



(51) International Patent Classification:

B32B 15/01 (2006.01) B32B 15/18 (2006.01)

B32B 15/20 (2006.01)

(21) International Application Number:

PCT/CN2017/111862

(22) International Filing Date:

20 November 2017 (20.11.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

201710236241X 12 April 2017 (12.04.2017) CN

201720383248X 12 April 2017 (12.04.2017) CN

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(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, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, 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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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).

Published:

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

(54) Title: COMPOSITE STRUCTURE AND METHOD FOR PRODUCING THE SAME AND ELECTRONIC DEVICE

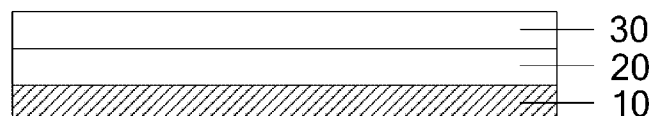


Fig. 1

(57) Abstract: A composite structure and a method for producing the same, and an electronic device are provided. The composite structure includes a first metal layer (10), a carbon nano-coating (20) and a black coating (30). The first metal layer (10) is applied on a surface of the first metal layer. The black coating (30) is applied on a surface of the carbon nano-coating (20) opposite to the first metal layer (10).



DESCRIPTION**COMPOSITE STRUCTURE AND METHOD FOR PRODUCING THE SAME AND
ELECTRONIC DEVICE****5 FIELD**

The present disclosure relates to the field of material technology, and more particular to a composite structure and a method for producing the same, and an electronic device having the same.

10 BACKGROUND

With the continuous development of electronic devices, their diversified and intelligentized functions cause increasing power consumption. Furthermore, a light source on the electronic device will generate a lot of heat or useless light.

Therefore, how to effectively dissipate heat and absorb light for the electronic device at a low
15 cost becomes an urgent problem to be solved.

SUMMARY

According to embodiments of a first aspect of the present disclosure, there is provided a composite structure. The composite structure includes a first metal layer, a carbon nano-coating
20 and a black coating. The carbon nano-coating is applied on a surface of the first metal layer. The black coating is applied on a surface of the carbon nano-coating opposite to the first metal layer.

In an embodiment of the present disclosure, the composite structure further includes a second metal layer, the first metal layer is attached to a surface of the second metal layer via an adhesive layer.

25 In an embodiment of the present disclosure, the adhesive layer is affixed to the first metal layer.

In an embodiment of the present disclosure, the second metal layer includes at least one selected from stainless steel, phosphor bronze, beryllium copper or copper-nickel-zinc alloy.

In an embodiment of the present disclosure, the first metal layer includes a copper foil.

30 In an embodiment of the present disclosure, the composite structure is strip-shaped.

In an embodiment of the present disclosure, the composite structure is a stretchable member.

In an embodiment of the present disclosure, the carbon nano-coating includes a carbon

nanomaterial, and the carbon nanomaterial includes at least one selected from carbon nanotubes, carbon nanofibers or carbon nanospheres.

In an embodiment of the present disclosure, the carbon nano-coating is a hybrid coating, and the hybrid coating includes epoxy resin, graphene, carbon nanotubes, silicon carbide and boron nitride.

According to embodiments of a second aspect of the present disclosure, there is provided a method for producing a composite structure. The method includes: providing a first metal layer; applying a carbon nano-coating on a surface of the first metal layer; and applying a black coating on a surface of the carbon nano-coating opposite to the first metal layer.

In an embodiment of the present disclosure, the method further includes attaching the first metal layer to a surface of a second metal layer via an adhesive layer.

In an embodiment of the present disclosure, the carbon nano-coating is applied on the surface of the first metal layer and the black coating is applied on the surface of the carbon nano-coating opposite to the first metal layer by brush coating, spraying or dip coating.

In an embodiment of the present disclosure, the carbon nano-coating is applied on the surface of the first metal layer and the black coating is applied on the surface of the carbon nano-coating opposite to the first metal layer by at least one selected from physical sputtering, spin coating, inkjet printing or slit coating.

According to embodiments of a third aspect of the present disclosure, there is provided an electronic device. The electronic device includes at least one of a heat source or a light source, on which the composite structure described above or produced by the method described above is provided.

In an embodiment of the present disclosure, the first metal layer of the composite structure is attached to a surface of at least one of the heat source or the light source via an adhesive layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional view of a composite structure according to an embodiment of the present disclosure.

