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(54) Title: METHOD FOR COATING THIN METAL SUBSTRATES USING PULSED OR COMBUSTION COATING PROCESSES

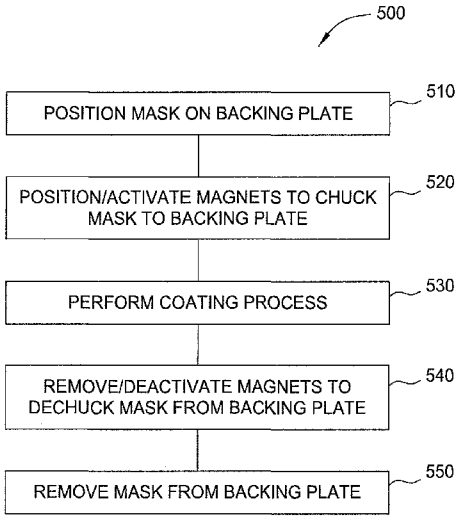


FIG. 5

(57) Abstract: Provided is a method for performing a coating process on a thin metal substrate. A mask apparatus comprising one or more thin metal sheet may be placed on a backing plate and the mask may be magnetically chucked to the backing plate. The magnetic chucking force may be configured to prevent distortion of the mask during a coating process, such as a detonation gun coating process. After the coating process has been performed, the mask may be dechucked from the backing plate.

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METHOD FOR COATING THIN METAL SUBSTRATES USING PULSED OR COMBUSTION COATING PROCESSES

BACKGROUND

Field

[0001] Embodiments of the present disclosure generally relate to methods of coating a workpiece. More specifically, embodiments described herein relate to methods for coating thin metal substrates with a pulsed or combustion coating process.

Description of the Related Art

[0002] Organic light emitting diodes (OLED) are used in the manufacture of television screens, computer monitors, mobile phones, etc. for displaying information. A typical OLED may include layers of organic material situated between two electrodes that are all deposited on a substrate in a manner to form a matrix display panel having individually energizable pixels. The OLED is generally placed between two glass panels, and the edges of the glass panels are sealed to encapsulate the OLED therein.

[0003] Deposition processes utilized in the manufacture of OLED devices generally employ various masks to pattern the substrates. The masks are generally suitable for patterning large area substrates and are often made of metallic materials. The masks also need to be cleaned occasionally or the masks may be exposed to corrosive environments in chambers used to manufacture the OLED devices. The cleaning processes and exposure to corrosive environments may reduce the effective lifetime of the masks which results in increased expense.

[0004] Coatings may be disposed on the masks to increase the lifetime of the mask. However, certain types of coating processes may damage the masks. For example, grid portions of the masks are generally very thin and may be

deformed during the coating processes which results in poor coating performance. In addition, the grid portions may be bent or broken as a result of the stresses exerted on the mask during the coating process.

[0005] Thus, there is a need for improved methods for coating masks and thin metal substrates.

SUMMARY

[0006] In one embodiment, a method of coating a mask is provided. The method includes positioning a mask having a surface area in contact with a surface of a non-magnetic backing plate and positioning one or more magnets adjacent a second surface of the non-magnetic backing plate opposite the first surface. A magnetically chucked surface area at the first surface is greater than the surface area of the mask. A coating process is performed and the one or more magnets adjacent the second surface are removed to dechuck the mask. The mask may then be removed from contact with the first surface of the non-magnetic backing plate.

[0007] In another embodiment, a method of coating a mask is provided. The method includes positioning a mask having a surface area in contact with a first surface of a non-magnetic backing plate and positioning one or more electromagnets adjacent a second surface of the non-magnetic backing plate opposite the first surface. The one or more electromagnets may be electromagnetically activated and an electromagnetically chucked surface area at the first surface is greater than the surface area of the mask. A coating process may be performed and the one or more electromagnets adjacent the second surface is deactivated to dechuck the mask. The mask may then be removed from contact with the first surface of the non-magnetic backing plate.

[0008] In yet another embodiment, a method of coating a mask is provided. The method includes positioning a ferromagnetic mask having a surface area on a first surface of a non-magnetic backing plate and positioning one or more permanent magnets adjacent a second surface of the non-magnetic backing plate opposite the first surface. A magnetically chucked surface area at the first surface is greater than the surface area of the ferromagnetic mask. A yttrium oxide detonation gun coating process may be performed and the one or more permanent magnets adjacent the second surface may be removed to dechuck the ferromagnetic mask. The ferromagnetic mask may then be removed from contact with the first surface of the non-magnetic backing plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only exemplary embodiments and are therefore not to be considered limiting of its scope, may admit to other equally effective embodiments.

