

WINDSHIELD TAG AND METHOD OF FABRICATING THE SAME

Field of the Invention

[0001] The present invention relates to Radio Frequency Identification (RFID)
5 tag. More specifically, the present invention relates to a RFID tag that is impervious to
effects of range degradation from solar films that cover over it.

Background

[0002] Windshields/windcreens and windows of vehicles, typically
automobiles are fixed with tinted films to primarily reduce heat caused by sunlight, as
10 well as, IR and UV light. The tinted films are generally a metalized thermoplastic layer,
such as plasticized polyvinyl butyral or polyurethane sheeting therein. Tinted film is
commonly provided in a form of film sheets, which can be added on to the windshields
and windows at the in-facing side of the glass, or in some cases embedded or laminated
between glasses as a unitary article. In the modern designs, these films are adapted to
15 reduce solar radiation influx while maintaining high luminous or visible light
transmission to reduce temperature buildup within the vehicle from exposure under sun.

[0003] Metal content tinted films are widely available in the market. These
types of films, especially those with high metal content, offer superior performance over
cutting out substantial light radiation from entering the vehicles. As sunlight is
20 fundamentally electromagnetic energy, the tinted films adapted to absorb or reflect the
light (visible and non-visible) are highly susceptible to influence radio transmissions
through the tinted films.

[0004] Traditionally, printed-material forms of tickets or license bands, such as season parking tickets, road tax license bands are issued by the relevant authorities in many forms. These tickets and bands are meant for pasting on the inner side of the windshield of the vehicles, where the printed information is visible from the outside of the vehicles. Such tickets and bands require regular replacements whenever they are renewed, which is cumbersome to the vehicle owners and it causes lots of wastage on printed materials. Accordingly, Radio Frequency Identify (RFID) tags have been widely adapted as a replacement for such tickets and bands. These RFID tags are readable electronically within a range, typically short range, contactless and the information stored therein are updatable without the need of replacing the tags.

[0005] Common RFID tag typically comprises an RFID inlet laminated with top and bottom material (eg. Polyester) that comes with adhesive backings as shown in **FIG. 1**. These RFID tags suffer from being detectable and readable by the reader from vicinity distance away (e.g. beyond 2 feet) when it is attached under the windshield with the tinted film between them, where the reader operationally reads the tag outside of the vehicle through the windshield (and the tinted film).

[0006] Further, these tags are often fabricated for tamper-proofing. Some manufacturers would resort to applying many die-cuts to the whole tag, such that the tag would be difficult to be removed. However, the aesthetics would be affected and usually not effective since the die-cuts are visible to human eyes and not refined enough to deter attempts for removal with some patience and use of warm air or chemical to weaken or ease off the effects of the adhesive sticking to the windscreen.

Summary

[0007] In accordance with one aspect of the present invention, an RFID tag comprises an RFID inlet having a RFID chip and an antenna embedded therein; a non-conducting layer attaching to the RFID inlay; and two surface printable layers sandwiching the RFID and the non-conducting layer there between.

[0008] In one embodiment, the RFID tag may further comprise an extended antenna extended from the RFID inlet through to the other side of the non-conducting layer, wherein the extended antenna is embedded in an extrusion inlay.

[0009] In another embodiment, the RFID inlay is an extrusion inlay. The RFID tag is fabricated through a precision lamination process. Yet, the non-conducting layer may be finely cut with precision laser in a criss-cross fashion.

[0010] In a further embodiment, the non-conducting layer is made up of flexible material, for example, generic grade foam. The RFID tag according to claim 1, wherein the two printable layer is made up of tamper-evident material. Possibly, the tamper-evident material is an eggshell label. It may further incorporate with diced inlet embedded within.

Brief Description of the Drawings

[0011] Preferred embodiments according to the present invention will now be described with reference to the figures accompanied herein, in which like reference numerals denote like elements;

[0012] **FIG. 1** illustrates a typical RFID tag;

[0013] FIG. 2A illustrates a perspective view of a RFID tag in accordance with one embodiment of the present invention; and

[0014] FIG. 2B illustrates a cross sectional view of the RFID tag of FIG. 2A.

Detailed Description

5 [0015] Embodiments of the present invention shall now be described in detail, with reference to the attached drawings. It is to be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art
10 to which the invention relates.