Fig. 2 is a schematic cross-sectional view of a composite structure according to another embodiment of the present disclosure.

Fig. 3 is a schematic view of a composite structure according to yet another embodiment of the present disclosure.

Fig. 4 is a flow chart of a method for producing a composite structure according to an embodiment of the present disclosure.

Fig. 5 is a schematic view of an electronic device according to an embodiment of the present disclosure.

5

DETAILED DESCRIPTION

In the following, technical solutions in embodiments of the present disclosure will be described clearly with reference to drawings. It should be appreciated that, the specific embodiments described herein are merely used to generally understand the present disclosure, but shall not be construed to limit the present disclosure. In addition, it should be illustrated that, for brief description, only parts of the structure related to the present disclosure, not all the structure, are shown in the drawings. Other embodiments obtainable by those skilled in the art based on the embodiments of the present disclosure without creative work all are within the protect scope of the present disclosure.

15 The terms "first", "second", and the like herein are used to distinguish different objects and are not refer to a specific sequence. In addition, It should be further understood that, when used in the specification, terms "including" and "containing" and any variations thereof specify the presence of stated features, operations, elements and/or components, but do not exclude the presence or addition of one or more other features, operations, elements, components and/or groups thereof. For example, a process, method, system, product or device including a series of steps or units is not limited to the listed steps or units, but may optionally further include steps or units not listed, or may optionally further include other steps or units inherent to the process, method, system, product or device.

25 Reference throughout this specification to "an embodiment," "some embodiments," "one embodiment", "another example," "an example," "a specific example," or "some examples," means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. Thus, the appearances of the phrases such as "in some embodiments," "in one embodiment", "in an embodiment", "in another example," "in an example," "in a specific example," or "in some examples," in various places throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure, or an independent or alternative embodiment or example mutually exclusive to other embodiments.

30

Furthermore, it is explicitly or implicitly appreciated that, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

5 In embodiments of a first aspect of the present disclosure, there is provided a composite structure, including a first metal layer; a carbon nano-coating applied on a surface of the first metal layer; and a black coating applied on a surface of the carbon nano-coating opposite to the first metal layer.

10 In embodiments of a second aspect of the present disclosure, there is provided a method for producing a composite structure, including providing a first metal layer; applying a carbon nano-coating on a surface of the first metal layer; and applying a black coating on a surface of the carbon nano-coating opposite to the first metal layer.

In embodiments of a third aspect of the present disclosure, there is provided an electronic device, including at least one of a heat source or a light source, on which the composite structure described above or produced according to the above method is provided.

15 The electronic device according to embodiments of the present invention may be a digital product, a communication product, a household appliance and the like.

Referring to Fig. 1, which is a schematic cross-sectional view of a composite structure according to an embodiment of the present disclosure, the composite structure includes a first metal layer 10, a carbon nano-coating 20 and a black coating 30 formed sequentially.

20 The carbon nano-coating 20 is applied on a surface of the first metal layer 10, and the black coating 30 is applied on a surface of the carbon nano-coating 20 opposite to the first metal layer 10, i.e. on a surface of the carbon nano-coating 20 away from the first metal layer 10.

25 Alternatively, in an embodiment, the first metal layer 10 may include a copper foil, which has a good heat dissipation effect due to its good thermal conductivity. Certainly, in other embodiments, the first metal layer 10 may also include other materials with good thermal conductivity, such as an aluminum foil.

30 The carbon nano-coating 20 includes, but may not be limited to, carbon nanomaterials, which refer to carbon materials with at least one dimension less than 100 nm in the dispersed phase. The dispersed phase may be composed of either carbon atoms or heterogeneous atoms (non-carbon atoms), or even may be nanopores. Carbon nanomaterials mainly include three types: carbon nanotubes, carbon nanofibers, and carbon nanospheres.

Taking carbon nanotubes as an example, in practical application, the carbon nano-coating 20

may also be a hybrid coating including several materials. Alternatively, the carbon nano-coating 20 may be a hybrid coating including epoxy resin, graphene, carbon nanotubes, silicon carbide and boron nitride. Herein, the content of each component in the hybrid coating is not specifically limited.

5 A black body has the best radiation characteristic and can totally absorb and emit radiation in any wavelength at any temperature. Therefore, providing the black coating 30 may improve heat dissipation and light absorption efficiency.