[0010] Figure 1 illustrates a plan view of a mask.

[0011] Figure 2 illustrates a partial, schematic cross sectional view of a portion of the mask of Figure 1 disposed on a chucking apparatus according to one embodiment.

[0012] Figure 3 illustrates a partial, schematic cross sectional view of a portion of the mask disposed on a chucking apparatus according to another embodiment.

[0013] Figure 4 illustrates a partial, schematic cross sectional view of a portion of the mask disposed on a chucking apparatus according to another embodiment.

[0014] Figure 5 schematically illustrates operations of a method for performing a coating process.

[0015] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

[0016] Embodiments described herein relate to methods for performing a coating process on a thin metal substrate. A mask apparatus comprising one or more thin metal sheet may be placed on a backing plate and the mask is magnetically chucked to the backing plate. The magnetic chucking force is configured to prevent distortion of the mask during a coating process, such as a detonation gun coating process. After the coating process has been performed, the mask may be dechucked from the backing plate.

[0017] Figure 1 illustrates a plan view of a mask 100. The mask 100 may be configured for use in OLED processing chambers, however, it is contemplated that the mask may be configured for use in other types of thin film deposition processes. The mask 100 includes a body 102 which may be rectangular, or any other suitable shape. Grid portions 104 of the mask 100 extend from the body 102 and define openings 106 in the mask 100. The grid portions 104 may be arranged in any suitable pattern or design to facilitate patterned deposition on a substrate. The mask 100 is formed from a ferromagnetic material, such as a nickel-iron alloy, for example Invar. The mask 100 may have a surface area

which may be defined by a combination of the body 102 and the grid portions 104 or the grid portions 104 alone.

[0018] Figure 2 illustrates a partial, schematic cross sectional view of a portion of the mask 100 of Figure 1 disposed on a chucking apparatus 200. The chucking apparatus 200 includes a backing plate 202, one or more magnets 204, and an optional protective material layer 206. The backing plate 202 has a first surface 201 and a second surface 203. In one embodiment, the grid portions 104 of the mask 100 may be placed in contact with the first surface 201. In another embodiment, the protective material layer 206 may be placed in contact with the first surface 201 and the grid portions 104 of the mask 100 may be placed in contact with the protective material layer 206.

[0019] The one or more magnets 204 may be disposed in contact with or adjacent to the second surface 203 of the backing plate 202 to magnetically chuck the grid portions 104 to the backing plate 202. Suitable coupling apparatus (not shown) may be utilized to position the magnets 204 relative to the second surface 203. In one embodiment, a single magnet is disposed adjacent the second surface 203 such that a majority of the grid portion 104 can be magnetically coupled to the backing plate 202. In another embodiment, multiple magnets are disposed adjacent the second surface 203 such that a majority of the grid portion 104 can be magnetically coupled to the backing plate 202. It is contemplated that the magnetically chucked surface area generated by the presence of the magnets 204 relative to the backing plate 202 may be greater than the surface area of the grid portions 104 being chucked to the backing plate 202. Thus, substantially all of the grid portions 104 may be coupled to the backing plate 202 by the magnetic force of the magnets 204.

[0020] The backing plate 202 may be formed from any suitable non-magnetic material which can be manufactured to have a flat surface. In one example, glass or granite materials may be utilized. In another example, non-magnetic

steel or other metals may be utilized. The backing plate 202 may be a solid body such that the first surface 201 is suitable for supporting either the grid portions 104 of the mask 100 or the protective material layer 206, depending upon the desired embodiment.

[0021] In the illustrated embodiment, the magnets 204 are permanent magnets. In this embodiment, the magnets 204 may be placed, positioned, or otherwise affixed to or adjacent the second surface 203 to generate a magnetic chucking force near the first surface 201. The protective material layer 206 may optionally be removably disposed on the first surface 201. In one embodiment, the protective material layer 206 is a polymeric material, such as a polyimide sheet. In operation, the protective material layer 206 may be positioned on the first surface 201 and may be held in place during a deposition process by the magnetic force exerted on the grid portions 104 generated by the magnets 204. In another embodiment, the protective material layer 206 may be glued, laminated, or otherwise affixed to the first surface 201. The protective material layer 206 may protect the first surface 201 from material deposits and increase efficiency when cleaning the chucking apparatus 200. In embodiments not utilizing the protective material layer 206, the grid portions 104 are disposed in contact with the first surface 201.

