

RFID Label

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The invention relates to an RFID transponder label, which can be applied to different surfaces of objects to be identified, wherein different materials of the surface of the object to be identified with the RFID transponder label do not affect the function of the transponder differently from the respective surface, and the RFID transponder label exhibits a clearly smaller construction height than in solutions known up to now. A thin label can therefore be addressed.

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Data communication between an RFID transponder label and read-write devices with a coupled RFID transponder antenna takes place by means of electromagnetic waves, whose propagation is affected and disrupted by different materials, especially metallic materials. For the identification of objects with surfaces that affect the electromagnetic waves, arrangements are required that prevent direct contact of the transponder with the surface of the object. An RFID transponder is here understood to be an arrangement of an RFID transponder antenna and an RFID transponder chip connected to the RFID transponder antenna. An RFID transponder label is understood to be an arrangement of an RFID transponder on a carrier or substrate.

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The manner of functioning of an RFID transponder or RFID transponder label that will be applied to a surface of objects that affect the electromagnetic waves, such as, for example, to metallic surfaces, can be improved, in that between the RFID transponder and the surface to which it is applied, additional layers are arranged which implement at least a spacing between RFID transponder and surface.

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By introducing these additional interlayers, the construction height of the RFID transponder label is considerably increased,

which leads to clear limitations in the application. Such interlayers can, for example, be electrically insulating layers.

Alternatively to this, instead of the insulating layer, a
5 ferromagnetically acting layer can be used. Embodiments of this are cited hereinafter.

In the *RFID Manual* by Finkenzeller, ISBN 3-446-19376-6, 1998 edition, page 75, section 4.1.8.3 on ferrite shielding in a
10 metallic environment, it is written, for instance, that the introduction of high-permeability ferrite can avoid to a large extent the occurrence of eddy currents. Here is a quotation from the source: "Installing magnetic antennas directly onto a metallic surface however is not possible. By inserting high-perme-
15 ability ferrite between coil and metal surface, the occurrence of eddy currents can be avoided to a large extent. Therefore an antenna installation is possible on a metal surface."

In the patent DE 601 02 577, an electronic label is described
20 with at least one electronic element and one coil, in which the coil includes at least one magnetically reflecting element that is independent of the construction group formed from the electronic components and the coil. Consequently, an arrangement is put forth which adopts the physical principle cited above and is
25 applied to the use case in an electronic label.

In US 6,371,380 (1999), the use of a magnetically absorbing plate is addressed as an IC-memory tag. This also makes possible the contactless readout of information on metal surfaces. The use is
30 described of an RFID transponder antenna on a substrate with a microchip, which makes possible the reading and writing of data with the transmission device by modulation of the magnetic field. The attached layer simply absorbs the magnetic field below the IC memory tag. The permeability of this layer is greater equal to
35 10.

In OS JP 2001 068916, the use of a ferrite layer, in combination with a good electrically conducting layer is described, in order to compensate for the resonance shift through the ferrite. This metal layer addition- ally serves to increase the distance be-
5 tween base and transponder. The construction consists of a combination of a data carrier which acts as a transmitter/ receiver, based on electromagnetic induction, or of a microwave system, an upper ferrite layer, and a lower, good conducting layer.

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Patents DE 101 49 126 and DE 103 43 188 involve methods for manufacturing shielding for a transponder which exhibits at least one chip and one RFID transponder antenna structure with an application-specific three-dimensional expansion, in which the
15 shielding is formed on a substrate. The methods include introducing and aligning ferromagnetic particles in an area of the substrate which exhibits at least the three-dimensional expansion of the RFID transponder antenna structure. The particles are aligned by means of a constant magnetic field and
20 then are locked in place.

In WO 03/067512 A1, a flexible plastic foil is made available, in which ferrite particles are stored as a weakly magnetic sub-
stance, as is assumed to be known. The ferrite in this foil
25 causes an increase in the permeability. This foil has a thick-
ness of at least 1.5 mm and a permeability $\mu > 10$. A reduction in the thickness of between 0.3 mm and 0.8 mm is only achieved by an increase in permeability of between 13 and 17. The resonance quality attained thereby lies between 20 and 30.

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Resulting from this, the need arises for coordination between permeability and thickness of the foil and therefore adjustment to a specific underlayer.

