulating film for etching an extended portion of the conductor, and the first end pin 24 of the first antenna coil 20 is etched on the extended portion of the insulating film.

[0047] It can be seen from the above-mentioned content that the antenna structure provided in this implementation of this specification can be used as an NFC antenna and applied to a payment device. Optionally, to satisfy a miniaturization requirement of the payment device, a portion of the conductor in the antenna structure that extends to the outer side of the wound portion can be arranged at a 90-degree included angle relative to a plane on which the wound portion of the coil is located. Then, the end pin on which the first conductive element is added can be connected to the main control board of the payment device. As such, the payment device can use the main control board to control communication between the payment device and the external device and perform NFC technology-based payment.

[0048] According to the above-mentioned antenna structure provided in this implementation of this specification, metal windings are etched on the front surface and the back surface of the flexible insulating film based on a winding shape of an antenna coil (the first antenna coil), and the metal windings are connected in series to form a conductor for constructing the antenna coil. This significantly reduces metal usage, and effectively reduces costs of an antenna. When subsequently applied to a payment device, the antenna structure can also significantly reduce costs of the payment device. In addition, in the above-mentioned antenna structure in this implementation of this specification, a conductive element (the first conductive element) is added to an end pin of the antenna coil. This not only protects the end pin from oxidation and corrosion, but also enhances conductivity of the end pin, extends a service life of the end pin, and provides better applicability.

[0049] In one or more implementations of this specification, the antenna structure can alternatively include a plurality of antenna coils. The following uses two antenna coils as an example for description. Based on the same invention concept, one or more implementations of this specification further provide another antenna structure. As shown in FIG. 3 and FIG. 4, FIG. 3 is a schematic diagram illustrating a front surface of another antenna structure, according to one

or more implementations of this specification. FIG. 4 is a schematic diagram illustrating a back surface of the antenna structure in FIG. 3.

[0050] It can be seen with reference to FIG. 3 and FIG. 4 that in the antenna structure provided in this implementation of this specification, in addition to a first winding 21, a third winding 31 can be further etched on a front surface of a flexible insulating film 10, and in addition to a second winding 22, a fourth winding 32 can be further etched on a back surface of the flexible insulating film 10.

[0051] The first winding 21 and the second winding 22 are connected in series to form a first conductor. On a plane parallel to the flexible insulating film 10, the first conductor is wound from the inside out or from the outside in for a plurality of turns to form an antenna coil, which is denoted as a first antenna coil 20. The third winding 31 and the fourth winding 32 are connected in series to form a second conductor. On the same plane as the first conductor, the second conductor is wound from the inside out or from the outside in for a plurality of turns to form an antenna coil, which is denoted as a second antenna coil 30.

[0052] The first antenna coil 20 and the second antenna coil 30 are wound together. For example, as shown in FIG. 3, the second antenna coil 30 can be wound on an inner side of the first antenna coil 20. It should be understood that the second antenna coil can alternatively be wound on an outer side of the first antenna coil. Implementations are not limited in this specification.

[0053] During manufacturing of an antenna, a metal layer can be attached to each of the front surface and the back surface of the flexible insulating film 10. For example, an aluminum foil layer can be adhered to each of the front surface and the back surface of the flexible insulating film 10. Then, receptively based on a shape of the first antenna coil 20 and a shape of the second antenna coil 30, that is, a shape of winding from the inside out for a plurality of turns or winding from the outside in for a plurality of turns, etching is performed to separately obtain the first winding 21 and the third winding 31 on the front surface of the flexible insulating film 10 and the second winding 22 and the fourth winding 32 on the back surface of the flexible insulating film 10. Then, the first winding 21 on the front surface of the flexible insulating film and the second winding 22 on the back surface of the flexible insulating film are conductively connected in series to form a complete conductor, which is denoted as the first conductor, and the third winding 31 on the front surface of the flexible insulating film and the fourth winding 32 on the back surface of the flexible insulating film are conductively connected in series to form a complete conductor, which is

denoted as the second conductor. A coil formed by winding the first conductor is the first antenna coil 20. A coil formed by winding the second conductor is the second antenna coil 30.

[0054] Optionally, the first winding 21 can include one segment of conductor, or the first winding 21 can include a plurality of segments of conductors. Similarly, the second winding 22 can include one segment of conductor, or the second winding 22 can include a plurality of segments of conductors. Implementations are not limited in this specification. It should be understood that all conductors included in the first winding 21 and all conductors included in the second winding 22 are conductively connected in series to each other to form the first conductor.

