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Near field communication housing structure

Abstract

An embodiment device includes a first housing formed of a first radio-transparent material and having an outer perimeter surface including a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, a second housing formed of a second radio-transparent material and secured to the first housing, a near field communication (NFC) chip disposed between the first housing and the second housing, a link having a first end and a second end extending into the body of the first housing.

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates generally to a device and method for a near field communication (NFC) housing structure, and, in particular embodiments, to a device and method for an NFC housing structure that can be worn by a user.

BACKGROUND

(2) Radio frequency identification (RFID) technology may be used for multiple purposes. Near field communication (NFC) is a more effective form of RFID. NFC can operate in one way or two way communication. In NFC, an initiator (active) device, such a phone, and a target (passive) device, such a wearable, communicate via an active NFC chip and a passive NFC chip, respectively. The reader generates an electromagnetic field to power the passive chip.

SUMMARY

(3) An embodiment device includes a first housing formed of a first radio-transparent material and having an outer perimeter surface including a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, a second housing formed of a second radio-transparent material and secured to the first housing, a near field communication (NFC) chip disposed between the first housing and the second housing, where the NFC chip is enclosed by both the first housing and the second housing, and a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first

housing towards the first outer perimeter portion.
(4) An embodiment device includes a first housing formed of a radio-transparent material and having an outer perimeter surface with a first outer perimeter portion, a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from the first outer perimeter portion or the second outer perimeter portion into a body of the housing, where the outer perimeter surface has a lobe at least partially defined by the first outer perimeter portion and the second outer perimeter portion, and where the one or more recesses are disposed in the lobe, a second housing formed of a second radio-transparent material secured to the first housing, a near field communication (NFC) chip disposed between the first housing and the second housing, where the NFC chip is enclosed by both the first housing and the second housing, one or more recesses disposed in the lobe, and a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the housing towards the first outer perimeter portion.
(5) An embodiment method includes providing a first housing formed of a first radio-transparent material having an outer perimeter surface having a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, providing a second housing formed of a second radio-transparent material, securing an near field communication (NFC) chip in the second housing, securing the second housing in the first housing, where the NFC chip is enclosed by both the first housing and the second housing, and attaching a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:
(2) FIGS. **1**A-**1**D illustrate components of an NFC housing structure according to embodiments;
(3) FIGS. **2**A-**2**B illustrate an assembled NFC housing structure according to embodiments;
(4) FIGS. **3**A-**3**B illustrate the first housing and the second housing according to an embodiment;
(5) FIGS. **4**A-**4**C illustrate NFC housing with different shapes according to an embodiment; and
(6) FIG. **5** is a flow diagram illustrating a process for forming an NFC housing.
DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS
(7) Illustrative embodiments of the system and method of the present disclosure are described below. In the interest of clarity, all features of an actual implementation may not be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions may be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time-consuming but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.
(8) Reference may be made herein to the spatial relationships between various components and to the spatial orientation of various aspects of components as the devices are depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the

present disclosure, the devices, members, apparatuses, etc. described herein may be positioned in any desired orientation. Thus, the use of terms such as “above,” “below,” “upper,” “lower,” or other like terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, as the device described herein may be oriented in any desired direction.

(9) Embodiments of the present application relate to an NFC housing structure that can be connected to a substrate via a connector that can be worn by a user.

(10) NFC chip wearables can be used for numerous applications. For example, NFC wearables can be used for credit card transactions or healthcare applications. Additionally, the NFC wearables may be used to provide a connection to content, services, or the like for assisting a user in executing a task. For example, NFC wearables may be used to provide content, such as a reference location related to health updates for a user, alerts for a user regarding the status of their medications, or even to provide a user with personalized instructions in a health crisis such as a panic attack. In some other examples, a wheelchair user may use the wearable to open or unlock a door, start a car, automatically dial a telephone, or access web-based content. In some embodiments, the NFC chip in a wearable may be an RFID chip with additional memory, processing or communication circuits, or the like, and, and may hold additional information related to a user, such as contact information, medical information, or the like. In some embodiments, the RFID chip may provide tracking of a user, for example, through active communications such as transmitting a location though a cellular or other wireless connection, through passive communication, such as providing a ‘ping’ or response to a message from a communications device or network, or the like.

(11) In operation, when a passive NFC chip is brought within range of an active NFC chip the active chip generates a magnetic field. The passive NFC chip is powered by the active chip and modulates the magnetic field. When designing wearables for a user containing an NFC chip, the NFC chip may be located in a housing. The housing may provide a protective structure for the NFC chip. The housing may then be connected to a chain, rope, or band to form a wearable that can be worn by the user. For example, a wearable may be a bracelet or a necklace.

(12) To make a wearable comfortable for a user, NFC housings are made to be as compact as possible.

(13) Embodiments relate to an NFC housing structure that can be connected to a wearable via a connector, such as a link, while still having dimensions small enough to be comfortable for the user without any interference between the connector and the NFC chip. In various embodiments, the NFC housing structure may include a second housing secured within a first housing. An NFC chip may be secured in the second housing and enclosed by both of the housings. This will be described in more detail below.