[0016] The inventors found that when an RFID tag is pasted on the windscreen with a solar film in between, the metallization on the solar film attached to the windshield would cause antenna tuning shift to the antenna of the RFID tag and attenuation to the RF energy received by the RFID tag. The tuning shift affects the
15 originally intended parameters, such as inductance, capacitance and Q-factor, of the tuned antenna of the RFID tag, which in turn adversely impacts its functional characteristics, such as resonance and power transfer efficiency, which is further made worse by the RF attenuation of the tinted film, thereby greatly reducing its reception range/distance.

20 [0017] With a large variety of brands and grade of the tinted film available, it is impractical to customise each RFID tag with its antenna tuned to the film. Therefore, it

would be desired that a RFID tag is fabricated with an antenna that does not adversely affect or have minimal effect on the tuning of the antenna.

[0018] **FIG. 2A** illustrates a perspective view of a RFID tag, or simply tag, **200**

and **FIG. 2B** illustrates a crossed sectional view across line **A-A** of the RFID tag **200** in

accordance with one embodiment of the present invention. The tag **200** can be adapted
attaching to a windshield **220** of a vehicle in a round circular planar shaped tag. The tag

200 comprises an overlay **202**, an inlay **204**, adhesive **206**, a non-conducting layer **208**

and an underlay **210**. The overlay **202** and the underlay **210** are printable substrates
disposed as two outer most layers of the tag **200** for sandwiching the remaining layers

there between. The inlay **204** is attached the overlay **202** via the adhesive **206**.

Similarly, the non-conducting layer **208** is attached to the inlay **204** through another
adhesive layer **206**. The underlay **210** is then laid on the non-conducting layer **208** to

seal said layers beneath to form the tag **200**. The underlay **210** adapted as the part of
the tag that attaches to the windshield. The tag may be attached to the windshield via

any suitable adhesive means applies on the underlay **210**, it can be held on the
windshield via any known windshield decals or the like. The multi-layer construction
may be formed with any known precision lamination process.

[0019] When in used, the tag **200** can be attached to the windshield of the

vehicle with the underlay **210** adjacent to the windshield **220**. In the case where the

windshield **220** is installed with tinted film on its inner side, the tag **200** is attached to
the windshield with the underlay **210** adjacent to the tinted film.

[0020] Through extensive research, the inventors uncovered a non-conducting

layer **208** facilitates a segregation layer that bring the inlay **204** (i.e. the antenna **242**)

further apart from the underlay **210** so that it has very little or no adverse influence exerted by the metallization on the solar film that affects the RFID antennas' frequency response. In other words, by bringing the antenna **242** further apart from the underlay **210**, it eliminates or minimizes the metallization on the solar film that would cause a tuning shift of the tuned antenna, which in turn affects its characteristics such as resonance and power transfer efficiency of the antenna and thereby reducing the working distance and the intended frequency response. This layer effectively uncouples the metalized films' undesired properties from influencing the desired properties of the RFID tag, such as resonance frequency, RF attenuation, eddy current losses, Q-factor.

[0021] In one embodiment of the present invention, the non-conducting layer **208** can be any generic foam sheets. One advantage selecting foam sheet as the non-conducting layer **208** is that it allows the tag **200** to be adhered snugly against the curved profile of a typical vehicle windscreen, unlike conventional rigid tags. Further the non-conducting layer **208** can be finely diced by precision laser to have tamper-proof cuts, such as criss-crossed cuts throughout the entire surface of the non-conducting layer **208**.

[0022] The above embodiment selects generic foam at least because it is cheaper in cost and easy to handle. The thickness of the layer **208** is also selected to be sufficiently thick so that any metallization on the tinted film would not affect or is only negligibly affected the tuning of the antenna. It is to be understood that other materials can also be used as long as the materials is capable of isolating the effects of the tinted film metallization to cause any tuning shift to the tuned antenna of the RFID tag **200**.

[0023] In a further embodiment, a specific density and shore hardness of the non-conducting layer can also be desired, wherein when force is applied to peel off the tag **200** from its' side would cause the non-conducting layer **208** to disintegrate.

[0024] The inlay **204** is an extrusion billet for encapsulating the RFID components therein. The RFID components include a chip **248** and an antenna **242** and an extended antenna **246** connected in a required manner. The antenna **242** is encapsulated within the main body of the inlay **204** while the extended antenna **246** is encapsulated within an extended tongue **244** of the inlay **204**. As shown in **FIG. 2B**, the chip **248** is selectively encapsulated in the extended tongue **244** and connecting to the antenna **242** via the extended antenna **246**. In other embodiment, it is also possible to provide the chip **248** at the main body of the inlay **204** as long as the antenna is properly tuned.

