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(54) A method for making a coil antenna on a substrate

(57) A method for making a coil antenna (111, 112; 211, 212) on a substrate (110, 210), comprising the steps of: providing a substrate (110, 210); applying a metal layer patterns (111, 112; 211, 212) on the first side (110A, 210A and on the second side (110B, 210B) of the substrate (110, 210) by plasma coating in areas corresponding to the desired shape of the coil antenna (111, 112; 211, 212), connecting the metal layer patterns on both sides of the substrate (110, 210) to form a coil antenna.

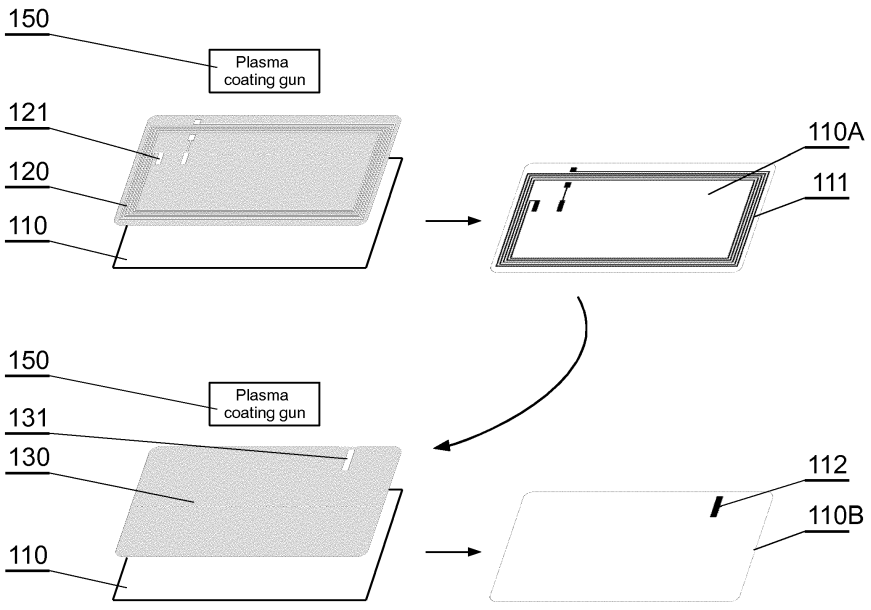

Fig. 1

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Description

[0001] The present invention relates to manufacturing coil antennas on substrates.

[0002] There are known several technologies for making coil antennas on a thin flexible substrate in order to provide for example a coil antenna for wireless communication systems, such as RFID systems. Such products can be used for example as inlays for chip cards. The known technologies include depositing a flexible metal wire, depositing a conductive yarn, printing the coil pattern with an inductive ink, etc. Each technology has its well-known advantages and disadvantages.

[0003] It would be desirable to provide an alternative technology for making a coil antenna on a substrate which is flexible and highly sensitive to high temperatures.

[0004] The object of the invention is a a method for making a coil antenna on a substrate, characterized by comprising the steps of: providing a substrate; applying a metal layer patterns on the first side and on the second side of the substrate by plasma coating in areas corresponding to the desired shape of the coil antenna, connecting the metal layer patterns on both sides of the substrate to form a coil antenna.

[0005] Preferably, the metal layer is applied on the substrate in an area determined by a coating mask.

[0006] Preferably, the conductive metal layer is further applied in areas outside the desired shape of the coil antenna pattern and the method further comprises applying a cleaning mask to the coated substrate and removing the metal layer in areas defined by the cleaning mask by plasma cleaning.

[0007] Preferably, the metal layer has a thickness from 10 to 100 micrometers.

[0008] Preferably, the metal layer is formed of a metal, preferably Cu, Al., Sn, Ni, Ag, Au or Zn.

[0009] Preferably, the metal layer is formed of a metal alloy, preferably CuSn, SnAg, ZnNi, AlMg, NiCr.

[0010] Preferably, the substrate is a plastic.

[0011] Preferably, the substrate is a paper.

[0012] The object of the invention is shown by means of exemplary embodiment on a drawing, in which:

Fig. 1 shows the first embodiment of the invention;
Fig. 2 shows the second embodiment of the invention.

[0013] The present invention involves making a coil antenna pattern on a substrate by plasma coating technology. The coil antenna comprises two patterns - a first pattern applied on the first surface of the substrate and a second pattern applied on the second surface of the substrate, the patterns being interconnected.