[0022] A thickness 208 of the grid portions 104 of the mask 100 may be between about 30 um and about 1 mm. While the illustrated embodiments are discussed with regard to grid portions of a mask, it is contemplated that any thin metal sheet or thin metal substrate may benefit from the embodiments described herein. More specifically, masks, grid portions of a mask, and thin metal substrate may be coated according to the embodiments describe herein before or after assembly of the metal substrate into a final apparatus. A coating process 210 may be performed to deposit a material on the mask 100. The coating process may be a detonation gun or other similar deposition process. In certain

embodiments, the coating process may be a pul sed deposition process or a continuous deposition process. In one embodiment, a ceramic material, such as yttrium oxide, may be deposited on the mask 100. The ceramic material may have a thickness of between about 1 um and about 20 um, such as about 10 um.

[0023] A detonation gun process generally creates a pressure gradient above and below the substrate which is being processed due to a high velocity blast wave which carries the material to be deposited. For example, a high pressure region may exist above the substrate and a low pressure region may exist below the substrate. The pressure differential above and below the substrate may cause the substrate (*i.e.* the grid portions 104) to become distorted which may damage the substrate or result in poor coating uniformity. According the to the methods described herein, the low pressure region below the substrate may be reduced or eliminated by magnetic chucking to prevent distortion of the substrate during a d etonation gun or other similar coating process. Accordingly, it is believed that the magnetic chucking may generate a flatness uniformity across the portions of the mask 100 being coated having a variation of less than about 200 um.

[0024] Figure 3 illustrates a partial, schematic cross sectional view of a chucking apparatus 300 according to another embodiment. In this embodiment, one or more electromagnets 302 may be coupled to or disposed adjacent to the second surface 203 of the backing plate 202. The el ectromagnets 302 may be coupled to a pow er source 304 c onfigured to electromagnetically activate and deactivate the electromagnets 302.

[0025] Figure 4 illustrates a partial, schematic cross sectional view of a chucking apparatus 400 ac cording to another embodiment. O ne or more magnets 404 may be permanent magnets or electromagnets, such as described with reference to the above embodiments. A backing plate 402 may comprise a body having the first surface 201 and the second surface 203. The grid portions

104 may be disposed in contact with the first surface 201 or the optional protective material layer 206 may be disposed between the first surface 201 and the grid portions 104. The bac king plate 402 m ay also include one or more raised regions 406 which extend from the first surface 201. The raised regions 406 may be positioned to extend from the first surface 201 between adjacent grid portions 104. For example, the raised regions 406 may extend above the grid regions 104 through the openings 106 (*See* Figure 1).

[0026] The raised regions 406 may be any suitable shape configured to reduce or prevent distortion of the grid portions 104 during the deposition process 210. It is believed that the shape and position of the raised regions 406 may influence the pressure gradient near sidewalls 408 of the grid portions adjacent the first surface 201 (or the optional protective material layer 206) and reduce or prevent the generation of a pressure gradient below the grid portions 104 which may result in distortion of the grid portions 104. For example, the raised regions 406 may direct fluids and deposition materials away from the sidewalls 408 to reduce or prevent the probability of generating a low pressure region below the grid portions 104. Accordingly, the range of velocities of the blast wave generated during a detonation gun coating process may be increased which may result in greater flexibility and improved process results when coating the mask 100.

[0027] Figure 5 s chematically illustrates operations of a method 500 f or performing a coating process. At operation 510, a mask may be positioned on a backing plate. The backing plate may be part of a larger magnetic chucking apparatus configured to chuck the mask during a deposition process. In one embodiment, the mask may be positioned on a first surface of the backing plate. At operation 520, magnets may be positioned or activated to chuck the mask to the backing plate. In one embodiment, permanent magnets may be positioned adjacent to a s econd surface of the backing plate oriented opposite the first

surface to generate a magnetic force at the first surface. In another embodiment, electromagnets positioned adjacent the second surface may be electromagnetically activated to generate a magnetic force at the first surface.