[0055] Similarly, the third winding 31 and the fourth winding 32 can each include a segment of conductor. Alternatively, the third winding 31 and the fourth winding 32 can each include a plurality of segments of conductors. Implementations are not limited in this specification. It should be understood that all conductors included in the third winding 31 and the fourth winding 32 are conductively connected in series to each other to form the second conductor.

[0056] Optionally, the first winding 21 on the front surface of the flexible insulating film and the second winding 22 on the back surface of the flexible insulating film can be conductively connected in series by riveting. As shown in FIG. 3 and FIG. 4, the first winding 21 and the second winding 22 can be conductively riveted at a first riveting point 23 shown in the figures. Similarly, the third winding 31 on the front surface of the flexible insulating film and the fourth winding 32 on the back surface of the flexible insulating film can be conductively connected in series by riveting. As shown in FIG. 3 and FIG. 4, the third winding 31 and the fourth winding 32 can be conductively riveted at a second riveting point 33 shown in the figures.

[0057] Optionally, the first conductor obtained by conductively connecting the first winding 21 and the second winding 22 in series can be wound in an arc shape, a rectangle shape, or other irregular shapes. Based on this, the first antenna coil 20 can be formed by winding the first conductor into a plurality of arc-shaped coils, a plurality of rectangular coils, or a plurality of coils of other irregular shapes. Implementations are not limited in this specification.

[0058] Similarly, the second conductor obtained by conductively connecting the third winding 31 and the fourth winding 32 in series can be wound in an arc shape, a rectangle shape, or other irregular shapes. Based on this, the second antenna coil 30 can be formed by winding the second conductor into a plurality of arc-shaped coils, a plurality of rectangular coils, or a plurality of coils of other irregular shapes. Implementations are not limited in this specification.

[0059] Optionally, portions of the conductor on the first antenna coil 20 that are located near both ends—namely, a portion of the conductor near a starting end of winding of the first antenna coil 20 and a portion of the conductor near a terminating end of winding of the first antenna coil 20—both extend to an outer side of a wound portion of the first antenna coil to serve as a first end pin 24 of the first antenna coil 20, for connecting to an external main control board. Similarly, portions of the conductor on the second antenna coil 30 that are located near both ends—namely, a portion of the conductor near a starting end of winding of the second antenna coil 30 and a portion of the conductor near a terminating end of winding of the second antenna coil 30—both extend to an outer side of a wound portion of the second antenna coil to serve as an end pin 34 of the second antenna coil 30, which is subsequently referred to as a second end pin 34 for short, for connecting to an external main control board.

[0060] Optionally, the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 can extend in the same direction.

[0061] Optionally, a portion of the conductor on the first antenna coil 20 that extends to the outer side of the wound portion can be located on the same plane as a coil of the wound portion. Similarly, a portion of the conductor on the second antenna coil 30 that extends to the outer side of the wound portion can be located on the same plane as a coil of the wound portion.

[0062] Optionally, to facilitate application of the antenna structure to a device with a relatively small volume, the portion of the conductor on the first antenna coil 20 that extends to the outer side of the wound portion can also form an angle with a plane on which the coil of the wound portion is located. A magnitude of the angle is determined based on a requirement of an application scenario. Implementations are not limited in this specification. Similarly, a portion of the conductor on the second antenna coil 30 that extends to the outer side of the wound portion can also form an angle with a plane on which the coil of the wound portion is located. A magnitude of the angle can also be set based on a requirement of an application scenario.

[0063] To protect the end pin from oxidation and enhance conductivity of the end pin, in the antenna structure provided in this implementation of this specification, a first conductive element (not shown in the figure) is added on the first end pin 24 of the first antenna coil 20, and a second conductive element (not shown in the figure) is added on the second end pin 34 of the second antenna coil 30. In this case, the first conductive element can protect the first end pin 24 of the first antenna coil 20 from oxidation. When the first end pin 24 on which the first conductive

element is added is connected to the main control board, conductivity is better. Similarly, the second conductive element can protect the second end pin 34 of the second antenna coil 30 from oxidation. When the second end pin 34 on which the second conductive element is added is connected to the main control board, conductivity is better.