[0014] Fig. 1 shows schematically the process according to the first embodiment of the invention. First, a substrate 110 is provided at a plasma coating station. A first coating mask 120 is placed on the substrate 110, wherein the coating mask 120 has openings 121 defining the shape of the first part of the coil antenna 111. Next, the substrate 110 with the first coating mask 120 applied thereon is coated with a metal layer by plasma coating. In a plasma coating gun 150, which moves across the surface of the mask 120, the metal or a metal alloy in form of a powder or a dispersion is injected to a high temperature plasma flame, wherein it is rapidly heated and accelerated, such that it hits the surface of the substrate and cools quickly to form the coating. Although the temperature of the plasma flame is high, typically in the order of 10.000°C, the temperature of the substrate can be kept very low, not to exceed the melting point of the substrate. Therefore, the substrate is not damaged and the metal layer can be effectively applied to the substrate. After the coating is applied, the coating mask 120 is removed to reveal only the substrate 110 with the first coil antenna pattern 111 applied on the first side 110A.

[0015] The coating mask 120 is then moved to a plasma cleaning station, wherein the metal coating is removed from the coating mask to make the mask re-usable.

[0016] Preferably, the coating mask 120 shows good durability and resistance to multiple coating/cleaning operations without deforming the shape of the coil antenna pattern.

[0017] Next, the substrate 110 is flipped to a second side 110B and a second coating mask 130 is applied thereon, the second coating mask 130 having openings 131 defining the shape of the second part of the coil antenna 112. Next, the substrate 110 with the second coating mask 130 applied thereon is coated with a metal layer by plasma coating in a way similar as for the first side 110A of the substrate 110. After the coating is applied, the coating mask 130 is removed to reveal only the substrate 110 with the second coil antenna pattern 112 applied on the second side 110B.

[0018] The coating mask 130 is then moved to a plasma cleaning station, wherein the metal coating is removed from the coating mask to make the mask re-usable.

[0019] Next, the coil antenna patterns 111, 112 are connected, for example by ultrasonic welding or by soldering, to create a full coil.

[0020] Fig. 2 shows schematically the process according to the second embodiment of the invention. First, a clean substrate 210 is provided at a plasma coating station. A large area of the first side 210A of the substrate is plasma-coated with a metal layer by a plasma coating gun 250. Next, a cleaning mask 220 is applied to the substrate, wherein the cleaning mask material defines the shape of the coil antenna and the openings 221 define the areas not belonging to the coil antenna. The substrate with the cleaning mask is then moved to a plasma cleaning station with a plasma cleaning gun 260, wherein the coating layer from the first side 210A is removed in areas outside the coil antenna, leaving the metal coating 211 only in areas defining the coil antenna.

[0021] Next, the substrate 210 is flipped to a second side 210B and a second coating mask 230 is applied thereon on a large area, by the plasma coating gun 250. Next, the second cleaning mask 230 is applied thereon, the second cleaning mask 130 having openings 231 defining the areas not belonging to the coil antenna. Next, the substrate 210 with the second cleaning mask 130 applied thereon is cleaned in a way similar as for the first side 210A of the substrate 210. After the cleaning is finished, the cleaning mask 230 is removed to reveal only the substrate 210 with the second coil antenna pattern 212 applied on the second side 210B.

[0022] The present invention allows to efficiently apply coil antenna on thin, flexible substrates sensitive to high temperatures, because substrate temperature during coating process is less than 120°C. The coatings applied may have thickness from 10 to 100 micrometers, which makes them highly flexible. The shape of the pattern can be adapted to particular needs by appropriate design of the coating and cleaning masks. The technology can be used with a variety of substrates. The patterns thus produced are highly durable, as the metal layer efficiently integrates with the substrate.

[0023] The invention is particularly useful to make RFID coil antennas, especially for HF and UHF transponders. These coils can be integrated with end products such as documents, passports, paper tickets, smart cards, etc.

Claims

1. A method for making a coil antenna (111, 112; 211, 212) on a substrate (110, 210), **characterized by** comprising the steps of:

   - providing a substrate (110, 210);
   - applying a metal layer patterns (111, 112; 211, 212) on the first side (110A, 210A) and on the second side (110B, 210B) of the substrate (110, 210) by plasma coating in areas corresponding to the desired shape of the coil antenna (111, 112; 211, 212),
   - connecting the metal layer patterns on both sides of the substrate (110, 210) to form a coil antenna.

2. The method according to claim 1, wherein the metal layer (111, 112) is applied on the substrate in an area determined by a coating mask (120, 130).