In the above embodiments, an applying manner used among layers of the composite structure may be one of a brush coating method, a spraying method and a dip coating method. In other
10 alternative embodiments, a physical or chemical deposition method, such as one or more selected from physical sputtering, spin coating, inkjet printing or slit coating, may also be used.

In practical application, the composite structure according to this embodiment is mainly attached on a surface of a heat source or a light source to dissipate heat or absorb light. For example, the composite structure may be disposed on a surface of a battery to dissipate heat, or
15 disposed on a base of an LED lamp to dissipate heat and absorb light at the same time, or disposed on a rear shell of a display to dissipate heat.

Referring to Fig. 2, which is a schematic cross-sectional view of a composite structure according to another embodiment of the present disclosure, the composite structure includes a second metal layer 40, an adhesive layer 50, a first metal layer 10, a carbon nano-coating 20 and a
20 black coating 30 arranged in a stacked manner.

The first metal layer 10 is attached to a surface of the second metal layer 40 via the adhesive layer 50.

Alternatively, the first metal layer 10 may include a copper foil, which has a good heat dissipation effect due to its good thermal conductivity. Certainly, in other embodiments, the first
25 metal layer 10 may also include other materials with good thermal conductivity, such as an aluminum foil.

Alternatively, the carbon nano-coating 20 includes, but may not be limited to, carbon nanomaterials, which refer to carbon materials with at least one dimension less than 100 nm in the dispersed phase. The dispersed phase may be composed of either carbon atoms or heterogeneous
30 atoms (non-carbon atoms), or even may be nanopores. Carbon nanomaterials mainly include three types: carbon nanotubes, carbon nanofibers, and carbon nanospheres.

Taking carbon nanotubes as an example, in practical application, the carbon nano-coating 20

may also be a hybrid coating including several materials. Alternatively, the carbon nano-coating 20 may be a hybrid coating including epoxy resin, graphene, carbon nanotubes, silicon carbide and boron nitride. Herein, the content of each component in the hybrid coating is not specifically limited.

5 Alternatively, a black body has the best radiation characteristic and can totally absorb and emit radiation in any wavelength at any temperature. Therefore, providing the black coating 30 may improve heat dissipation and light absorption efficiency.

Alternatively, the second metal layer 40 may include at least one selected from stainless steel, phosphor bronze, beryllium copper or copper-nickel-zinc alloy.

10 It should be appreciated that, in other alternative embodiments, the second metal layer 40 may also be a metal layer of a heat source or a light source. For example, the second metal layer 40 may be a base of an LED lamp, the first metal layer 10 may be directly attached on a surface of the base of the LED lamp via the adhesive layer 50 to achieve heat dissipating and light absorbing effects.

15 Referring to Fig. 3, which is a schematic view of a composite structure according to yet another embodiment of the present disclosure, a layer construction of the composite structure may be a construction as mentioned in the above two embodiments, and will not be elaborated herein.

For example, the composite structure includes an adhesive layer 50, a first metal layer 10, a carbon nano-coating 20 and a black coating 30 arranged in a stacked manner, and in this
20 embodiment, the composite structure is strip-shaped.

Specifically, as shown in Fig. 3, the layer construction of the composite structure shown in the dotted circle may be as shown in Fig. 2, and will not be elaborated herein. As the copper foil, the carbon nano-coating and the black coating all may be made to be very thin, and are thus bendable.

25 In this embodiment, the composite structure is made into the strip structure, when used, the coiled strip may be directly unfolded and attached on a heat source or a light source. Therefore, the composite structure according to embodiments of the present disclosure has a higher production efficiency, a higher yield and a lower processing cost, as compared with the related art where attachment of graphite flakes, blackening treatment and the like are performed separately.

30 In addition, in other embodiment, the composite structure may also be made into a stretchable structure. For example, the composite structure is a stretchable member. As a surface of the heat source or the light source is not necessarily planar, a better attachment to a non-planar surface may

be achieved by the stretchable composite structure.

Alternatively, the adhesive layer is affixed to the first metal layer. For example, the copper foil described in the above embodiments may be a copper foil tape which commonly includes an adhesive itself, and therefore an additional adhesive layer 50 may not be necessary.

5 Referring to Fig. 4, which is a flow chart of a method for producing a composite structure according to an embodiment of the present disclosure, the method includes the followings.

At block 41: a first metal layer is provided.