[0064] Optionally, the first conductive element can be carbon paste screen-printed on the first end pin 24 of the first antenna coil 20, and the second conductive element can be carbon paste screen-printed on the second end pin 34 of the second antenna coil 30. In other words, the carbon paste can be screen-printed on the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 through screen-printing. In a process of screen-printing the carbon paste, the carbon paste exhibits strong adhesion to an etched aluminum foil after the carbon paste is baked, so that conductivity and corrosion resistance of the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 are both good, and performance is significantly improved. It should be understood that another conductive material can alternatively be screen-printed on the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30. For example, silver paste can be screen-printed on the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30. Implementations are not limited in this specification.

[0065] Optionally, the first conductive element can alternatively be a wiring terminal riveted onto the first end pin 24 of the first antenna coil 20, and the second conductive element can alternatively be a wiring terminal riveted onto the second end pin 34 of the second antenna coil 30. In other words, the wiring terminals can be riveted onto the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 by riveting, and the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 are covered by the wiring terminals. As such, the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 can also be prevented from being oxidized and corroded, and conductivity of the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 can be enhanced.

[0066] Optionally, the first conductive element can alternatively be a metal coating applied onto the first end pin 24 of the first antenna coil 20, and the second conductive element can alternatively be a metal coating applied onto the second end pin 34 of the second antenna coil 30. In other words, a metal layer can be plated onto the first end pin 24 of the first antenna coil 20 and

the second end pin 34 of the second antenna coil 30. For example, nickel or gold can be plated onto the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30. As such, the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 can be prevented from being oxidized and corroded, and conductivity of the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 can be enhanced. It should be understood that other metals can also be plated onto the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30. Implementations are not limited in this specification.

[0067] Optionally, when the first conductive element is added on the first end pin 24 of the first antenna coil 20, the added first conductive element is positioned directly opposite to and in close contact with the first end pin 24 of the first antenna coil 20, and a coverage area of the first conductive element is greater than a range of the first end pin 24 of the first antenna coil 20. It should be understood that the coverage area of the first conductive element only needs to be slightly greater than the range of the first end pin 24 of the first antenna coil 20. As such, the first conductive element can cover the entire first end pin 24 of the first antenna coil 20 to prevent the first end pin from being corroded, while avoiding excessive extension beyond the range of the first end pin 24 of the first antenna coil 20, thereby preventing a problem of large misalignment that could affect conductivity.

[0068] Similarly, when the second conductive element is added on the second end pin 34 of the second antenna coil 30, the added second conductive element is positioned directly opposite to and in close contact with the second end pin 34 of the second antenna coil 30, and a coverage area of the second conductive element is greater than a range of the second end pin 34 of the second antenna coil 30. It should be understood that the coverage area of the second conductive element only needs to be slightly greater than the range of the second end pin 34 of the second antenna coil 30. As such, the second conductive element can cover the entire second end pin 34 of the second antenna coil 30 to prevent the second end pin from being corroded, while avoiding excessive extension beyond the range of the second end pin 34 of the second antenna coil 30, thereby preventing a problem of large misalignment that could affect conductivity.

[0069] Optionally, the flexible insulating film 10 and the first antenna coil 20 and the second antenna coil 30 obtained by etching are made of relatively soft materials. Even if the first conductive element is added on the first end pin 24 of the first antenna coil 20, and the second

conductive element is added on the second end pin 34 of the second antenna coil 30, the first end pin 24 and the second end pin 34 are still relatively soft, which makes it inconvenient to connect the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 to the external main control board. To improve the convenience of antenna connection, an insulation reinforcement film can further be adhered to each of a back surface of the first end pin 24 of the first antenna coil 20 and a back surface of the second end pin 34 of the second antenna coil 30, so as to improve hardness and strength of the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30, thereby making it more convenient to connect the antenna structure to the external main control board.

[0070] Optionally, the insulation reinforcement film can be a polyimide (PI) film or a PET film. It should be understood that the insulation reinforcement film can alternatively be other insulating films. Implementations are not limited in this specification.

[0071] Optionally, a shape of the flexible insulating film 10 used to etch the first antenna coil 20 and the second antenna coil 30 can be set based on a shape of the first antenna coil 20 and a shape of the second antenna coil 30. In other words, the shape of the flexible insulating film 10 matches the shape of the first antenna coil 20 and the shape of the second antenna coil 30. It should be understood that an area of the flexible insulating film 10 is greater than an area occupied by the first antenna coil 20 and the second antenna coil 30, so that the entire first antenna coil 20 and the entire second antenna coil 30 can be etched onto the flexible insulating film 10. For example, as shown in FIG. 3 and FIG. 4, if the first antenna coil 20 and the second antenna coil 30 are each formed by winding a plurality of arc-shaped coils, the flexible insulating film 10 can be a circular insulating film. It should be understood that the flexible insulating film 10 further includes an extended portion of the insulating film for etching an extended portion of the conductor, and the first end pin 24 of the first antenna coil 20 and the second end pin 34 of the second antenna coil 30 are both etched on the extended portion of the insulating film.