3. The method according to claim 1, wherein the conductive metal layer (211, 212) is further applied in areas (210A, 210B) outside the desired shape of the coil antenna pattern and the method further comprises applying a cleaning mask (220, 230) to the coated substrate (210A, 210B) and removing the metal layer in areas defined by the cleaning mask (210A, 210B) by plasma cleaning.

4. The method according to claim 1, wherein the metal layer (111, 112; 211, 212) has a thickness from 10 to 100 micrometers.

5. The method according to claim 1, wherein the metal layer (111, 112; 211, 212) is formed of a metal, preferably Cu, Al., Sn, Ni, Ag, Au or Zn.

6. The method according to claim 1, wherein the metal layer (111, 112; 211, 212) is formed of a metal alloy, preferably CuSn, SnAg, ZnNi, AlMg, NiCr.

7. The method according to claim 1, wherein the substrate (110, 210) is a plastic.

8. The method according to claim 1, wherein the substrate (110, 210) is a paper.

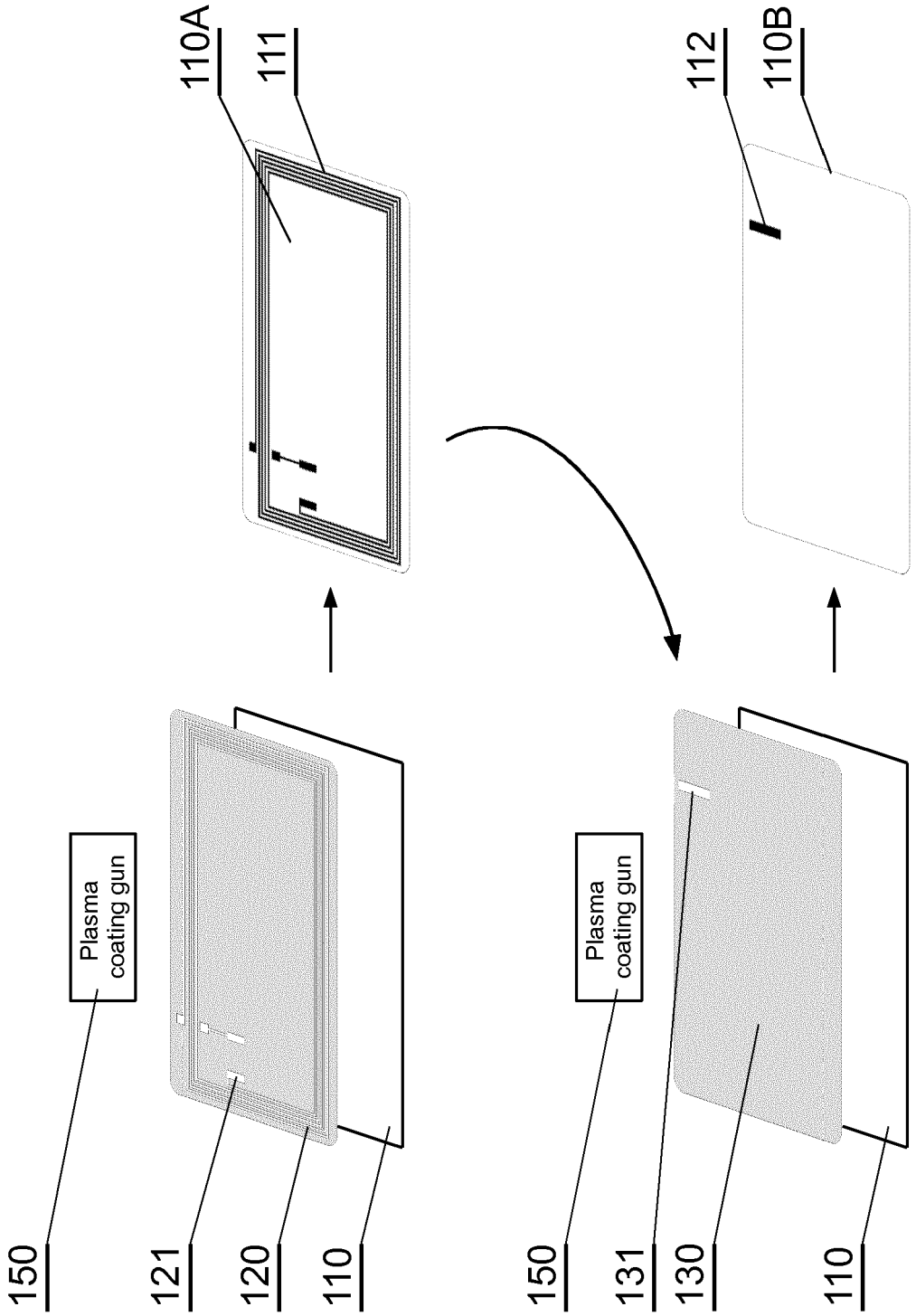
110A
111
112
110B
Plasma coating gun
Plasma coating gun
150
121
120
110
150
131
130
110

