

METHOD AND APPARATUS FOR MAKING A RADIO FREQUENCY INLAY

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for making radio
5 frequency (RF) inlays and the resulting inlay, and more particularly to a method and
apparatus for making high frequency RF devices that include an integrated circuit and an
antenna affixed to a substrate material.

BACKGROUND OF THE INVENTION

An RF inlay is generally understood to be an integrated circuit and antenna joined
10 together on some type of substrate. Typically, the inlay is subjected to further processing
to make a final product. Further processing may include adding additional outer layers of
material such as plastic to make a card-shaped device. Other finishing techniques may
form the inlay into a variety of final forms depending upon the final application of the
product.

15 In general terms, the integrated circuit is inductively coupled to one or more
interrogating devices or readers through the antenna by means of radio frequency
communication. The integrated circuit or chip contains information that is useful for
performing various tasks. One type of information is identification information pertaining
to the holder or user of the RF device. In this case, the RF device may also be referred to
20 as a radio frequency identification (RFID) device. Not all RF devices necessarily contain
information about the identity of the user and some RF devices contain information in
addition to the identity of the user.

RF inlays in their finished form are used in a variety of applications. For example,
RF inlays are used for making security access devices (RFID devices) or may be used for
25 other applications that may or may not involve identification of the user, including but not
limited to access to computer or computer networks and databases, public transportation
passes, toll way access passes, vending machine payment devices, and bank debit and/or
credit cards and passports. Given the variety and expanding end user applications for RF
devices, they are also sometimes referred to as "smart cards." Some identification
30 applications, such as passports, now utilize RFID inlays or RFID prelams (transponders
that have been subjected to a lamination process) to store identification data and to allow
efficient and rapid transfer of the identification data for processing by appropriate

governmental agencies. The identification data may include biometric data, such as fingerprints, and/or photos of the passport holder, as well as information identifying the holder.

5 A variety of methods exist for manufacturing RF inlays. In some methods a substrate of one or more layers is processed in various steps including hot and/or cold lamination. A chip and antenna subassembly is incorporated in one or more of the layers and the layers are joined together by adhesives or by softening the plastic layer and, by means of pressure, joining the layers together. In other methods, wire is affixed to or embedded within a substrate in the form of an antenna and the opposing ends of the
10 antenna coil are attached to the terminals of an integrated circuit (IC or chip) or to the terminal areas of a chip module. A chip module as that term is used herein comprises an integrated circuit attached to a lead frame having enlarged terminal areas. The terminal areas of the chip are connected to the enlarged terminal areas of the lead frame by either extremely small and delicate wires, on the order of 20 to 28 microns in diameter, or
15 through a conductive adhesive such as in the case of a flip chip. The chip and the electrical connections to the terminal areas of the lead frame are encased in an epoxy layer for protection. The combination or subassembly of the chip/chip module and the coil of wire that forms an antenna is sometimes referred to as a transponder. The wire forming the antenna may be embedded fully or partially within the substrate by use of an ultrasonic
20 wire embedding technique, as understood by those skilled in the art. The chip/chip module may be secured to the substrate by either placing it on the surface of the substrate or by placing it in a recess formed in the substrate. Adhesive may or may not be used to adhere the chip/chip module to the substrate. The ends of the coil of wire may be bonded or connected to the terminal areas of the chip or chip module at about the same time as the
25 wire is embedded in the substrate, or the bonding may be done in a separate or subsequent manufacturing step.

Nominally, the wire used in the manufacture of RF inlays, where the wire is ultrasonically embedded in a substrate, is 110 to 120 microns in diameter, which includes an outer insulating layer. The wire is insulated to prevent short-circuiting of the antenna,
30 as the windings of wire forming the antenna are closely positioned and may touch. The insulation layer is typically made from polyurethanes, polyvinylbutyrals, polyamides, polyesterimids and similar compounds. Thicker or larger diameter wires, compared to thinner or smaller diameter wires, are more easily handled and typically provide a farther

moving said second loop of wire to a position directly over or in contact with said second terminal area; and

electrically connecting said second loop of wire to said second terminal area.

16. The method of claim 14, further comprising:

5 removing insulation from said second loop of wire prior to electrically connecting said second loop of wire to said second terminal area.

17. The method of claim 10, further comprising:

forming said first loop of wire and said length of wire from a continuous length of wire.

10 18. The method of claim 14, further comprising:

forming said first loop of wire, said second loop of wire and said length of wire from a continuous length of wire.

19. A radio frequency device comprising:

15 a substrate defining a substrate plane, and an integrated circuit positioned on said substrate or in a recess formed on said substrate;

a pair of terminal areas associated with said integrated circuit and positioned adjacent thereto;

20 a wire affixed to said substrate to form an antenna, said wire comprising a first portion laterally offset and spaced from one of said terminal areas and a first wire loop formed from said first portion, a second portion of the wire embedded in said substrate to form windings of the antenna, and a third portion of said wire laterally offset and spaced from the other of said terminal areas and a second wire loop formed from said second portion.

20. A radio frequency inlay, as claimed in claim 19, wherein:

25 said first and second wire loops are positioned above said substrate.