(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
12 December 2024 (12.12.2024)

WIPO | PCT

(10) **International Publication Number**
WO 2024/250188 A1

(51) **International Patent Classification:**
H01Q 1/38 (2006.01)

(21) **International Application Number:**
PCT/CN2023/098797

(22) **International Filing Date:**
07 June 2023 (07.06.2023)

(25) **Filing Language:** English

(26) **Publication Language:** English

(71) **Applicant: HUAWEI TECHNOLOGIES CO., LTD.** [CN/CN]; Huawei Administration Building, Bantian, Longgang District, Shenzhen, Guangdong 518129 (CN).

(72) **Inventors: REBEGEA, Serban**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **MURILLO BARRERA, Alejandro**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **GUNTUPALLI, Ajay Babu**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **BISCONTINI, Bruno**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **OBERMAIER, Johann Baptist**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **RIST, Bernhard**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **OLMEZ, Tekin**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **ILSANKER, Sebastian**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **ZIERHUT, Dieter**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **WANG, Liansong**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE). **LIU, Daiming**; Huawei Technologies Duesseldorf GmbH, Riesstr. 25, 80992 Munich (DE).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) **Title:** A RADIATING STRUCTURE COMPRISING A RADIATOR FOIL ADHERED TO A SUBSTRATE

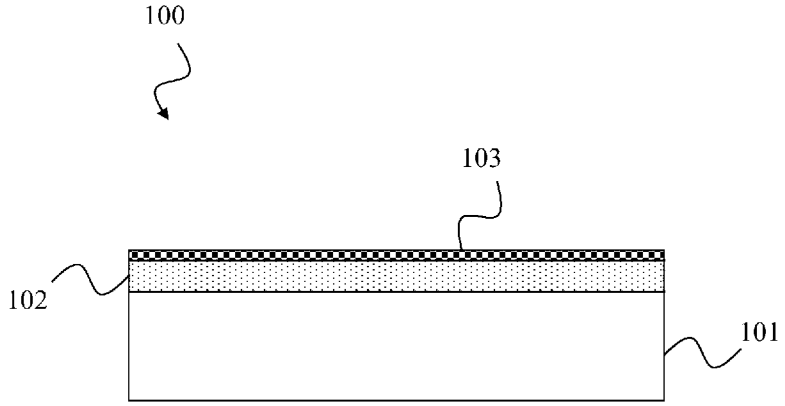

FIG. 1

(57) **Abstract:** This disclosure provides a radiating structure for an RF device. The radiating structure comprises a dielectric layer (also referred to as substrate) and one or more conductive antenna elements adhered to the substrate. In particular, the radiating structure comprises a first conductive foil adhered to a first surface of the dielectric layer. A first conductive pattern comprising one or more radiators is formed on the first conductive foil.

WO 2024/250188 A1

[Continued on next page]

Published:

— *with international search report (Art. 21(3))*

A RADIATING STRUCTURE COMPRISING A RADIATOR FOIL ADHERED TO A SUBSTRATE

TECHNICAL FIELD

The present disclosure provides a radiating structure for an antenna device and/or a radio frequency (RF) device. The radiating structure comprises a dielectric layer (also referred to as a substrate) and at least one conductive foil comprising radiators, which is adhered to the surface of the dielectric layer.

BACKGROUND

Within a social and technological context that prioritizes efficiency, high-performance and low-loss equipment is key. For example, regarding antenna devices for cellular communications, the pursuit of efficiency is performed at several levels. On the one hand, advanced radiation features adapted to the service environment are fundamental. On the other hand, low losses at the different stages of the communication signal path should also be optimized.

Within a typical antenna device, the signals are conducted through a feeding network (also referred to as distribution network), which distributes the signals to available radiators of a radiating structure. The radiators are the interfaces between the distribution network and the propagation environment (the air).

The distribution network may be implemented as transmission lines, and possibly other components. Examples of transmission are microstrip, stripline, or waveguides. Losses along these transmission lines occur both in the conductors and in dielectric materials embedding the conductors. High conductivity materials are thus beneficial for implementing the conductors. Moreover, low-density dielectric materials may reduce the electrical length of the transmission lines, and may thus lead to lower losses. However, such dielectric materials usually results in a bulkier design of the antenna device. Finally, the radiators are typically implemented as flat conductive patterns, which are also subject to losses at the conductors and the surrounding dielectrics.