Alternatively, the first metal layer may include a copper foil, which has a good heat dissipation effect due to its good thermal conductivity. Certainly, in other embodiments, the first
10 metal layer may also include other materials with good thermal conductivity, such as an aluminum foil.

At block 42: a carbon nano-coating is applied on a surface of the first metal layer.

The carbon nano-coating includes, but may not be limited to, carbon nanomaterials, which refer to carbon materials with at least one dimension less than 100 nm in the dispersed phase. The
15 dispersed phase may be composed of either carbon atoms or heterogeneous atoms (non-carbon atoms), or even may be nanopores. Carbon nanomaterials mainly include three types: carbon nanotubes, carbon nanofibers, and carbon nanospheres.

Taking carbon nanotubes as an example, in practical application, the carbon nano-coating may also be a hybrid coating including several materials. Alternatively, the carbon nano-coating
20 may be a hybrid coating including epoxy resin, graphene, carbon nanotubes, silicon carbide and boron nitride. Herein, the content of each component in the hybrid coating is not specifically limited.

In some embodiments, the carbon nano-coating is applied on the surface of the first metal layer by brush coating, spraying or dip coating. In other embodiments, the carbon nano-coating is
25 applied on the surface of the first metal layer by at least one selected from physical sputtering, spin coating, inkjet printing or slit coating.

At block 43: a black coating is applied on a surface of the carbon nano-coating opposite to the first metal layer.

A black body has the best radiation characteristic and can totally absorb and emit radiation in
30 any wavelength at any temperature. Therefore, providing the black coating may improve heat dissipation and light absorption efficiency.

In some embodiments, the black coating is applied on the surface of the carbon nano-coating

opposite to the first metal layer by brush coating, spraying or dip coating. In other embodiments, the black coating is applied on the surface of the carbon nano-coating opposite to the first metal layer by at least one selected from physical sputtering, spin coating, inkjet printing or slit coating.

Alternatively, in another embodiment, after block 43, the method may further include
5 attaching the first metal layer to a surface of a second metal layer via an adhesive layer.

The second metal layer may include at least one selected from stainless steel, phosphor bronze, beryllium copper or copper-nickel-zinc alloy.

Alternatively, in yet another embodiment, before block 41, the method may further include attaching the first metal layer to a surface of a second metal layer via an adhesive layer.

10 In the following, the above embodiments will be illustrated with reference to two specifically practical applications.

In an example of the first practical application, a copper foil tape may be firstly attached to a heat source or a light source, and then a carbon nano-coating and a black coating are applied on a surface of the copper foil tape.

15 In an example of the second practical application, a composite tape may be prepared first, i.e. the composite tape includes an adhesive layer, a copper foil layer, a carbon nano-coating and a black coating. When in use, the composite tape is attached to a heat source or a light source.

It should be appreciated that, the layer construction of the composite structure mentioned in the above examples is merely exemplary, and the layer constructions described in the above
20 embodiments with respect to the composite structure may be applied in the above examples.

Referring to Fig. 5, which is a schematic view of an electronic device according to an embodiment of the present disclosure, the electronic device 500 includes at least one of a light source or a heat source (not shown in Fig. 5) on which a composite structure is provided.

25 The light source of the electronic device 500 may be a camera, a backlight module of a display screen, etc.; and the heat source of the electronic device 500 may be a battery, a circuit board, a sensor, etc.

It should be appreciated that, the composite structure in this embodiment may be the composite structure as described in the above composite structure embodiments or the composite structure produced by the method described in the above method embodiments, their principles
30 and structures are similar, and will not be elaborated herein.

In the above manners, the composite structure according to any one of embodiments of the present disclosure may have heat dissipation and light absorption effects on the light source and

the heat source of the electronic device, and may have lowered production cost and improved product yield.

The composite structure and the method for producing the same and the electronic device according to embodiments of the present disclosure are described in detail hereinbefore. Principles and implementation manners of the present disclosure are explained in detail with some specific examples. It should be appreciated by those skilled in the art that, the embodiments described above are used to generally understand the technical solutions and core idea of the present disclosure, and cannot be construed to limit the present disclosure, and changes, alternatives, and modifications can be made in the embodiments or technical features included therein without departing from spirit, principles and scope of the present disclosure.

CLAIMS

1. A composite structure, comprising:

a first metal layer;

5 a carbon nano-coating applied on a surface of the first metal layer; and

a black coating applied on a surface of the carbon nano-coating opposite to the first metal layer.