(14) The first housing may include an outer perimeter surface that forms a lobe. The lobe may be at least partially defined by a first outer perimeter portion and a second outer perimeter portion of the outer perimeter surface. The dimensions and shape of the first housing allow for one or more recesses to be disposed within the lobe without penetrating the second housing. The geometry and dimensions of the first housing, therefore, allows one or more recesses to be formed in the lobe that are small enough to secure the connector. The one or more recesses secure the connector so that the connector is separated from the NFC chip by enough of a distance so that it does not interfere with the NFC chip. The connector may be a metallic connector to provide an improved mechanical connection to the NFC housing structure. Using a metallic link provides a stronger connection between the first housing and a rope or chain of a user wearable. The spacing between the connector and the NFC chip allows for use of a metallic connector because the spacing prevents the metallic connector from acting as an antenna of NFC chip and prevents the metallic chip from interfering and weakening the electromagnetic signals transmitted to and from the NFC chip.

(15) FIGS. **1**A-**1**D illustrate components of an NFC housing structure according to embodiments. FIG. **1**A is an isometric view illustrating a first housing of the NFC housing structure according to some embodiments.

(16) A first housing **102** may include a first cavity **104** and one or more recesses disposed in a lobe **106**. The first housing **102** may be formed of a first radio transparent material, and may have a first thickness. The first thickness may be between 2.5 and 6 mm, for example 3 mm.

(17) The first housing **102** may be manufactured from any suitable radio transparent material. For example, from a hardwood such as maple, walnut, or the like. In other embodiments, the first housing **102** may be formed from a radio transparent resin or synthetic material, such as acrylic, polyethylene, fiberglass composites, glass, sapphire, or the like, with the radio transparent material or a combination of materials being sufficiently strong to handle machining or forming processes as described below. The material of the first housing **102** is not limited to the disclosed embodiments, as other advantageous materials, or combinations of materials, may be employed.

(18) In various embodiments, the first housing **102** may have a rectangular or square cross-sectional shape a length **116** and width **117** that are substantially equal, along with a height **114**. The length **116** and the width **117** may each be within a range of 10 mm to 50 mm, for example 15 mm. The height **114** may be within a range of 1 mm to 3 mm, for example 2 mm. In other embodiments, the cross-sectional shape of the first housing **102** may be a rectangle, a circle, an "eye" shape, a flower shape, a star, or the like. The cross-sectional shape of the first housing **102** is not limited to the disclosed embodiments, as other advantageous shapes may be used. Advantageously, the shape and the dimensions of the first housing allow for the formation of one or more recesses in an outer perimeter surface **115** of the first housing **102** that house, retain, accept, or secure a connector. The one or more recesses may be formed in a lobe so that the one or more recesses are spaced at a distance away from the second housing securing an NFC chip. The spacing between the one or more recesses and the NFC chip ensure that the connector does not interfere with the NFC chip.

(19) The first housing **102** may have an outer perimeter surface **115** surrounding a body of the housing in which the first cavity **104** is disposed. The first cavity **104** may have a square shape. On the other hand, the first cavity **104** may have a shape that is rectangular, round, or any other shape. The first cavity **104** may be sized to secure or hold a second housing holding an NFC chip. The shape of the first cavity **104** may be the same or different from the cross-sectional shape of the first housing **102**.

(20) FIG. **1**B illustrates an isometric view of a second housing of the NFC housing structure according to some embodiments. In various embodiments, the first cavity **104** may be configured or sized to accept or secure a second housing **120** holding an NFC chip. The first cavity **104** may be configured so that the second housing **120** fits securely inside of it. In addition, the of the first cavity **104** may have a wall thickness **107** between 1.2 mm and 4.0 mm, for example 1.3 mm. However, based on the material type or shape, the minimum wall thickness **107** may be higher. For example, a softer material requires a higher minimum wall thickness **107**. In embodiments where the first cavity **104** is a square cross-sectional shape, it may have a length **118** and width **119** between 5 mm and 45 mm, for example 12.5 mm. The depth **112** of the first cavity **104**, regardless of shape, may be between 1 mm and 4.5 mm, for example 2 mm.

(21) The outer perimeter surface **115** of the first housing **102** may comprise at least two outer perimeter portions **105**, **109**. Each portion of the outer perimeter surface **115** may correspond to the outer walls of the first housing **102**. For example, the first housing **102** in FIG. **1**A includes a first outer perimeter portion **105**, a second outer perimeter portion **109**, a third outer perimeter portion (not shown) and a fourth outer perimeter portion (not shown).

(22) The outer perimeter surface **115** defines the outer perimeter of the walls of the first housing **102** that surround the first cavity **104**. The outer perimeter surface **115** forms one or more lobes that allow for one or more recesses to be formed in the first housing **102** that are small enough to secure

a connector without penetrating the first cavity **104**. The lobes allow for a connector to be secured in the first housing while the link is at a sufficient distance from the first cavity **104** so that the connector does not interfere with the NFC chip.