In addition to the above-described loss issues, the assembly of the typical antenna device is often complicated, and requires specific machines. Arrangements of antenna elements at imprecise distances between each other, which may result from the complicated assembly, may lead to performance loss.

SUMMARY

In view of the above, an objective of this disclosure is to provide an easy, e.g., manual, way of assembly of a radiating structure for an RF device, particularly an antenna device, wherein the radiating structure includes the radiators. Another objective is to reduce the losses in the RF device. Another objective is to ensure precise distances between different elements of the RF device, for instance, a distance between radiators and directors, in order to reduce losses. Another objective is to allow the assembly of multiple radiators and directors at the same time. Another objective is to reduce a weight of the radiating structure, and thus of the RF device.

These and other objectives are achieved by the solutions described in the independent claims. Advantageous implementations of are described in the dependent claims.

A first aspect of this disclosure provides a radiating structure for a RF device, the radiating structure comprising: a dielectric layer; and a first conductive foil adhered to a first surface of the dielectric layer; wherein a first conductive pattern comprising one or more radiators is formed on the first conductive foil.

The RF device may be an antenna device, that is, the radiating structure is suitable for an antenna device. Since the radiators are formed on the conductive foil, and the conductive foil is adhered to the dielectric layer, multiple radiators can be assembled onto the substrate at the same time. The assembly is very easy and can be done manually. Further, the distances between the radiators on the foil can be precisely predetermined, to minimize losses. The dielectric layer can be of low weight, and the conductive foil may be very thin, so that the overall weight of the radiating structure is low.

Each radiator may be configured to radiate a wireless signal, which is provided to the radiator, for instance, by a distribution network of the RF device. Each radiator may also be configured to receive a wireless signal and provide it to the distribution network or a receiver.

The one or more radiators may be patterned on the conductive foil. A microstrip technology may be used to form the first conductive pattern including the radiators on the first conductive foil. The first conductive pattern may comprise further antenna elements, which may interact with the radiators. The first conductive foil may be self-adhering, or may be adhered with an adhesive like a glue to the dielectric layer. The dielectric layer may have a low dielectric constant, for example, close that of air or foam.

In an implementation form of the first aspect, the first conductive pattern comprises a plurality of patch radiators.

As the patch radiators are flat, they are well suited to be patterned on a thin conductive foil. All patch radiators may be the same, i.e., same size and shape. The radiators may form an array of radiators on the first conductive foil. For instance, the patch radiators may be arranged in a matrix of rows and columns.

In an implementation form of the first aspect, the radiating structure further comprises a second conductive foil adhered to a second surface of the dielectric layer, the second surface being opposite the first surface; wherein a second conductive pattern comprising one or more electrical elements is formed on the second conductive foil.

In an implementation form of the first aspect, the one or more electrical elements are one or more directors, which are respectively associated with the one or more radiators.

Thus, also the electrical elements, specifically the directors, may be easily, e.g., manually assembled. The directors may be assembled all at once. The one or more directors may be patterned on the second conductive foil. A microstrip technology may be used to form the second conductive pattern including the directors on the second conductive foil. The second conductive pattern may comprise further antenna elements, which may interact with the directors. The second conductive foil may be self-adhering, or may be adhered with an adhesive like a glue to the dielectric layer.

Each director may have a fixed and predetermined distance to its associated radiator. This can be very precise, due to the two conductive foils being adhered to the opposite sides of the substrate.

In an implementation form of the first aspect, the second conductive pattern comprises a plurality of patch directors.

As the patch directors are flat, they are well suited to be patterned on a thin conductive foil. All patch directors may be the same, i.e., same size and shape. The directors may form an array of directors on the second conductive foil. For instance, the patch directors may be arranged in a matrix of rows and columns.

In an implementation form of the first aspect, the first conductive foil is adhered to the first surface of the dielectric layer by a first adhesive layer; and/or the second conductive foil is adhered to a second surface of the dielectric layer by a second adhesive layer.

The adhesive layers may respectively be glue, epoxy, or the like. This allows for a simple and cheap assembly.

In an implementation form of the first aspect, at least one of the first conductive foil and the second conductive foil is a one-sided-adhesive foil.

This allows for a quick assembly without the need of adhesives.

In an implementation form of the first aspect, the dielectric layer comprises or is made of a foam.

In an implementation form of the first aspect, the foam is a rigid foam.

Foam is very light of weight, and has a low dielectric constant close to air, due to the air included in the foam material. The rigid foam may provide good support.