[0072] Optionally, the antenna structure provided in this implementation of this specification can further include a conductive spring plate (not shown in the figure). A first connection end of the conductive spring plate is configured to connect to an end pin on which the first conductive element is added, that is, the first connection end of the conductive spring plate is configured to connect to the first end pin 24 on which the first conductive element is added; a second connection end of the conductive spring plate is configured to connect to an end pin on which the second

conductive element is added, that is, the second connection end of the conductive spring plate is configured to connect to the second end pin 34 on which the second conductive element is added; and a third connection end of the conductive spring plate is configured to connect to the external main control board. For example, the antenna structure provided in this implementation of this specification can be applied to a payment device, and the third connection end of the conductive spring plate is configured to connect to a main control board of the payment device.

[0073] When the antenna structure provided in this implementation of this specification is applied to the payment device, the antenna structure can be used as an NFC antenna. In an optional implementation of this specification, the payment device can control conduction to or disconnection from the first end pin 24 of the first antenna coil 20 via the main control board of the payment device. Similarly, the payment device can further control conduction to or disconnection from the second end pin 34 of the second antenna coil 30 via the main control board of the payment device.

[0074] For example, assume that the antenna structure includes only the first antenna coil 20 and the second antenna coil 30, and the second antenna coil 30 is wound on an inner side of the first antenna coil 20. As shown in FIG. 5, a portion of the conductor on the first antenna coil that extends to an outer side of a wound portion and an extended portion of the insulating film, and a portion of the conductor on the second antenna coil that extends to the outer side of the wound portion and an extended portion the insulating film can each be arranged at a 90-degree included angle relative to a plane on which a coil of the wound portion is located. Then, the extended portion of the insulating film can be adhered to an inner wall of a housing of the payment device, and the conductive spring plate can be fastened inside the housing of the payment device. The third connection end of the conductive spring plate is conductively connected to the main control board of the payment device.

[0075] When the payment device detects that the payment device is powered by an external power supply or an internal battery, the payment device can control, by using the main control board, the first connection end of the conductive spring plate to be conductively connected to the first end pin on which the first conductive element is added, while disconnecting the second connection end of the conductive spring plate from the second end pin on which the second conductive element is added. In this case, the payment device communicates with an external device by using the first antenna coil, thereby enabling NFC technology-based payment.

[0076] When detecting that neither the external power supply nor the internal battery is providing power, the payment device can control, by using the main control board, the second connection end of the conductive spring plate to be conductively connected to the second end pin on which the second conductive element is added, while disconnecting the first connection end of the conductive spring plate from the first end pin on which the first conductive element is added. In this case, the second antenna coil can function as an NFC tag, and an external device can read information in the NFC tag, thereby enabling NFC technology-based payment.

[0077] According to the above-mentioned antenna structure provided in the implementations of this specification, metal windings are etched on both the front surface and the back surface of the flexible insulating film based on winding shapes of antenna coils (the first antenna coil and the second antenna coil), and the metal windings are connected in series to form conductors for constructing the antenna coils. This not only significantly reduces costs of the payment device and facilitates promotion and application of the payment device, but also ensures that the payment device performs NFC technology-based communication by switching conduction between the two antenna coils, whether the payment device is powered or unpowered. As such, communication efficiency of the payment device is improved, and applicability is better.

[0078] Based on the same invention concept, one or more implementations of this specification further provide another antenna structure. The antenna structure can include a flexible insulating film. For example, the flexible insulating film can be a PET film. A first winding is etched on a front surface of the flexible insulating film, a second winding is etched on a back surface of the flexible insulating film, and the first winding and the second winding are connected in series to form a first conductor. On a plane parallel to the flexible insulating film, the first conductor is wound from the inside out or from the outside in for a plurality of turns to form an antenna coil, which is denoted as a first antenna coil.

[0079] For a specific way of forming the first antenna coil, references can be made to content of the above-mentioned implementations. Details are omitted here. In addition, for a specific structure of the first antenna coil, references can also be made to FIG. 1 and FIG. 2.