(23) At least one lobe **106** may be defined by at least one of the outer perimeter portions **105**, **109**. The lobe **106** may be an area bounded by one or more portions of the outer perimeter surface **115** that provide a region of the body of the first housing **102** that is spaced apart from the first cavity **104**. The lobe **106** may be the portions of the first housing **102** that are the farthest away from the first cavity **104**. In one embodiment, a lobe **106** may formed where outer perimeter portions of the outer perimeter surface **115** intersect (i.e. meet) For example, as illustrated in FIG. **1**A, a lobe **106** may be formed where the first outer perimeter portion **105** and the second outer perimeter portion **109** meet. Additionally, in some embodiments, a lobe **106** may be formed at the second and third outer perimeter portions, the third and fourth outer perimeter portions, and the first and fourth outer perimeter portions. The shape of the lobe **106** may be defined by the shape of the outer perimeter surface **115**. For example, if the outer perimeter surface **115** has corners (e.g. a square or a star) the lobe **106** may, in some embodiments, include a corner of the outer perimeter. In other embodiments where the cross-sectional shape of the outer perimeter is round, the lobe **106** may be rounded.

(24) One or more recesses **108**, **110** may be disposed within the lobe **106**. The one or more recesses **108**, **110** may extend from one of first outer perimeter portion **105** or the second outer perimeter portion **109** into the body of the first housing **102**. The one or more recesses **108**, **110** may secure a connector that may be used to couple the first housing **102** to a substrate, carrier or the like, such a rope or a chain of a bracelet or a necklace. The one or more recesses **108**, **110** may be any suitable shape that allows the connector to be secured to a substrate or a carrier. For example, the recesses may be circular, square, triangular or the like.

(25) In various embodiments, the one or more recesses **108**, **110** may include two separate recesses **108**, **110**. A first recess **108** may extend from the first outer perimeter portion **105** into the body of the first housing **102** towards the second outer perimeter portion **109**. A second recess **110** may extend from the second outer perimeter portion **109** into the body of the first housing **102** towards the first outer perimeter portion **105**. The first recess **108** and the second recess **110** may each extend into the body of the housing to substantially equal depths. In other embodiments, the one or more recesses **108**, **110** may be a single recess, such as a through hole, extending from the first outer perimeter portion **105** to the second outer perimeter portion **109**. The one or more recesses may also be formed in a second lobe (not shown) that is opposite the first housing **102** from the lobe **106**. This allows for a connector to be coupled to opposite lobes and allow both sides of the first housing **102** to be coupled to a wearable. For example, one or more recesses may also be formed at the lobe where the third and fourth outer perimeter surfaces meet.

(26) In some embodiments, the lobe **106** provides an area where the one or more recesses may be formed without penetrating the first cavity **104**. Thus, the lobe **106** provides enough distance between the connector and an NFC chip disposed in the cavity to prevent interference between the connector and the chip. This will be shown in more detail below.

(27) FIG. **1**B illustrates a second housing **120**. The second housing **120** may be formed of a second non-radio transparent material having a second thickness. The second housing **120** may be manufactured from any suitable non-radio transparent acrylic material known in the art. The second thickness **135** may be between 1 mm and 5 mm, for example 2 mm.

(28) The second housing **120** may include a second cavity **122**. The second housing **120** may be configured to be secured in the first cavity **104** of the first housing **102**. Therefore, the outer perimeter of the second housing **120** is the same shape of the first cavity **104**. In one embodiment, the second housing **120** may have a square shape. In other embodiments, the second housing **120** may have a rectangular, circular, oval, or any other cross-sectional shape. The dimensions of the second housing **120** may be sized to fit within the first housing. The second housing may be secured to the first housing using an adhesive. The second housing may have a length **136** and a

width **138** between 5 mm and 45 mm, for example 8.4 mm. The second housing **120** may be secured within the first cavity **104** using a suitable attachment structure or system, such as a friction fit, adhesive, latch, screw, or the like.

(29) A second cavity **122** may be formed in the second housing **120**. The second cavity may be configured to accept an NFC chip. The shape of the outside portion of the second cavity **122** may be the same as the cross-sectional shape of the NFC chip. Thus, the second cavity **122** may have a square, circular, oval, or any cross-sectional shape to conform to the outside shape of the NFC chip. The second cavity **122** may have a length **132** and a width **134** having sizes provided to fit an NFC chip along with a second adhesive used to secure the chip. The length **132** and the width **134** may be between 3.5 mm and 30 mm, for example about 9 mm. The dimensions of the second cavity **122** ensure that the wall thickness **137** between the second cavity and the second housing **120** may be at least 1.0 mm.

(30) FIG. **1**C illustrates a connector that may be used to couple an NFC housing structure to a user's wearable. The connector may be a link **140** that may be a magnetic or ferrous material such as a metal or an alloy, or may be a conductive non-metallic material. In various embodiments, the link **140** may be a bendable metallic material having a first end **142** and a second end **144**. For example, the link **140** may be a stainless steel pinch bail link. The link **140** may have a diameter between 0.5 mm and 1 mm, for example, 0.75 mm. The first end **142** and the second end **144** may be bent to form an open shape or a closed shape so long as the link **140** may couple the NFC housing structure to a user's wearable via the one or more recesses. In some embodiments, the link **140** may be bent so that the first end **142** and the second end **144** do not touch. In some embodiments, the link **140** may be bent in a triangular shape, a square shape, a round shape, or another shape allowing the first housing **102** to be coupled to a substrate or a carrier. The shape of the link **140** is not limited by the presented embodiments, as any shape permitting attachment to a substrate or carrier may be advantageously employed.