In an implementation form of the first aspect, the radiating structure further comprises: a distribution network configured to feed the one or more radiators; wherein the one or more radiators are fed in a dual-polarized or single-polarized manner; and/or wherein the one or more radiators are capacitively fed.

The distribution network may be a feeding network, and may be configured to provide communication signals to the radiators for transmission over the air.

A second aspect of this disclosure provides a method for assembling a radiating structure for RF device, the method comprising: providing a dielectric layer; and adhering a first conductive foil to a first surface of the dielectric layer; wherein a first conductive pattern comprising one or more radiators is formed on the first conductive foil.

The method of assembling the radiating structure is easy and may be performed manually. Thus, also assembly of the RF device is simplified. Else, the same advantages as described above for the radiating structure of the first aspect are achieved.

In an implementation form of the second aspect, the method further comprises adhering a second conductive foil to a second surface of the dielectric layer, the second surface being opposite the first surface; wherein a second conductive pattern comprising one or more electrical elements is formed on the second conductive foil.

In an implementation form of the second aspect, adhering the first conductive foil to the first surface of the dielectric layer comprises bending the first conductive foil and/or wrapping the first conductive foil partly around the dielectric layer; and/or adhering the second conductive foil to the second surface of the dielectric layer comprises bending the second conductive foil and/or wrapping the second conductive foil partly around the dielectric layer.

According to the above aspects and implementation forms, a supporting low-density dielectric layer (substrate), for example, a foam material may be provided, and a flexible conductive pattern, which is provided on a first foil and comprises at least the one or more radiators, is adhered to the substrate. A second flexible conductive pattern of additional electrical elements (possibly directors) can be adhered by a second foil onto the opposite side of the supporting substrate. The procedure to assemble the electrical foils onto the dielectric substrate is simple and fast, wherein the electrical foils may be implemented as a one-sided-adhesive, flexible conductive foils, respectively. The assembly procedure can be both performed manual and in an automatized manner.

BRIEF DESCRIPTION OF DRAWINGS

The above described aspects and implementation forms are explained in the following description of exemplary embodiments in relation to the enclosed drawings, in which

FIG. 1 shows a radiating structure according to this disclosure with a first conductive foil.

FIG. 2 shows an exemplary radiating structure according to this disclosure with a first and a second conductive foil.

FIG. 3 shows an exemplary radiating structure according to this disclosure with a distribution network.

FIG. 4 shows a method for assembling a radiating structure according to this disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

FIG. 1 shows a radiating structure 100 according to this disclosure. The radiating structure 100 is for an antenna device and/or for an RF device. The radiating structure 100 may be a part of the antenna device and/or the RF device. This disclosure accordingly also provides also the antenna device and/or the RF device including the radiating structure 100 as an embodiment.

The radiating structure 100 comprises a dielectric layer 101. The dielectric layer 101 may comprise foam or may be made of a foam. The dielectric layer may have a low dielectric constant and a low weight. Nevertheless, the dielectric layer 101 may be stable and provide support. For instance, a rigid foam may be used to implement the dielectric layer 101.

Further, the radiating structure 100 comprises a first conductive foil 102, which is adhered to a first surface of the dielectric layer 101 (the upper surface in FIG. 1). The first conductive foil 102 may be adhered to the dielectric layer 101 by an adhesive, for example, a glue, or may be adhered to the dielectric layer 101 using an adhesive surface of the first conductive foil 102. The first conductive foil 102 comprises a first conductive pattern 103, and the first conductive pattern 103 comprising one or more radiators. That is, the one or more radiators are formed on the first conductive foil 102. The one or more radiators may be used for radiating wireless signals in the antenna device and/or RF device. To this end, the radiators may be fed accordingly, for instance, by a feeding network.

FIG. 2 shows an exemplary radiating structure 100 according to this disclosure, which builds further on the radiating structure 100 shown in FIG. 1. Same elements in FIG. 1 and 2 are labelled with the same reference signs, and may be implemented likewise. A redundant description of these elements is omitted if not necessary.

As can be seen in FIG. 2(a), the radiating structure 100 further comprises – in addition to the first conductive foil 102 comprising the first conductive pattern 103 – a second conductive foil 202, which is adhered to a second surface of the dielectric layer 101, e.g., the foam layer. The second surface is opposite the first surface, to which the first conductive foil 102 is adhered. That is the second conductive foil 202 is adhered to the other side of the dielectric layer 101 than the first conductive foil 102.