[0025] The extended tongue **244** is adapted to extend through the non-conducting layer **208** to the other side of the non-conducting layer **208** such that the extended tongue **244** is disposed adjacent to the underlay **210**. In one embodiment, the extended tongue **244** with the extended antenna **246** and the chip **248** embedded therein can be fabricated as separate part from the inlay **204** and then connected it to the antenna **242** via suitable conductive adhesive tape to form.

[0026] There are many ways to form the extended tongue **244** through the non-conducting layer **208**. In one embodiment, a through-slit may be cut on the non-conducting layer **208** at a corresponding location for allowing the extended tongue **244** to slit through the non-conducting layer before it is attached to the inlay **204**.

[0027] Both antenna **242** and the extended antenna **246** are connected in a manner that they are tuned as one unified tuned antenna for the RFID tag **200**. Relatively, the antenna **242** occupies more surface area across the tag **200** while the extended antenna **246** contains only minor portion of the antenna that has only negligible effect on the tuned antenna of the RFID tag, thus even when there is any tuning shift over at the extended antenna **246** part caused by the metalized solar film, it would not affect the overall tuning of the tuned antenna of the RFID tag.

[0028] The extended antenna **246** offers a provision of a three-dimensional (3D) antenna structure, as opposed to a planer antenna structure, which extend across the extrusion antenna layer **204** and the non-conducting layer **208**, which can be formed during lamination of the multi-layered between the overlay **202** and underlay **210**. Any attempt to slice the tag (usually through the non-conducting layer because it is thicker and forms the main body) to remove it from the windscreen will cut broken the antenna rendering it no longer functional.

[0029] It is further desired that the extended tongue **244** be attached to the inlay **204** through a conductive adhesive tape having lesser adhesion force than that of the adhesive provided on the underlay **210** for attaching the tag **200** under the windshield **220**. In such configuration, any attempt to peel the tag **100** off the windshield **220** would result in the separation of the extended tongue **244** from the inlay **204**, thereby rendering the tag **200** not longer useable.

[0030] Further to prevent removal of the tag from the installed vehicle windscreen, the entire RFID inlet antenna is finely cut with precision laser in a criss-cross fashion, just short of reaching the antenna trace which has to be left in-tact. Being

very fine and hidden from outside view as the antenna inlet is sandwiched in between the layers, anybody who attempts to remove would not be able to do so with the tag intact.

[0031] In one embodiment, preferably, the overlay **202** and underlay **210** are made up of temper-evident materials. For example, a tamper-evident fragmentable eggshell label may be used. These layers will crumble and fragment into pieces upon any attempted removal or temper. In yet a further embodiment, when the tamper-evident material incorporate with the finely diced inlet embedded within, it works even better for making unauthorized access to the tag easily detectable.

[0032] In one example, the RFID tag may be fabricated based on ISO/IEC 15693 standard in about **113mm** die-cut diameter with about 3mm thickness tag. The tag may be made of a high temperature flexible substrate and/or face stock for example. In one implementation, the RFID tag may be operated at a carrier frequency of 13.56MHz. The chip of the RFID tag may have a 1kbits memory. Preferably, the RFID tag can be made for Anti-UV Printing for single/double sides.

[0033] The present invention offers an improved configuration of an RFID tag that is suitable for attaching on a windshield of a vehicle. It can be attached to the windshield with better conformance and the radio transmission of the RFID tag is less influenced by any tinted film installed on the windshield of the vehicles. The RFID tag is also adapted with tamper-deterrent features, which allows any tempering to be easily detected. The RFID tag can be made as one time use tag, of which, once broken it has to be replaced.

[0034] In a further embodiment, the RFID tag is fabricated without the extended tongue, i.e. the tag comprises the overlay and underlay, an inlay and a non-conducting layer layered in a similar manner. In this case, the RFID's chip can be embedded within the inlay. Similarly, the non-conducting layer is adapted with at a thickness allowing
5 the antenna to main its tuned parameters as explained above.