(31) In various embodiments, the link **140** may be coupled to the first housing **102** by inserting each end into the one or more recesses. The first end **142** and the second end **144** may extend into the body of the first housing **102** from opposite outer perimeter portions **105**, **109**. For example, the first end **142** may extend from the first outer perimeter portion **105** into the body of the first housing **102** towards the second outer perimeter portion **109**. The second end **144** may extend from the second outer perimeter portion **109** into the body of the first housing **102** towards the first outer perimeter portion **105**. In other embodiments, the link **140** may be completely closed, or the ends of the link **140** may connect or touch. In such an embodiment, the one or more recesses **108**, **110** may be a through hole extending contiguously through the first housing, permitting the link to extend contiguously through the through hole recess.

(32) FIG. **1**D illustrates a cut-away view of the NFC housing structure along plane **101**. The first housing **102** and the second housing **120** may enclose an NFC chip **148**. The second housing **120** may be secured to the first housing **102** with the NFC chip **148** face down. The NFC chip **148** may be enclosed between the first housing **102** and the second housing **120**. Therefore, the second housing **120** is secured in the first housing **102** such that the bottom surface **124** is flush with or at a level above the upper lip **103** of the first cavity. The second housing **120** may be secured to the first housing using a first adhesive **150**. Therefore, the dimensions of the second housing **120** may be configured to fit within the first cavity **104**, with additional room for the first adhesive **150**. In some embodiments, the first adhesive **150** may be, or may comprise, a liquid adhesive such as Polyvinyl acetate (PVA) glue, cyanoacrylate (CA) glue, epoxy, or the like. In other embodiments, the first adhesive may be, or may comprise, another adhesive such as double sided tape, reactive adhesive, or another adhesive suitable for permanently or semi-permanently attaching the second housing **120** to the first housing **102**. In other embodiments, the adhesive may be omitted, and the second housing may be attached to, or retained within the cavity of, the first housing **102** by mechanical fastening such as a friction fit between the first and second housing **102**, **120**, by mechanical

latching elements on the first or second housing **102**, **120**, by a fastener such as a screw or pin, or by an external retaining elements such as a clip, or another element that retains the second housing in the cavity.

(33) In addition, the walls of the second housing **120** may overlap the walls of the first housing **102** in a vertical direction and when viewed from the side. For example, a first outer perimeter portion **126** of the second housing **120** may overlap the first outer perimeter portion **105** of the first housing **102**, a second outer perimeter portion **128** of the second housing **120** may overlap the second outer perimeter portion **109** of the first housing **102**, and so on.

(34) The shapes and dimensions between the first housing **102** and the second housing **120** provide a spacing of at least 1 mm between the second cavity **122** and the walls of the first housing **102**. Therefore, due to the spacing between the second cavity **122** and the walls of the first housing **102**, the one or more recesses **108**,**110** are formed only in the outer perimeter of the first housing **102**. For example, the second recess **110** may extend from the second outer perimeter portion **109** towards the first outer perimeter portion **105** without penetrating the second housing **120**.

(35) While the first housing **102** and second housing **120** are illustrated here as each being single pieces, it should be understood that the first housing **102** and second housing **120** are not limited to such an implementation. For example, either the first housing **102** or second housing **120**, or both, may be formed from multiple elements with the second housing **120** still being configured to be at least partially disposed in the first cavity **102**. Thus, in an embodiments, the second housing **120** may include an inner second housing that houses the NFC chip, and may further have an outer second housing that at least partially covers the inner second housing. The inner second housing may be formed to secure different shaped NFC chips, and the outer second housing formed to secure the inner second housing in different shaped first cavities. In some embodiments, the outer second housing may also provide decorative features such as colors, or the like, or may be used to grip or provide a region for removing the second housing **120** for replacement of, or access to, the NFC chip **148**. Similarly, the first housing **102** may be formed in multiple parts with, for example, an outer first housing providing protective, decorative, or other features, and an inner first housing securing the second housing **102**. For example, the outer first housing may include a shock absorbing material such as a silicone material, and the inner first housing may be a more rigid material such as acrylic, polyethylene, fiberglass composite, or the like, with the connector or link **140** extending into the inner first housing to secure the NFC housing to a substrate.

(36) FIGS. **2**A-**2**B illustrate an assembled NFC housing structure according to embodiments, where FIG. **2**A illustrates an isometric view of an assembled NFC housing structure and FIG. **2**B illustrates a top view of the assembled NFC housing structure.

(37) FIG. **2**A is an isometric view of an assembled NFC housing structure **200**. The NFC housing structure **200** may have the second housing **120** secured in the first housing **102**. The outer walls of the second housing **120** are completely bound by the inner surface of the walls of that define the first cavity **104**. Therefore, the NFC chip **148** is secured between the first housing **102** and the second housing **120**. The second housing **120** is secured in the first cavity **104** such that the bottom surface **124** of the second cavity is flush with or at a level above the upper lip **103** of the first cavity **104**. Advantageously, the NFC chip **148** is protected from the environment and is not visible. The link **140** is coupled to the NFC housing structure **200** via the one or more recesses **108**, **110**, and is separated from the second cavity **122** by a distance preventing interference between the NFC chip **148** and the link **140**. This will be shown in more detail in FIG. **2**B below.