The second conductive foil 202 comprises a second conductive pattern 203, and the second conductive pattern 203 comprises one or more electrical elements. That is, the one or more electrical elements are formed on the second conductive foil 202. The one or more electrical elements may be or comprise one or more directors 205. That is, one or more directors 205 may be formed on the second conductive foil 202, as shown in FIG. 2. The second conductive foil 202 is thus also referred to as "director foil". The one or more directors 205 on the second conductive foil 202 may respectively be associated with the one or more radiators 204 formed on the first conductive foil 102. This means, in operation of the radiating structure 100, each director 205 is designed and arranged to direct the electromagnetic radiation emitted by the radiator 204 it is associated with. The first conductive foil 102 may be referred to as "radiator foil".

The one or more radiators 204 may be one or more patch radiators, i.e., each radiator 204 may be formed as a conductive patch on the first conductive foil 102. Likewise, the one or more directors 205 may be one or more patch directors, i.e., each director 205 may be formed as a conductive patch on the second conductive foil 202. The first conductive foil 102 and/or the second conductive foil 202 may thus also be referred to as "patch foils" or "patch layers". Each patch director 205 of the second conductive foil 202 is in this case associated with one patch radiator 204 of the first conductive foil 102, and vice versa, as explained above.

FIG. 2(a) shows further that the first conductive foil 102 may be adhered to the first surface of the dielectric layer 101 by a first adhesive layer 201a. In a similar manner, the second conductive foil 202 may be adhered to the second surface of the dielectric layer 101 by a second adhesive layer 201b. However, it is also possible that either the first conductive foil 102 or the second conductive foil 202, or both conductive foils 102, 202, is/are a one-sided-adhesive foil, and thus require no adhesive layer.

FIG. 2(b) shows the exemplary patch radiators 204 in more detail. Each patch radiator 204 of the first conductive foil 202 may be fed in a dual-polarized or in a single-polarized manner. Notably, this may generally be the case for the one or more radiators 204 of the radiating structure 100, even if they are not implemented as patch radiators. The radiators 204 may thus be dual-polarization radiators coupled to two feeding probes. The radiators 204 may also be single-polarization radiators coupled to one feeding probe. The feeding of the radiators 204 may be implemented by capacitive feeding. The feeding may be realized by a feeding network or distribution network of the radiating structure 100, or of the antenna device and/or RF device.

FIG. 3 illustrates such a feeding (or distribution) network 301, which is configured to feed the one or more radiators 204 of the radiating structure 100. The distribution network may comprise a plurality of distribution network layers, which are arranged in parallel to each other and perpendicular to the dielectric layer 101. Thereby, each distribution network layer may have one or more feeding probes coupled respectively to one or more of the radiators 204.

FIG. 4 shows a method 400 according to this disclosure. The method 400 is for assembling the radiating structure 100 shown in FIG. 1, and may also be used to assemble the radiating structure 100 of FIG. 2 or of FIG. 3. The method 400 may be performed manually or automatically, for instance, by a suitable apparatus.

The method 400 comprises a step 401 of providing the dielectric layer 101, e.g., implemented as a rigid foam layer or substrate. The method 400 further comprises a step 402 of adhering the first conductive foil 102 to a first surface of the dielectric layer 101. The first conductive pattern 103, which comprises the one or more radiators 204, is formed on the first conductive foil 102. The first conductive foil 102 may be pre-produced, however, the method 400 may also comprise a step of forming the first conductive pattern 103.

To reach the radiating structure 100 shown in FIG. 2, the method 400 may further comprise a step of adhering the second conductive foil 202 to the second surface of the dielectric layer 101. The second conductive foil 202 comprises the second conductive pattern 203 comprising the one or more electrical elements, e.g., the one or more directors 205. The second conductive foil 202 may be pre-produced, however, the method 400 may also comprise a step of forming the second conductive pattern 203.

The solutions of this disclosure achieves several advantages. For example, the used materials – i.e., the dielectric material of the dielectric layer 101 and the material of the conductive foils 102, 202 – lead to a cheap manufacturing and a lightweight radiating structure 100. The conductive foils 102, 202 can be easily attached to the dielectric layer 101, which leads to an easy assembling method 400. For instance, the conductive foils 102, 202 may be adhered to the dielectric layer 101 by gluing, i.e., no soldering is needed for this assembly step. This reduces costs that would arise from a more complex assembly or the used of solder joints. Since the radiating structure 100 can have a very low weight, another advantage is the decrease of the overall weight of the antenna device and/or RF device. Moreover, as a low-loss foam can be used as the dielectric layer 101 and high-conductivity foils 102, 202 can be used, the losses of the radiating structure 100 may be significantly lower than for typical antenna and RF devices.