[0035] In a further alternative embodiment, the RFID tag may be provided with a non-conducting layer on each sides of the inlay under the overlay and underlay. The advantage of doing so is that the RFID tag can be attached to the windscreen on either side of the RFID tag.

10 **[0036]** While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations, and combinations thereof could be made to the present invention without departing from the scope of the invention.

Claims

1. An in-vehicle RFID tag for attaching under a windshield that has a tinted solar film installed thereto, the in-vehicle RFID tag comprising:
 - a RFID inlay having a RFID chip and a tuned antenna embedded therein;
 - 5 a non-conducting layer attaching to one side of the RFID inlay;
 - an overlay attaching on the other side of the RFID inlay; and
 - an underlay attaching to the non-conducting layer, wherein the underlay and the overlay sandwiched the RFID and the non-conducting layer there between,
 - wherein, when in use, the RFID tag is to be placed with the underlay in adjacent
 - 10 to an attaching surface, such that the RFID inlay is spaced apart from the attaching surface via the non-conducting layer.
2. The RFID tag according to claim 1, wherein the tuned antenna comprises an extended antenna extending from the RFID inlay through to the other side of the non-
- 15 conducting layer, wherein the extended antenna is embedded in an extrusion inlay and connected as one tuned antenna for the RFID tag.
3. The RFID tag according to claim 1, wherein the RFID inlay is an extrusion inlay.
- 20 4. The RFID tag according to claim 1, wherein the RFID tag is fabricated through a precision lamination process.
5. The RFID tag according to claim 1, wherein the non-conducting layer is made up of flexible material.
- 25 6. The RFID tag according to claim 1, wherein the non-conducting layer is finely cut with precision laser in a criss-cross fashion.

7. The RFID tag according to claim 1, wherein the underlay and the overlay is made up of tamper-evident material.

8. The RFID tag according to claim 7, wherein the tamper-evident material is an eggshell label.

9. The RFID tag according to claim 1, further comprising a further non-conducting layer attaches to the other side of the RFID inlay under the overlay.

10. A method for forming an in-vehicle RFID tag for attaching under a windshield that has a tinted solar film installed thereto, the method comprising:

forming an RFID inlay having a RFID chip and a tuned antenna embedded therein;

attaching one side of the RFID inlay to an overlay;

attaching a non-conducting layer to other side of the RFID inlay; and

attaching an underlay to the other side of the conducting layer, wherein the underlay and overlay sandwiched the RFID and the non-conducting layer therebetween;

wherein, when in use, the RFID tag is to be placed with the underlay in adjacent to an attaching surface, such that the RFID inlay is spaced apart from the attached surface via the non-conducting layer.

11. The method according to claim 10, further comprising forming an extended antenna extending from the tuned antenna of the RFID inlay through to the other side of the non-conducting layer, wherein the extended antenna is embedded in an extrusion inlay and connected as one tuned antenna for the RFID tag.

12. The method according to claim 10, wherein the RFID inlay is an extrusion inlay.

13. The method according to claim 10 is a precision lamination process.

14. The method accordingly to claim 10, wherein the non-conducting layer is made up of flexible material.
- 5 15. The method according to claim 10, wherein the non-conducting layer is finely cut with precision laser in a criss-cross fashion.
16. The method according to claim 10, wherein the two printable layer is made up of tamper-evident material, such as an eggshell label.
- 10 17. The method according to claim 10, further comprising attaching a further non-conducting layer to the other side of the RFID inlay.
- 15 18. An in-vehicle RFID tag for attaching under a windshield that has a tinted solar film installed thereto, the in-vehicle RFID tag comprising:
- a RFID inlay having a RFID chip and a tuned antenna embedded therein;
 - a non-conducting layer attaching to one side of the RFID inlay;
 - an overlay attaching on the other side of the RFID inlay;
 - 20 an underlay attaching to the non-conducting layer, wherein the underlay and the overlay sandwiched the RFID and the non-conducting layer there between; and
 - an extended antenna extending from the RFID inlay through to the other side of the non-conducting layer and connected to the tuned antenna as one tuned antenna for the RFID tag,
- 25 wherein, when in use, the RFID tag is to be placed with the underlay in adjacent to an attaching surface, such that the RFID inlay is spaced apart from the attaching surface via the non-conducting layer.
19. The RFID tag of claim 18, wherein the underlay has adhesive on the outer surface
- 30 for adhering the underlay onto the attaching surface.