(38) FIG. **2**B illustrates the top view of an assembled NFC housing structure **200**. The second housing **120** is secured to the first housing **102** via the first adhesive **150**. Similarly, the NFC chip **148** is secured to the second housing via a second adhesive **152**.

(39) When a distance between the NFC chip **148** and a link **140** used to couple an NFC housing structure **200** to a wearable are too close, the link **140** may interrupt the electric field generated by the NFC chip **148**. In turn, this may cause interference between the signals exchanged between the

passive NFC chip and its corresponding active NFC chip. Therefore, the lobe **106** separates the link **140** and the NFC chip **148** by a distance **202**. The distance **202** may be at least 0.5 mm and 15 mm. For example, the distance **202** may be about 1 mm, or greater. The distance **202** ensures that the link **140** does not interfere with the communication with NFC chip **148**.

(40) FIGS. **3**A-**3**B illustrate the first housing and the second housing according to embodiments of the presented principles, where FIG. **3**A illustrates an isometric view of the first housing having a cavity with a circular cross-sectional shape, and FIG. **3**B illustrates an isometric view of the second housing having a circular cross-sectional shape.

(41) The first housing **102** may include a first cavity **104** having a circular shape. Due to the round shape of the first cavity **104**, the wall thickness between the edge of the first housing **102** and the first cavity **104** may vary. In various embodiments, the minimum wall thickness **307** between the edge of the first housing **102** may be at least 0.5 mm

(42) The diameter **302** of the first cavity **104** may be provided such that the minimum wall thickness **307** is met. In various embodiments, the first cavity **104** may have a diameter **302** between 10 mm and 30 mm, for example 12.2 mm. As described above, while the aforementioned examples show a first cavity **104** having a square or a circle cross-sectional shape, other shapes such as an oval, a rectangle, a dome, or the like may be used.

(43) In some embodiments, the second housing **120** may also have a circular cross section shape so that it can securely fit within the first cavity **104**. In various embodiments, the second housing **120** may have a diameter between 10 mm and 30 mm, for example, about 12.2 or 13 mm. As described above, while the aforementioned examples show a second housing **120** having a square or a circle cross shape, other shapes such as an oval, a rectangle, or the like may be used so long as the first cavity **104** and the second housing **120** have the same shape.

(44) In addition, as described above, although the second housing **120** is shown as having a circular shape, the second cavity **122** may have a square shape with the same dimensions described above to secure the NFC chip **148**. Due to the round shape of the second cavity **122**, the wall thickness between the edge of the second housing **120** and the second cavity **122** may vary. In various embodiments, the minimum wall thickness **337** between the edge of the second housing **120** may be between 0.1 mm and 20.0 mm, for example 1.3 mm. However, in some embodiments, the second cavity **122** may have corners that intersect or touch the outer perimeter surface, as the walls of the second housing **120** may be at least partially enclosed by the first housing **102** when assembled.

(45) While the aforementioned examples show a second cavity **122** having a square shape, other shapes such as an oval, a rectangle, a dome, or the like may be used so long as the second cavity **122** is the same shape as the NFC chip **148**.

(46) FIGS. **4**A-**4**C illustrate NFC housings with different shapes according to various embodiments.

(47) FIG. **4**A illustrates an NFC housing structure **402** with a first housing **102** with a flower shape. The flower shape of the first housing **102** forms rounded lobes that provide an additional distance between the link **140** and the NFC chip. For example, the rounded lobes formed by the flower shape allow for a greater distance between the one or more recesses and the second housing **120** than the first housing **102** described in FIGS. **1**A and **3**A. Although the flower shape includes six petals, this is for example purposes only, as a first housing **102** in the shape of a flower may include any sufficient quantity of petals. The NFC housing structure **402** may have a second housing **120** having a circular shape. Although the NFC housing structure **402** includes a second housing **120** having a circular shape, this is also for example purposes only. The second housing **120** may be any of the shapes described above.

(48) FIG. **4**B illustrates an NFC housing structure **404** with a first housing **102** having a star shape. Advantageously, the first housing **102** having a star shape also forms lobes on each edge of the start that provide an additional distance between the link **140** and the NFC chip. For example, the edges

or points of the star shaped housing allow an additional distance between the one or more recesses and the second housing **120** than the edges of the square first housing **102** in FIGS. **1**A and **3**A. Although a five point star is shown, a star having any number of points can be used. In addition, although a second housing **120** having a round shape is shown, the second housing **120** may have any shape described above.

(49) FIG. **4**C illustrates an NFC housing structure **406** having an eye shape. Similarly, the eye shape allows for rounded lobes that provide an additional distance between the link **140** and the second housing **120**.

(50) FIG. **5** is a flow diagram illustrating a method of forming an NFC housing according to an embodiment of the present application.