The method 400 is in itself of low-complexity and allows a manual process, or a simple automatized assembly process. The method 400 may be easily adapted to a diversity of flat-faced substrates.

The solutions of this disclosure can be potentially used in any electronic device. In particular, antenna devices and/or RF devices benefit from the radiating structure 100 and the assembly method 400. Specifically, the solutions of this disclosure can be used to implement radiating elements (the radiators 204), and dual-polarized capacitive feeding.

The present disclosure has been described in conjunction with various embodiments as examples as well as implementations. However, other variations can be understood and effected by those persons skilled in the art and practicing the claimed matter, from the studies of the drawings, this disclosure and the independent claims. In the claims as well as in the description the word “comprising” does not exclude other elements or steps and the indefinite article “a” or “an” does not exclude a plurality. A single element or other unit may fulfill the functions of several entities or items recited in the claims. The mere fact that certain measures are recited in the mutual different dependent claims does not indicate that a combination of these measures cannot be used in an advantageous implementation.

Claims

1. A radiating structure (100) for a radio frequency, RF, device, the radiating structure (100) comprising:

a dielectric layer (101); and

a first conductive foil (102) adhered to a first surface of the dielectric layer (101);

wherein a first conductive pattern (103) comprising one or more radiators (204) is formed on the first conductive foil (102).

2. The radiating structure (100) according to claim 1, wherein the first conductive pattern (103) comprises a plurality of patch radiators (204).

3. The radiating structure (100) according to claim 1 or 2, further comprising:

a second conductive foil (202) adhered to a second surface of the dielectric layer (101), the second surface being opposite the first surface;

wherein a second conductive pattern (203) comprising one or more electrical elements is formed on the second conductive foil (202).

4. The radiating structure (100) according to claim 3, wherein the one or more electrical elements are one or more directors (205), which are respectively associated with the one or more radiators (204).

5. The radiating structure (100) according to claim 4, wherein the second conductive pattern (203) comprises a plurality of patch directors (205).

6. The radiating structure (100) according to one according to one of the claims 1 to 5, wherein:

the first conductive foil (102) is adhered to the first surface of the dielectric layer (101) by a first adhesive layer (201a); and/or

the second conductive foil (202) is adhered to a second surface of the dielectric layer (101) by a second adhesive layer (201b).

7. The radiating structure (100) according to one of the claims 1 to 5, wherein:

at least one of the first conductive foil (102) and the second conductive foil (202) is a one-sided-adhesive foil.

8. The radiating structure (100) according to one of the claims 1 to 7, wherein the dielectric layer (101) comprises or is made of a foam.

9. The radiating structure (100) according to claim 8, wherein the foam is a rigid foam.

10. The radiating structure (100) according to one of the claims 1 to 9, further comprising:

a distribution network (301) configured to feed the one or more radiators (204);

wherein the one or more radiators (204) are fed in a dual-polarized or single-polarized manner; and/or

wherein the one or more radiators (204) are capacitively fed.

11. A method (400) for assembling a radiating structure (100) for a radio frequency, RF, device, the method (400) comprising:

providing (401) a dielectric layer (101); and

adhering (402) a first conductive foil (102) to a first surface of the dielectric layer (101);

wherein a first conductive pattern (103) comprising one or more radiators (204) is formed on the first conductive foil (102).

12. The method (400) according to claim 11, further comprising;

adhering a second conductive foil (202) to a second surface of the dielectric layer (101), the second surface being opposite the first surface;

wherein a second conductive pattern (203) comprising one or more electrical elements is formed on the second conductive foil (202).

13. The method (400) according to claim 11 or 12, wherein:

adhering the first conductive foil (102) to the first surface of the dielectric layer (101) comprises bending the first conductive foil (102) and/or wrapping the first conductive foil (102) partly around the dielectric layer (101); and/or adhering the second conductive foil (202) to the second surface of the dielectric layer (101) comprises bending the second conductive foil (202) and/or wrapping the second conductive foil (202) partly around the dielectric layer (101).