2. The composite structure according to claim 1, further comprising:

10 a second metal layer, wherein the first metal layer is attached to a surface of the second metal layer via an adhesive layer.

3. The composite structure according to claim 2, wherein the adhesive layer is affixed to the first metal layer.

15

4. The composite structure according to claim 2 or 3, wherein the second metal layer comprises at least one selected from stainless steel, phosphor bronze, beryllium copper or copper-nickel-zinc alloy.

20 5. The composite structure according to any one of claims 1 to 4, wherein the first metal layer comprises a copper foil.

6. The composite structure according to any one of claims 1 to 5, wherein the composite structure is strip-shaped.

25

7. The composite structure according to any one of claims 1 to 6, wherein the composite structure is a stretchable member.

8. The composite structure according to any one of claims 1 to 7, wherein the carbon nano-coating comprises a carbon nanomaterial, and the carbon nanomaterial comprises at least one selected from carbon nanotubes, carbon nanofibers or carbon nanospheres.

30

9. The composite structure according to any one of claims 1 to 8, wherein the carbon nano-coating is a hybrid coating comprising epoxy resin, graphene, carbon nanotubes, silicon carbide and boron nitride.

5 10. A method for producing a composite structure, comprising:
providing a first metal layer;
applying a carbon nano-coating on a surface of the first metal layer; and
applying a black coating on a surface of the carbon nano-coating opposite to the first metal
layer.

10 11. The method according to claim 10, further comprising:
attaching the first metal layer to a surface of a second metal layer via an adhesive layer.

15 12. The method according to claim 10 or 11, wherein the carbon nano-coating is applied on
the surface of the first metal layer and the black coating is applied on the surface of the carbon
nano-coating opposite to the first metal layer by brush coating, spraying or dip coating.

20 13. The method according to claim 10 or 11, wherein the carbon nano-coating is applied on
the surface of the first metal layer and the black coating is applied on the surface of the carbon
nano-coating opposite to the first metal layer by at least one selected from physical sputtering, spin
coating, inkjet printing or slit coating.

25 14. An electronic device, comprising at least one of a heat source or a light source, on which a
composite structure is provided, wherein the composite structure comprises:

a first metal layer;
a carbon nano-coating provided on a surface of the first metal layer; and
a black coating provided on a surface of the carbon nano-coating away from the first metal
layer.

30 15. The electronic device according to claim 14, wherein the first metal layer of the
composite structure is attached to a surface of at least one of the heat source or the light source via
an adhesive layer.