(51) In block **502**, a first housing **102** formed of a first radio transparent material may be provided. The first housing **102** may be formed using a CO.sub.2 laser, a mill, a drill or any other mechanical machine. For example, in some embodiments, the first housing **102** may be cut using a CO.sub.2 laser using settings that vary based on the hardness of the material used. For example, the first housing **102** may be cut using a 45 Watt CO.sub.2 laser in a single pass using full power at a speed of 180 mm/s, but may vary based on material, depth, size of the housing, and the like.

(52) The first housing **102** may include a first cavity **104**. The first cavity **104** may be etched using a CO.sub.2 laser, a mill, a drill or any other mechanical machine. For example, the first housing **102** may be manufactured using a CO.sub.2 laser using settings that vary based on the hardness or type of the material of the first housing **102**. For example, the first cavity **104** may be etched using a 45 Watt CO.sub.2 laser in two passes, at a speed of 1000 mm/s, at 270 lines/cm, and at full power.

(53) The first housing **102** may include an outer perimeter surface **115** that includes a first outer perimeter portion **105** and a second outer perimeter portion **109**. The outer perimeter surface **115** may have one or more recesses **108**, **110**. Each one of the one or more recesses may extend from the first outer perimeter portion **105** or the second outer perimeter portion **109** and into the body of the first housing **102**. The one or more recesses **108**, **110** may be manufactured using a CO.sub.2 laser, a mill, a drill, or any other mechanical tool. For example, the one or more recess may comprise a first recess **108** and a second recess **110**. The first recess **108** may extend from the first outer perimeter portion **105** into the body of the first housing **102** towards the second outer perimeter portion **109**. The second recess **110** may extend from the second outer perimeter portion **109** into the body of the first housing **102** towards the first outer perimeter portion **105**.

(54) Alternatively, the one or more recess may include a single through hole that extends from the first outer perimeter portion **105** to the second outer perimeter portion **109**. The first housing **102** may comprise the same material and may be formed in the same manner described in FIG. **1**A described above.

(55) As next illustrated in block **504**, and described with reference to FIG. **1**B, a second housing **120** may be provided. The second housing **120** may comprise the same material and may be formed in the same manner described in FIG. **1**B above. The second housing **120** may be manufactured using a CO.sub.2 laser, a mill, a drill, casting, molding or any other suitable machine or process. For example, the second housing **120** may be cut using a 45 Watt CO.sub.2 laser in a single pass using full power at a speed of 180 mm/s. The second housing may include a second cavity **122**. The second cavity **122** may be etched using a CO.sub.2 laser, a mill, a drill, casting, molding or any other mechanical machine. For example, the second cavity **122** may be etched using a 45 Watt CO.sub.2 laser in two passes, at a speed of 1000 mm/s, at 270 lines/cm, and at full power.

(56) As next illustrated in block **506**, and described with reference to FIG. **1**D, an NFC chip **148** may be secured within the second housing **120**. The NFC chip **148** may be secured in the second housing **120** using the second adhesive.

(57) As next illustrated in block **508**, and described with reference to FIG. **1**D, and FIGS. **2**A-**2**B, the second housing **120** may be secured in the first housing **102** using the first adhesive **150**. The NFC chip **148** may be enclosed by both the first housing **102** and the second housing **120**.

(58) As next illustrated in block **510** and described with reference to FIG. **1**C, and FIGS. **2**A-**2**B, a link **140** having a first end **142** and a second end **144** may be attached to the first housing **102**. The first end **142** may extend from the first outer perimeter portion **105** into the body of the first housing towards the second outer perimeter portion **109**. The second end **144** may extend from the second outer perimeter portion **109** into the body of the first housing towards the first outer perimeter portion **105**. In other words, both ends of the link **140** may be couple to the first housing **102** via the one or more recesses. The link **140** may be formed in the same manner and comprise the material as the link **140** described in FIG. **1**C.
(59) In embodiments, the NFC housing structure **200** may include a one piece housing. For example, the NFC housing structure **200** may include a housing with a slit cut into an edge of the housing that the NFC chip **148** may be inserted into. On the other hand, the NFC housing structure **200** may only include the first housing **102** with the NFC chip **148** being secured and exposed in the first housing **102**. Also the NFC housing structure may include three different housings. A first housing may function as an outer housing and two inner housings may be secured within the outer housing that secure the NFC chip **148**.
(60) Although the first housing **102** is secured to a substrate using an adhesive, other means may be used. For example, a hole may be drilled in the bottom face **111** of the first housing **102** and a mechanical means such as a screw or rivet may be used to secure the first housing **102** to a substrate prior to securing the second housing **120** in the first housing **102**.
(61) In addition, although a metal material is used to couple the NFC housing structure **200** to a user wearable additional means may be used. For example, non-metallic, strong, and bendable materials may be used as the link **140**, such as a plastic.
(62) An embodiment device includes a first housing formed of a first radio-transparent material and having an outer perimeter surface including a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, a second housing formed of a second radio-transparent material and secured to the first housing, a near field communication (NFC) chip disposed between the first housing and the second housing, where the NFC chip is enclosed by both the first housing and the second housing, and a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.
(63) In some embodiments, the link is formed from a metallic material. In some embodiments, the outer perimeter surface has a lobe at least partially defined by the first outer perimeter portion and the second outer perimeter portion, and the one or more recesses are disposed in the lobe. In some embodiments, the link and the NFC chip are separated by a distance of at least 1 mm. In some embodiments, the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion. In some embodiments, the one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion. In some embodiments, the first radio-transparent material is wood and the second radio-transparent material is an acrylic material. In some embodiments, a bottom surface of the second housing is flush with or at a level above an upper lip of the first housing.
(64) An embodiment device includes a first housing formed of a radio-transparent material and having an outer perimeter surface with a first outer perimeter portion, a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from the first outer perimeter portion or the second outer perimeter portion into a body of the housing, where the outer perimeter surface has a lobe at least partially defined by the first outer