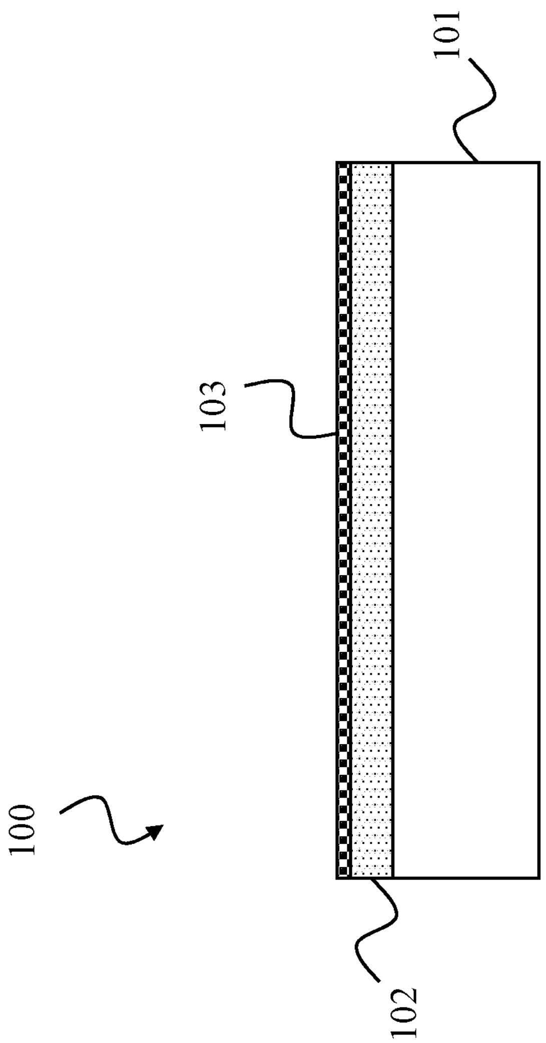

FIG. 1

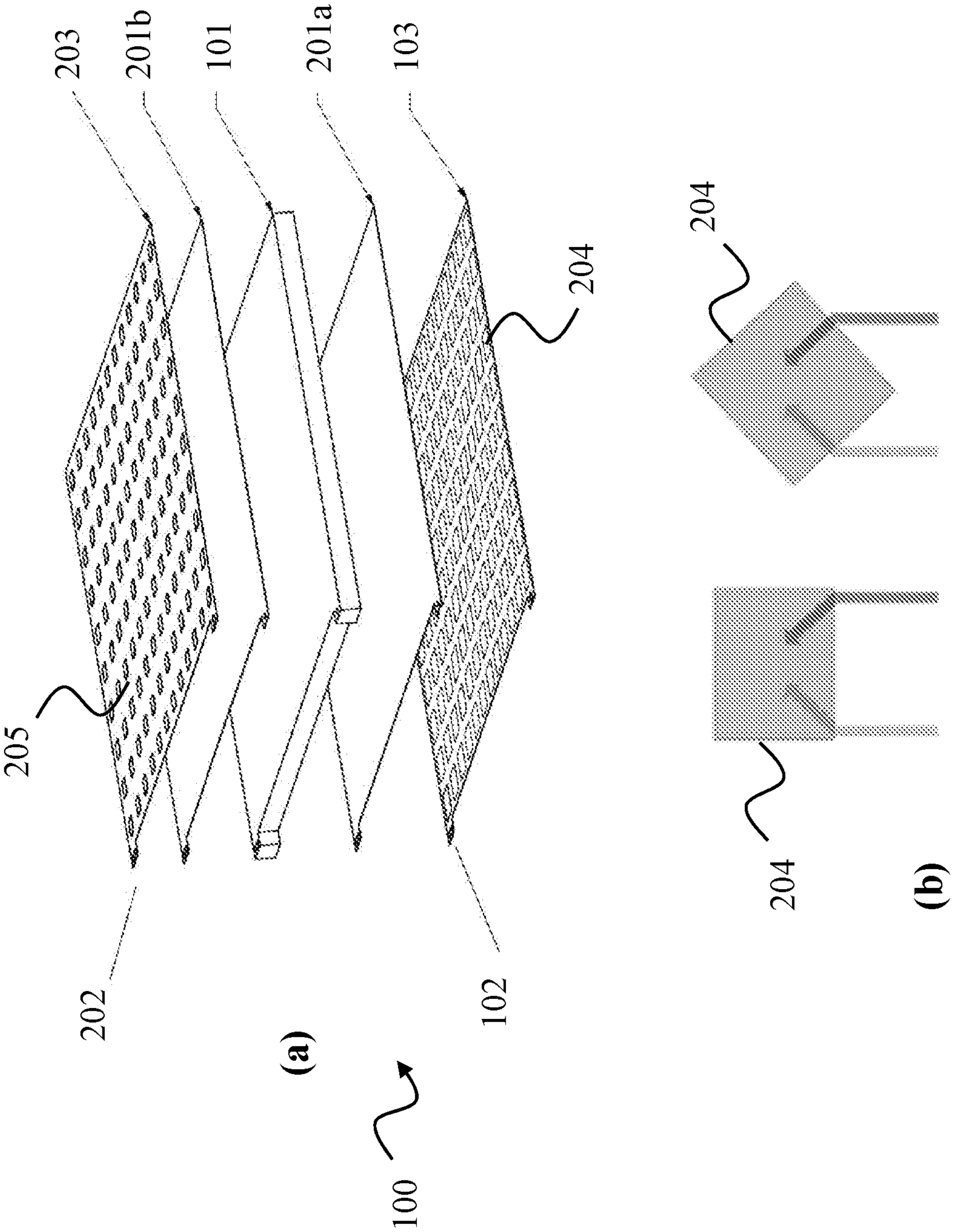

FIG. 2

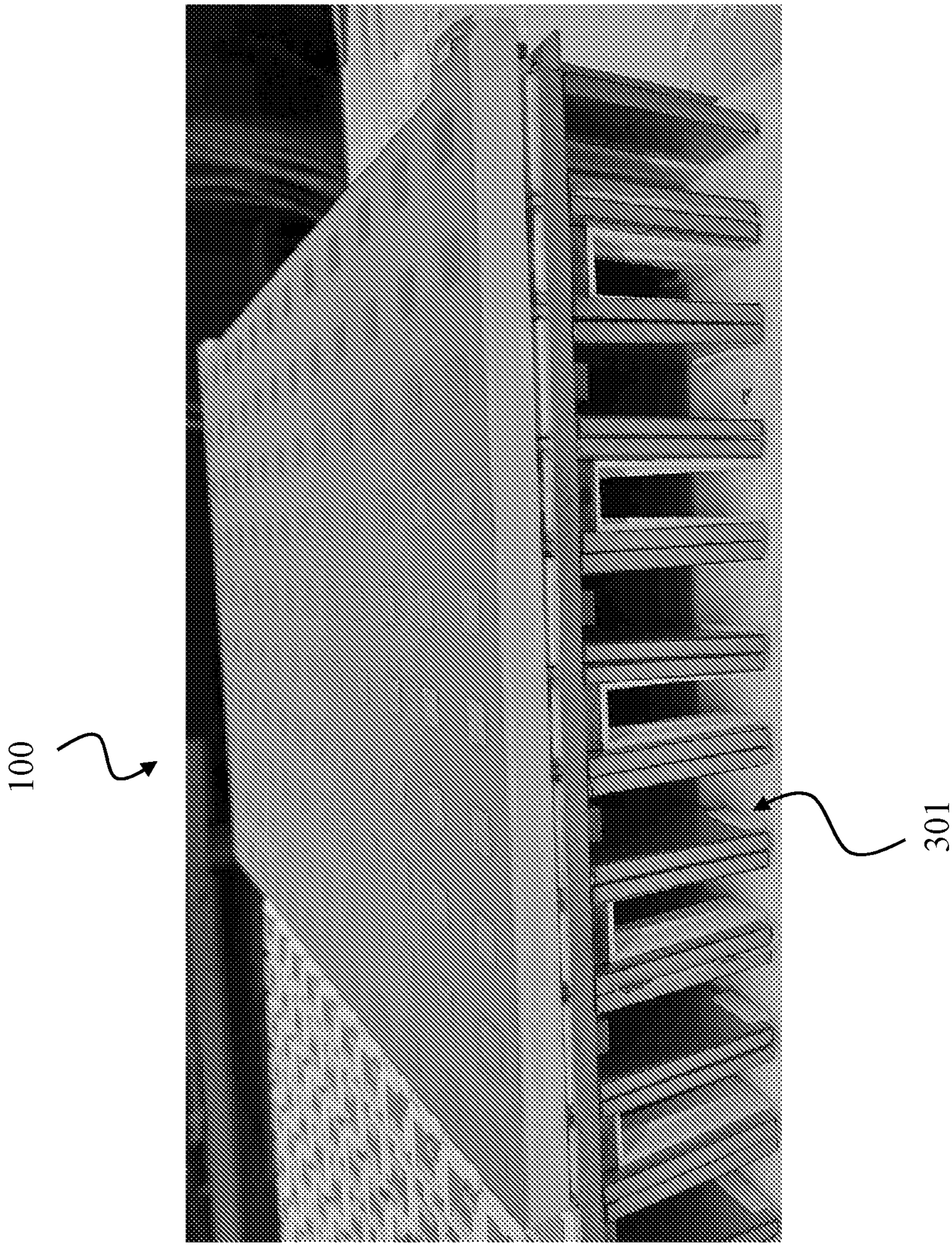

FIG. 3

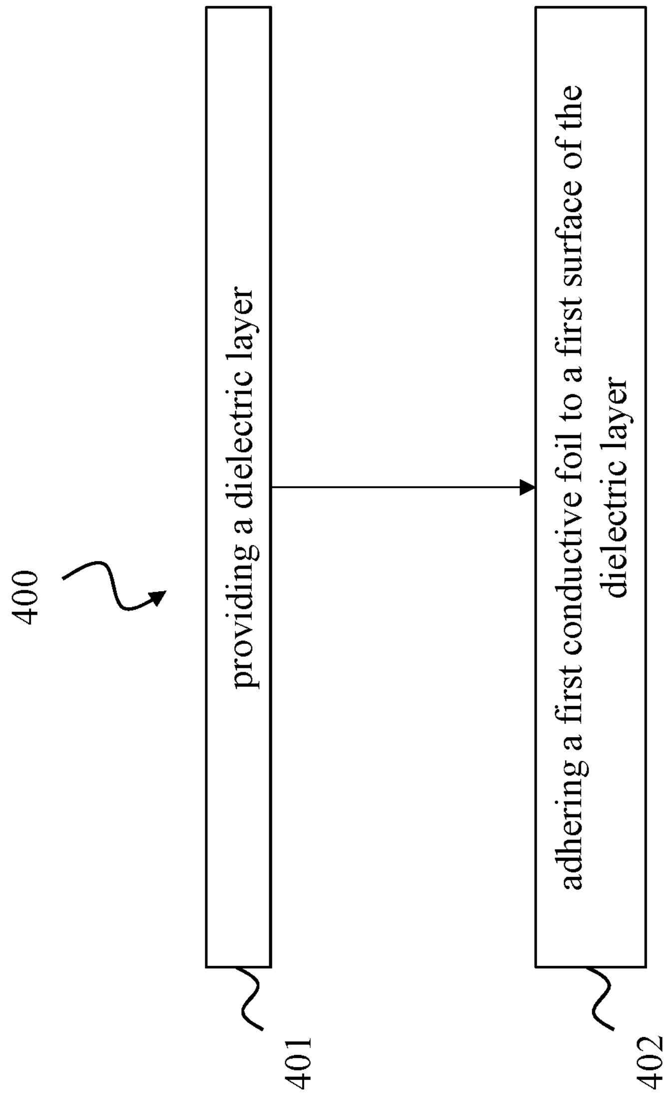
400
providing a dielectric layer
adhering a first conductive foil to a first surface of the dielectric layer
401
402

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/098797

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 1/38(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, CNTXT, ENTXTC, DWPI, IEEE： antenna, radiat+, patch, dielectric, adhe+, parasitic, conduct+, foil, array, layer, director

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 114899610 A (NO.63660 TROOPS OF PLA) 12 August 2022 (2022-08-12) description, paragraphs [0032]-[0041], figures 1-3	1-13
X	CN 212676473 U (EASTONE CENTURY TECHNOLOGY CO., LTD.) 09 March 2021 (2021-03-09) description, paragraphs [0028]-[0033], figures 1-2	1-13
X	CN 114784512 A (NO.63660 TROOPS OF PLA) 22 July 2022 (2022-07-22) description, paragraphs [0036]-[0048], figures 1-3	1-13
A	US 2020259267 A1 (SAMSUNG ELECTRO-MECHANICS,LTD.) 13 August 2020 (2020-08-13) the whole document	1-13

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "D" document cited by the applicant in the international application
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 November 2023	**14 December 2023**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**PAN,XiaoDan** Telephone No. **(+86) 010-53961796**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/098797

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	114899610	A	12 August 2022	None			
CN	212676473	U	09 March 2021	None			
CN	114784512	A	22 July 2022	None			
US	2020259267	A1	13 August 2020	US	2022102872	A1	31 March 2022
				JP	2020129790	A	27 August 2020
				KR	20200117962	A	14 October 2020