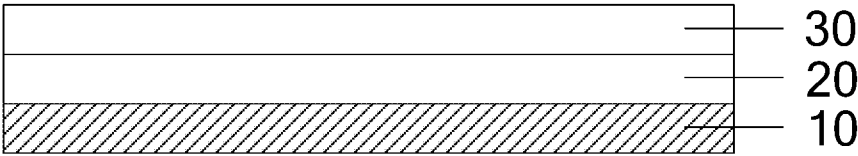


Fig. 1

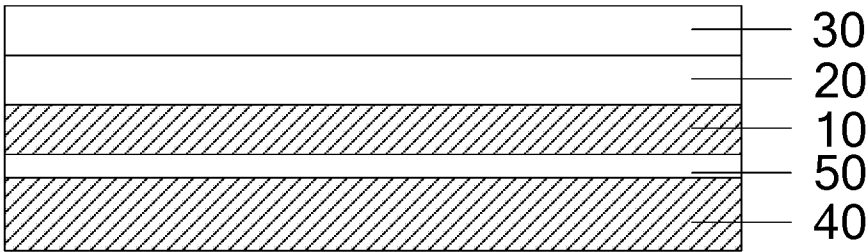


Fig. 2

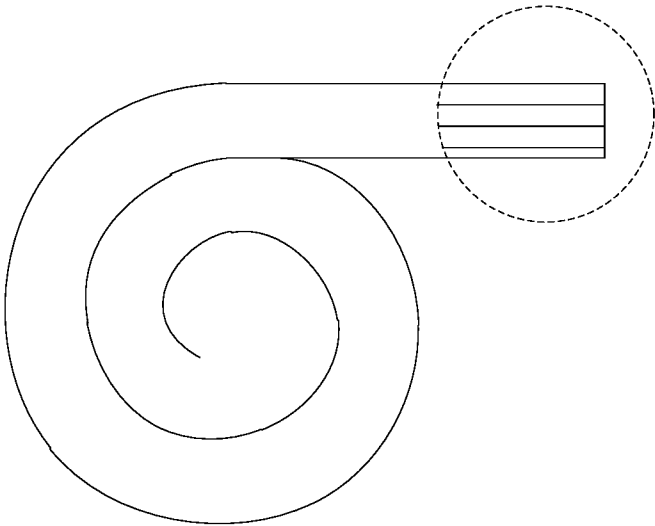


Fig. 3

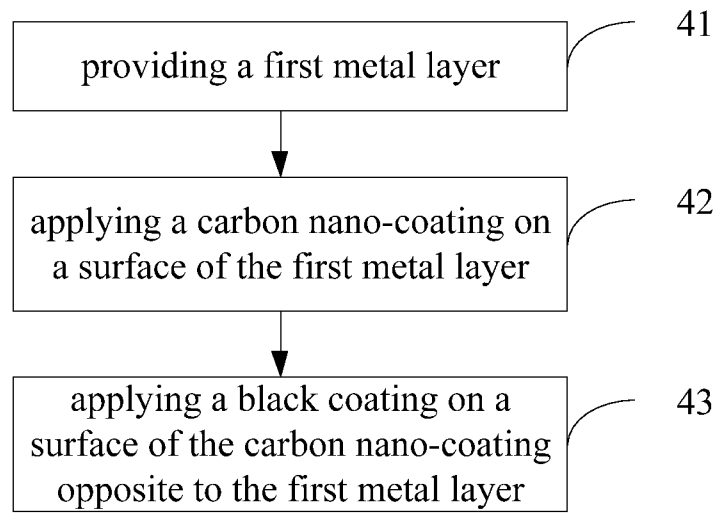


Fig. 4

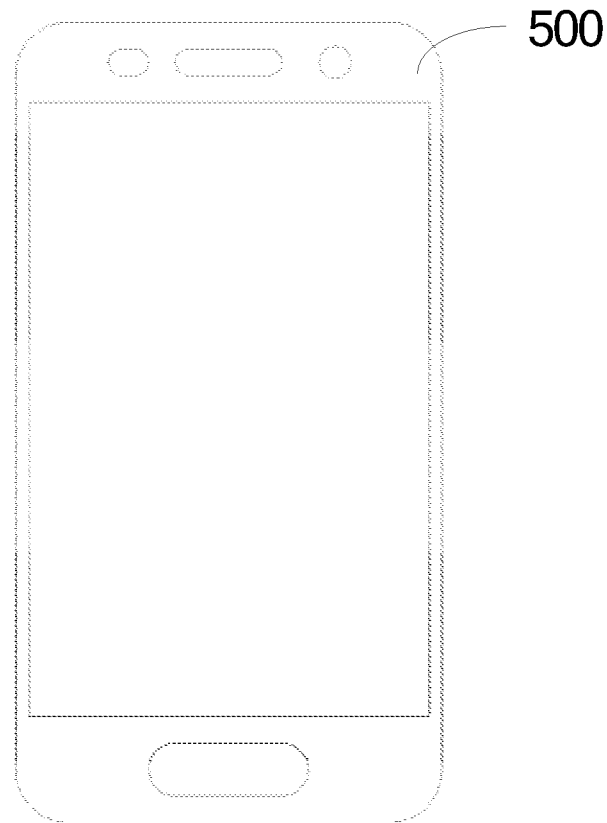


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/111862

A. CLASSIFICATION OF SUBJECT MATTER

B32B 15/01(2006.01)i; B32B 15/20(2006.01)i; B32B 15/18(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)

B32B; H05K

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)

CNABS CNKI VEN :metal sheet layer black coating carbon nanotubes nanofibers nanosphers nano w coating

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105325067 A (ILJIN MATERIALS CO LTD) 10 February 2016 (2016-02-10) claims 1-26, description from [0009] to [0201], figures 1-6	1-15
PX	CN 107053787 A (GUANGDONG OPPO MOBILE COMMUNICATION CO L) 18 August 2017 (2017-08-18) description from [0004] to [0054]	1-15

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

* Special categories of cited documents:

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Date of the actual completion of the international search

09 February 2018

Date of mailing of the international search report

28 February 2018

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2017/111862

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	105325067	A	10 February 2016	KR	20140147719	A	30 December 2014
				KR	101707042	B1	17 February 2017
				CN	105325067	B	19 September 2017
CN	107053787	A	18 August 2017	None			