perimeter portion and the second outer perimeter portion, and where the one or more recesses are disposed in the lobe, a second housing formed of a second radio-transparent material secured to the first housing, a near field communication (NFC) chip disposed between the first housing and the second housing, where the NFC chip is enclosed by both the first housing and the second housing, one or more recesses disposed in the lobe, and a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the housing towards the first outer perimeter portion.

(65) In some embodiments, the link is formed from a metallic material. In some embodiments, the link and the NFC chip are separated by a distance of at least 1 mm. In some embodiments, the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion. In some embodiments, the one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion. In some embodiments, a bottom surface of the second housing is flush with or at a level above an upper lip of the first housing.

(66) An embodiment method includes providing a first housing formed of a first radio-transparent material having an outer perimeter surface having a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, providing a second housing formed of a second radio-transparent material, securing an near field communication (NFC) chip in the second housing, securing the second housing in the first housing, where the NFC chip is enclosed by both the first housing and the second housing, and attaching a link having a first end and a second end, where the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.

(67) In some embodiments, the link and the NFC chip are separated by a distance greater than 1 mm. In some embodiments, the outer perimeter surface has a lobe at least partially defined by the first outer perimeter portion and the second outer perimeter portion, and where the one or more recesses are disposed in the lobe. In some embodiments, forming one or more recesses includes forming one recess, the one recess being a through hole extending from the first outer perimeter portion to the second outer perimeter portion. In some embodiments, one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion. In some embodiments, the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.

(68) Example embodiments of the invention are summarized here. Other embodiments can also be understood from the entirety of the specification as well as the claims filed herein.

Claims

1. A device, comprising: a first housing formed of a first radio-transparent material and having an outer perimeter surface comprising a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, wherein the first housing further has a first interior recess extending from a first side of the first housing into the body of the first housing, and wherein first walls of the first

housing define and bound the first interior recess; a second housing formed of a second radio-transparent material and secured to the first housing, the second housing having a second interior recess extending from a second sides of the second housing into a body of the second housing, wherein second walls of the second housing define and bound the second interior recess, wherein outer surfaces of the second walls of the second housing at least partially extend into the first interior recess in a first direction substantially perpendicular to a lateral direction, and wherein the entirety of the second housing is within, in the lateral direction, the first walls; a near field communication (NFC) chip disposed between the first housing and the second housing and within the second interior recess, wherein the NFC chip is enclosed by both the first housing and the second housing; an adhesive disposed in the second interior recess and extending contiguously along a first sidewall surface of the second interior recess, along a bottom surface of the second interior recess and along a second sidewall surface of the second interior recess, wherein the first sidewall surfaces and second sidewall surface face each other and the bottom surface and define the second interior recess, wherein the adhesive is in direct contact with a top surface of the NFC chip, a first side surface of the NFC chip, and a second side surface of the NFC chip opposite the first side surface, wherein the NFC chip and adhesive substantially fill the second interior recess, wherein a bottom surface of the NFC chip is in direct contact with a bottom surface of the first interior recess, and wherein the NFC chip is a passive device; and a link formed from a metallic material and having a first end and a second end, wherein the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion, and wherein at least a first wall portion of a first wall of the first walls of the first housing is disposed directly between the NFC chip and the link.

2. The device of claim 1, wherein the first end of the link is formed from the metallic material, wherein the second end of the link is formed from the metallic material, and wherein portions of the first end and second end are disposed within the body of the first housing, and wherein long axes of the first and second end are aligned with each other.

3. The device of claim 1, wherein the outer perimeter surface comprises a lobe at least partially defined by the first outer perimeter portion and the second outer perimeter portion, and wherein the one or more recesses are disposed in the lobe.

4. The device of claim 1, wherein the link and the NFC chip are separated by a distance that is between 1 mm and 15 mm, and that is selected to avoid interference between the link and the NFC chip.

5. The device of claim 1, wherein the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.

6. The device of claim 1, wherein the one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion.

7. The device of claim 1, wherein a bottom outer surface of the second housing is flush with, or at a level above, an upper lip of the first housing.

8. The device of claim 1, wherein a length and a width of the of the second interior recess are between 3.5 mm and 15 mm, and wherein a length and a width of the NFC chip are each between 3.5 mm and 15 mm and are each shorter than the respective length and width of the second interior recess.