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In DE 10 2007 037 293.2, the use is described of individual ferrite strips underneath an RFID transponder instead of an

embodiment variant over the entire surface. This high-permeability shielding material exhibits either an anisotropic permeability or is aligned in fundamental sections parallel to one another, in which the long edges of the strips in the
5 current-flow direction include fundamental sections of the RFID transponder antenna structure.

In addition, in DE 197 33 849 a theft-proof shield is described which can be coordinated, by combination with a weakly magnetic
10 element, with regard to frequency at the query transmitter.

There exists a need for RFID transponder labels which can be applied to different surfaces of objects to be identified, in which different materials of the surface of the object to be
15 identified by the RFID transponder label do not affect the function of the RFID transponder differently from the respective surface and the RFID transponder label exhibits a clearly smaller construction height than in solutions known up to now.

20 According to the invention, the problem is solved such that, for electro-magnetic coupling of the RFID transponder to surfaces of objects to be identified, at least 2 layers of magnetically differently acting material are introduced between the objects to be identified by the RFID transponder and the surface.

25 In one embodiment, a first layer of a first magnetically acting material and a second layer of a second magnetically acting material are applied for this purpose to the RFID transponder, which consists of the RFID transponder antenna with an RFID
30 transponder chip installed, in which both magnetically acting materials differ in their magnetic properties from one another.

The RFID transponder label is then applied to the surface of objects to be identified so that the magnetically acting layers
35 are disposed between the object to be identified and the RFID transponder.

Further possible additional layers, for example self-adhesive layers, printed overlayers, and so on, complement the RFID transponder label of generally known type for a final product.

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In one embodiment, a ferromagnetic layer is disposed beneath the RFID transponder (RFID transponder antenna with the RFID transponder chip installed) and on this ferromagnetically acting layer is disposed a second, diamagnetically acting layer.

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By means of this combination of 2 differently magnetically acting layers, it is achieved that with an RFID transponder label that is applied to different surfaces of objects to be identified, in which the surfaces of the object to be identified consist of different materials, the function of the transponder is not affected differently by the different surfaces.

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In the same way, by means of this arrangement, a clearly smaller construction height of the RFID transponder label is achieved as a whole, and especially of the magnetically acting layers. By means of the combination of two differently magnetically acting layers, a construction height is achieved for the magnetically functional layer of 0.3 mm maximum. Both magnetically acting layers are so coordinated with one another that they, in combination with one another, compensate for undesirable effects of the material of the surfaces to which the RFID transponder label is applied.

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In WO 03/067512, on the other hand, a ferrite layer of at least 1.5 mm is taken as the starting point for the necessary thickness. "A reduction in the thickness of between 0.3 mm and 0.8 mm is only achieved by an increase in permeability of between 13 and 17."

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In the applicant's own investigations, it appears that the thickness of the ferromagnetic layer required for this should lie

between 0.05 mm and 0.2 mm and the permeability of this layer should be $10 < \mu < 60$. The diamagnetic layer with a permeability of less than 1 has a thickness of 0.1 mm maximum.

5 One embodiment is represented in the figure.

Designated therein by the reference number 1 is the magnetically acting layered construction with a first layer made of ferromagnetically acting material and a second layer made of a non-ferromagnetically acting material. In the embodiment, the layer acting diamagnetically is executed from a non-ferromagnetically acting material. It could however also be executed as paramagnetically acting.

15 Reference number 2 designates the RFID transponder, which includes an RFID transponder antenna and an RFID transponder chip installed at the RFID transponder antenna. The RFID transponder antenna and the RFID transponder chip are introduced into a carrier material in the embodiment. The carrier material is not depicted separately because the magnetically acting layers 1 can be arranged on the upper side of the carrier material, that is, below the RFID transponder antenna and the RFID transponder chip, or on the underside of the carrier material. In the latter case, the substrate forms a separation layer between the magnetically acting layers 1 and the RFID transponder with RFID transponder antenna and RFID transponder chip.

The RFID transponder 2 can be introduced at the surface 3 of the objects to be identified, which consists, for example, of a metallic material. For this, for instance, an adhesive layer can be applied to the underside of the RFID transponder label, which in the case of magnetic layers 1 disposed on the underside of the substrate, covers them directly, whereas the adhesive layer covers the underside of the substrate if the magnetically acting layers 1 are disposed on the upper side of the substrate.