Fig. 1

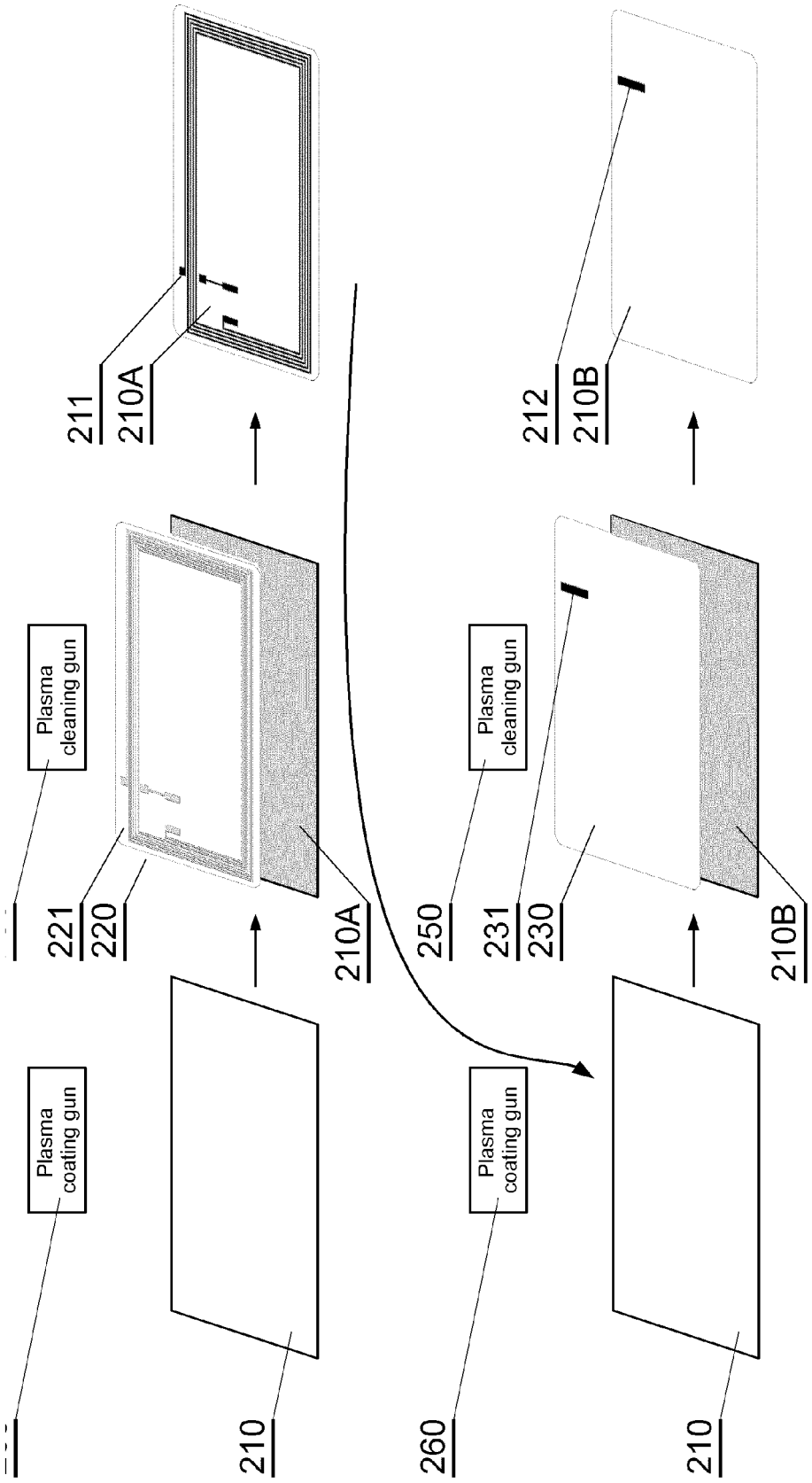
211
210A
Plasma cleaning gun
221
220
210A
Plasma coating gun
210
212
210B
Plasma cleaning gun
250
231
230
210B
Plasma coating gun
260
210

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 13 46 1562

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 April 2014	Cordeiro, J

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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24-04-2014

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