9. A device, comprising: a first housing formed of a radio-transparent material and having an outer perimeter surface comprising a first outer perimeter portion, a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, wherein the outer perimeter surface comprises a lobe at least partially defined by the first

outer perimeter portion and the second outer perimeter portion, wherein the one or more recesses are disposed in the lobe, wherein the first housing further has a first interior recess extending from a first side of the first housing into the body of the first housing, and wherein first walls of the first housing define and bound the first interior recess; a second housing formed of a second radio-transparent material secured to the first housing, the second housing having a second interior recess extending from a second sides of the second housing into a body of the second housing, wherein second walls of the second housing define and bound the second interior recess, wherein outer surfaces of the second walls of the second housing at least partially extend into the first interior recess in a first direction substantially perpendicular to a lateral direction, and wherein the entirety of the second housing is within, in the lateral direction, the first walls; a near field communication (NFC) chip disposed between the first housing and the second housing and within the second interior recess, wherein the NFC chip is enclosed by both the first housing and the second housing; an adhesive disposed in the second interior recess and extending contiguously along a first sidewall surface of the second interior recess, along a bottom surface of the second interior recess and along a second sidewall surface of the second interior recess, wherein the first sidewall surfaces and second sidewall surface face each other and the bottom surface and define the second interior recess, wherein the adhesive is in direct contact with a top surface of the NFC chip, a first side surface of the NFC chip, and a second side surface of the NFC chip opposite the first side surface, wherein the NFC chip and adhesive substantially fill the second interior recess, wherein a bottom surface of the NFC chip is in direct contact with a bottom surface of the first interior recess, and wherein the NFC chip is a passive device; and a link formed from a metallic material and having a first end and a second end, wherein the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion, and wherein at least a first wall portion of a first wall of the first walls of the first housing is disposed directly between the NFC chip and the link.

10. The device of claim 9, wherein the first end of the link is formed from the metallic material, wherein the second end of the link is formed from the metallic material, and wherein portions of the first end and second end are disposed within the body of the first housing, and wherein long axes of the first and second end are aligned with each other.

11. The device of claim 9, wherein the link and the NFC chip are separated by a distance that is between 1 mm and 15 mm, and that is selected to avoid interference between the link and the NFC chip.

12. The device of claim 9, wherein the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.

13. The device of claim 9, wherein the one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion.

14. The device of claim 9, wherein a bottom surface of the second housing is flush with or at a level above an upper lip of the first housing.

15. A method, comprising: providing a first housing formed of a first radio-transparent material having an outer perimeter surface comprising a first outer perimeter portion and a second outer perimeter portion, the outer perimeter surface having one or more recesses, each of the one or more recesses extending from one of the first outer perimeter portion or the second outer perimeter portion into a body of the first housing, wherein the first housing further has a first interior recess extending from a first side of the first housing into the body of the first housing, and wherein first walls of the first housing define and bound the first interior recess; providing a second housing formed of a second radio-transparent material, the second housing having a second interior recess extending from a second sides of the second housing into a body of the second housing, wherein

second walls of the second housing define and bound the second interior recess; securing an near field communication (NFC) chip in the second housing and within the second interior recess, wherein the NFC chip is a passive device; securing the second housing in the first housing, wherein the NFC chip is enclosed by both the first housing and the second housing, wherein outer surfaces of the second walls of the second housing at least partially extend into the first interior recess in a first direction substantially perpendicular to a lateral direction, wherein the entirety of the second housing is within, in the lateral direction, the first walls, wherein an adhesive is disposed in the second interior recess and extends contiguously along a first sidewall surface of the second interior recess, along a bottom surface of the second interior recess and along a second sidewall surface of the second interior recess, wherein the first sidewall surfaces and second sidewall surface face each other and the bottom surface and define the second interior recess, wherein the adhesive is in direct contact with a top surface of the NFC chip, a first side surface of the NFC chip, and a second side surface of the NFC chip opposite the first side surface, wherein the NFC chip and adhesive substantially fill the second interior recess, wherein a bottom surface of the NFC chip is in direct contact with a bottom surface of the first interior recess, and wherein the NFC chip is a passive device; and attaching a link formed from a metallic material and having a first end and a second end, wherein the first end extends from the first outer perimeter portion into the body of the first housing towards the second housing, and the second end extends from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion, and wherein at least a first wall portion of a first wall of the first walls of the first housing is disposed directly between the NFC chip and the link.

16. The method of claim 15, wherein the link and the NFC chip are separated by a distance greater than 1 mm.

17. The method of claim 15, wherein the outer perimeter surface comprises a lobe at least partially defined by the first outer perimeter portion and the second outer perimeter portion, and wherein the one or more recesses are disposed in the lobe.

18. The method of claim 15, wherein forming one or more recesses comprises forming one recess, the one recess being a through hole extending from the first outer perimeter portion to the second outer perimeter portion.

19. The method of claim 15, wherein one or more recesses is a single recess that is a through hole extending from the first outer perimeter portion to the second outer perimeter portion.

20. The method of claim 15, wherein the one or more recesses include a first recess extending from the first outer perimeter portion into the body of the first housing towards the second outer perimeter portion and a second recess extending from the second outer perimeter portion into the body of the first housing towards the first outer perimeter portion.