[0080] Optionally, portions of the conductor on the first antenna coil that are located near both ends—namely, a portion of the conductor near a starting end of winding and a portion of the conductor near a terminating end of winding—both extend to an outer side of a wound portion of the first antenna coil. A portion of the conductor extending to the outer side of the wound portion

and a coil of the wound portion can be located on the same plane, or a portion of the conductor extending to the outer side of the wound portion can form an angle with a plane on which a coil of the wound portion is located. Implementations are not limited in this specification.

[0081] Optionally, on the portion of the conductor extending to the outer side of the wound portion, a tuning capacitor can be connected in series at a position near an end of the portion of the conductor. In this case, the antenna structure can be used as a tuning antenna configured to tune a frequency of another antenna. For example, the antenna structure can be applied to a payment device, and the antenna structure is placed near an antenna that needs to be tuned, so as to adjust a frequency of the antenna that needs to be tuned.

[0082] Optionally, the tuning capacitor can be conductively connected in series to an end of the first antenna coil by using conductive silver adhesive. During specific arrangement of an antenna, the tuning capacitor can be bonded to the end of the first antenna coil by using the conductive silver adhesive, and the conductive silver adhesive, the first antenna coil, and the tuning capacitor are bonded together through hot-pressing bonding, so that a connection between the three is stronger.

[0083] The above-mentioned antenna structure provided in this implementation of this specification can be used as a tuning antenna to tune others antenna in a device. In addition, because the antenna structure significantly reduces metal usage, and effectively reduces antenna costs, when the antenna structure is subsequently applied to a payment device, costs of the payment device can also be significantly reduced, thereby facilitating promotion and application of the payment device and enriching payment experience of a user.

[0084] Based on the same invention concept, one or more implementations of this specification further provide a payment device. The payment device can include the antenna structure provided in any one of the above-mentioned implementations.

[0085] For example, an antenna structure that includes only a first antenna coil whose end pin (or an end pin on which a first conductive element is added) can be used to connect to an external main control board is used as an NFC antenna, and is applied to a payment device. During specific use, the end pin of the first antenna coil (or the end pin on which the first conductor element is added) can be conductively connected to a main control board of the payment device. When an external power supply or an internal battery supplies power, the payment device can perform NFC technology-based payment with an external device through the antenna structure.

[0086] For example, an antenna structure including the first antenna coil and a second antenna coil can be further applied to the payment device. During specific use, when the payment device detects that the payment device is powered by an external power supply or an internal battery, the payment device can control, by using the main control board, a first connection end of a conductive spring plate to be conductively connected to the end pin on which the first conductive element is added, while disconnecting a second connection end of the conductive spring plate from an end pin on which a second conductive element is added. In this case, the payment device communicates with an external device by using the first antenna coil, thereby enabling NFC technology-based payment.

[0087] When detecting that neither the external power supply nor the internal battery is providing power, the payment device can control, by using the main control board, the second connection end of the conductive spring plate to be conductively connected to the end pin on which the second conductive element is added, while disconnecting the first connection end of the conductive spring plate from the end pin on which the first conductive element is added. In this case, the second antenna coil can function as an NFC tag, and an external device can read information in the NFC tag, thereby enabling NFC technology-based payment.

[0088] For example, an antenna structure that includes only the first antenna coil whose end is connected in series to a tuning capacitor can also be applied to the payment device, and another antenna, such as an NFC antenna, in the payment device is tuned by using the antenna structure.

[0089] Optionally, when any antenna structure is applied to the payment device, the antenna structure can be pasted inside a housing of the payment device. For a specific method, references can be made to content of the above-mentioned implementations, and details are omitted here.

[0090] According to the payment device provided in this implementation of this specification, because an antenna structure with lower costs is applied, costs of the payment device are also significantly reduced, making it easier to promote and use the payment device, and providing better applicability.

[0091] The implementations of this specification are described in a progressive method. For same or similar parts in the implementations, references can be made to each other. Each implementation focuses on a difference from another implementation. Particularly, implementations of a payment device are briefly described since they are basically similar to the implementations of the above-mentioned antenna structure. For related parts, references can be

made to related descriptions in the implementations of the above-mentioned antenna structure.