The physical mechanism of the magnetically acting layers can be described as follows.

5 The ferromagnetically acting layer bundles the electromagnetic waves arriving from the RFID reader and concentrates them in the surface area of the RFID transponder antenna of the RFID transponder. As a result, it severely restricts the electromagnetic waves radiating from the RFID reader in the immediate vicinity of the RFID transponder antenna from occurring
10 unimpeded at the metallic surface, and as a result eddy currents are produced in the surface of the object to be identified (in the metallic layer), which are directed right against the electromagnetic waves arriving and these "cancel". To achieve this effect, a minimum thickness is required for this ferromag-
15 netically acting layer, at the appropriate permeability of 0.3 mm to 0.8 mm minimum (see also WO 03/067512 for this.)

The second disposed, magnetically acting layer described in one embodiment with diamagnetic properties, for example with a
20 permeability of less than 1, causes, for its part, a scattering of the electromagnetic waves and therefore a field displacement.

As a result, the electromagnetic waves bundled in the surface area of the RFID transponder antenna are further scattered by
25 means of the effect of the ferromagnetic layer and are specifically conducted outward. This effect causes the number of electromagnetically acting waves underneath the RFID transponder antenna to be clearly reduced, and therefore the formation of eddy currents in the surface is likewise clearly decreased. At
30 the same time, total reflection of the electromagnetic waves is severely reduced at the surface due to the effect of the diamagnetic layer, and as a result the energy made available to the RFID transponder from the reader is increased.

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Patent claims

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1. An RFID transponder label, including a carrier substrate, an RFID transponder antenna disposed on the carrier substrate, and an RFID transponder chip connected to the RFID transponder antenna, as well as at least two additional layers, wherein the additional layer construction consists of a first layer with a first magnetically acting material and a second layer with a second magnetically acting material and the first magnetically acting material and the second magnetically acting material exhibit different magnetic properties.

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2. The RFID transponder label according to claim 1, characterized in that the geometric dimensions (length, width) of the two differently magnetically acting layers are different in size.

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3. The RFID transponder label according to claim 1 or 2, characterized in that the geometric dimensions (length, width) of the magnetically acting layers are different as to the size of the RFID transponder (particularly for the surface of the transponder antenna).

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4. The RFID transponder label according to one of claims 1 through 3, characterized in that the magnetically acting layers themselves consist of a plurality of individual magnetically acting layers.

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5. The RFID transponder label according to one of claims 1 through 4, characterized in that at least one magnetically acting layer consists of a foil material made up of one or a plurality of layers.

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6. The RFID transponder label according to one of claims 1 through 5, characterized in that the magnetically acting material is applied to an insulating carrier which itself has no magnetically active properties.

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7. The RFID transponder label according to one of claims 1 through 6, characterized in that at least one magnetically acting layer is a ferromagnetically acting layer with a thickness of 0.3 mm maximum.

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8. The RFID transponder label according to one of claims 1 through 6, characterized in that at least one magnetically acting layer consists of a diamagnetic material and in the layer are contained diamagnetic substances, for example gold, sulfur, lead, bismuth, or combinations of them.

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9. The RFID transponder label according to one of claims 1 through 4 or 7 to 8, characterized in that at least one magnetically acting layer is manufactured by using organic and/or inorganic pastes or mixtures of them with magnetically acting particles.

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10. The RFID transponder label according to claim 9, characterized in that at least one magnetically acting layer is manufactured by a printing method.

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11. The RFID transponder label according to claim 1 through 8, characterized in that at least one magnetically acting layer is manufactured by vacuum-technology, galvanic, or currentless precipitation.

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12. The RFID transponder label according to claim 11, characterized in that at least one magnetically acting layer is applied to a non-magnetically acting carrier.
- 5 13. The RFID transponder label according to claim 11, characterized in that at least one magnetically acting layer is applied to a magnetically acting layer and/or a magnetically acting carrier.
- 10 14. The RFID transponder label according to one of claims 11 through 13, characterized in that at least one magnetically acting layer is additionally structured.
- 15 15. The RFID transponder label according to one of claims 1 through 14, characterized in that the surface of at least one magnetically acting layer is structured in the surface execution.
16. The RFID transponder label according to claim 15, characterized in that the surface of at least one magnetically acting layer is structured by mechanical methods, e.g. by imprinting.