[0092] In this specification, the relationship terms such as "first" and "second" are merely used to distinguish one entity or operation from another, and do not necessarily require or imply that any actual relationship or sequence exists between these entities or operations. Moreover, the terms "include", "comprise", or any other variants thereof are intended to cover a non-exclusive inclusion, so that a process, a method, an article, or a device that includes a list of elements not only includes those elements but also includes other elements that are not expressly listed, or further includes elements inherent to such a process, method, article, or device. A person of ordinary skill in the art can understand a specific meaning of the previously described terms in one or more implementations of this specification according to a specific situation.

[0093] It is worthwhile to note that one or more implementations of this specification and the features in the implementations can be mutually combined in the case of no conflict. One or more implementations of this specification are not limited to any single aspect, nor is it limited to any single implementation, nor is it limited to any combination and/or permutation of these aspects and/or implementations. Moreover, each aspect and/or implementation in one or more implementations of this specification can be used alone or in combination with one or more other aspects and/or implementations thereof.

[0094] Finally, it should be noted that the above-mentioned implementations are only used to illustrate the technical solutions of one or more implementations of this specification, and are not intended to limit same. Although this specification is described in detail with reference to the above-mentioned implementations, those of ordinary skill in the art should understand that they can still modify the technical solutions described in the above-mentioned implementations, or make equivalent substitutions to some or all technical features therein. These modifications or substitutions do not make the essence of the corresponding technical solutions depart from the scope of the technical solutions of one or more implementations of this specification, and all of them shall fall within the scope of the claims and one or more implementations of this specification.

[0095] One or more implementations of this specification are described above with reference to optional implementations. However, these implementations are merely examples, and serve only as illustrative purposes. On this basis, various replacements and improvements can be made to one or more implementations of this specification, and fall within the protection scope of one or more implementations of this specification.

CLAIMS

What is claimed is:

1. An antenna structure, comprising:

a flexible insulating film, wherein a first winding is etched on a front surface of the flexible insulating film, a second winding is etched on a back surface of the flexible insulating film, and the first winding and the second winding are connected in series to form a first conductor;

the first conductor is wound from the inside out or from the outside in for a plurality of turns to form a first antenna coil; and

a first conductive element is added on an end pin of the first antenna coil, and is configured to connect to an external main control board.

2. The antenna structure according to claim 1, wherein a third winding is further etched on the front surface of the flexible insulating film, a fourth winding is further etched on the back surface of the flexible insulating film, and the third winding and the fourth winding are connected in series to form a second conductor; the second conductor is wound from the inside out or from the outside in for a plurality of turns to form a second antenna coil; a second conductive element is added on an end pin of the second antenna coil, and is configured to connect to the main control board; and the second antenna coil is wound on an inner side of the first antenna coil.

3. The antenna structure according to claim 2, wherein both the first conductive element and the second conductive element are carbon paste screen-printed on corresponding end pins.

4. The antenna structure according to claim 2, wherein both the first conductive element and the second conductive element are wiring terminals riveted onto corresponding end pins.

5. The antenna structure according to claim 2, wherein both the first conductive element and the second conductive element are metal coatings applied onto corresponding end pins.

6. The antenna structure according to any one of claims 2 to 5, wherein both the first conductive element and the second conductive element are positioned directly opposite to and in close contact with corresponding end pins, respectively, and completely cover the corresponding end pins.

7. The antenna structure according to any one of claims 2 to 5, wherein the first winding and the second winding are conductively connected in series by riveting, and the third winding and the fourth winding are conductively connected in series by riveting.

8. The antenna structure according to any one of claims 2 to 5, wherein the antenna structure further comprises a conductive spring plate, a first connection end of the conductive spring plate is configured to connect to the end pin on which the first conductive element is added, a second connection end of the conductive spring plate is configured to connect to the end pin on which the second conductive element is added, and a third connection end of the conductive spring plate is configured to connect to the main control board.

9. The antenna structure according to any one of claims 2 to 5, wherein insulation reinforcement films are adhered to a back surface of the end pin of the first antenna coil and a back surface of the end pin of the second antenna coil.

10. An antenna structure, comprising:

a flexible insulating film, wherein a first winding is etched on a front surface of the flexible insulating film, a second winding is etched on a back surface of the flexible insulating film, and the first winding and the second winding are connected in series to form a first conductor;

the first conductor is wound from the inside out or from the outside in for a plurality of turns to form a first antenna coil;

a tuning capacitor is connected in series at a position near an end of the first antenna coil; and

the tuning capacitor is conductively connected in series to the first antenna coil by using conductive silver adhesive.

11. A payment device, wherein the payment device comprises the antenna structure according to any one of claims 1 to 9 or claim 10.