[0028] At operation 530, a coating process may be performed. The coating process may be any suitable deposition process, such as a detonation gun coating process. In one embodiment, yttrium oxide is deposited on the mask via the detonation gun coating process. At operation 540, the magnets may be removed or deactivated to dechuck the mask from the backing plate. In an embodiment utilizing permanent magnets, the magnets may be removed from a position adjacent the second surface of the backing plate such that little or no magnetic force is generated at the first surface of the backing plate. In an embodiment utilizing electromagnets, the power supplied to the electromagnets may be terminated such that little or no magnetic force is generated at the first surface. At operation 550, the mask may be removed from the backing plate.

[0029] It is believed that the embodiments described herein may provide for improved methods of coating thin metal substrates. More specifically, mask apparatus having thin grid portions may be more efficiently and effectively coated by detonation gun processes. By preventing distortion of the thin metal grid portions as a result of magnetic chucking, detonation gun processes may be utilized with improved deposition characteristics and reduced probabilities of mask damage.

[0030] While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

What is claimed is:

1. A method of coating a mask, comprising:

positioning a mask having a surface area in contact with a first surface of a non-magnetic backing plate;

positioning one or more magnets adjacent a second surface of the non-magnetic backing plate opposite the first surface to form a magnetically chucked surface area at the first surface, wherein the magnetically chucked surface area at the first surface is greater than the surface area of the mask in contact with the first surface;

performing a coating process;

removing the one or more magnets adjacent the second surface to de-chuck the at least a portion of the mask; and

removing the mask from contact with the first surface of the non-magnetic backing plate.

2. The method of claim 1, wherein the non-magnetic backing plate comprises a protective material layer disposed on the first surface of the non-magnetic backing plate.

3. The method of claim 2, wherein the protective material layer is removably disposed on the first surface of the non-magnetic backing plate.

4. The method of claim 2, wherein the protective material layer comprises a polymeric material.

5. The method of claim 1, wherein the one or more magnets are permanent magnets.

6. The method of claim 1, wherein the mask comprises a ferromagnetic material.

7. The method of claim 1, wherein the coating process is a detonation gun coating process.

8. The method of claim 7, wherein the detonation gun coating process deposits a yttrium oxide material on the mask.

9. The method of claim 8, wherein the yttrium oxide material is deposited to a thickness of between about 1 um and about 20 um.

10. The method of claim 1, wherein the mask in contact with the first surface of the non-magnetic backing plate has a thickness of between about 30 um and about 1 mm.

11. The method of claim 1, wherein a flatness uniformity of the mask when magnetically chucked to the backing plate has a variation of less than about 200 um.

12. The method of claim 1, wherein a chucking force of the magnetically chucked surface area is configured to prevent distortion of the mask during the coating process.

13. A method of coating a mask, comprising:

positioning a mask having a surface area in contact with a first surface of a non-magnetic backing plate;

positioning one or more electromagnets adjacent a second surface of the non-magnetic backing plate opposite the first surface;

electromagnetically activating the one or more electromagnets, wherein an electromagnetically chucked surface area at the first surface is greater than the surface area of the mask in contact with the first surface;

performing a coating process;

deactivating the one or more electromagnets adjacent the second surface to de-chuck the mask; and

removing the mask from contact with the first surface of the non-magnetic backing plate.

14. The method of claim 13, wherein the non-magnetic backing plate comprises a polymeric protective material layer removably disposed on the first surface of the non-magnetic backing plate.

15. The method of claim 13, wherein the mask comprises a ferromagnetic material.

16. The method of claim 13, wherein the coating process is a detonation gun coating process configured to deposit a yttrium oxide material on the mask.

17. The method of claim 16, wherein the yttrium oxide material is deposited to a thickness of between about 1 um and about 20 um.

18. A method of coating a mask, comprising:

positioning a ferromagnetic mask having a surface area on a first surface of a non-magnetic backing plate;

positioning one or more permanent magnets adjacent a second surface of the non-magnetic backing plate opposite the first surface, wherein a magnetically chucked surface area at the first surface is greater than the surface area of the ferromagnetic mask in contact with the first surface;

performing a yttrium oxide detonation gun coating process;

removing the one or more permanent magnets adjacent the second surface to de-chuck the ferromagnetic mask; and

removing the ferromagnetic mask from contact with the first surface of the non-magnetic backing plate.

19. The method of claim 18, wherein the non-magnetic backing plate comprises a glass material or a substantially non-magnetic steel material.

20. The method of claim 18, further comprising:

positioning a removable polymeric material layer in contact with the first surface of the non-magnetic backing plate such that the ferromagnetic mask is disposed in contact with the polymeric material layer.

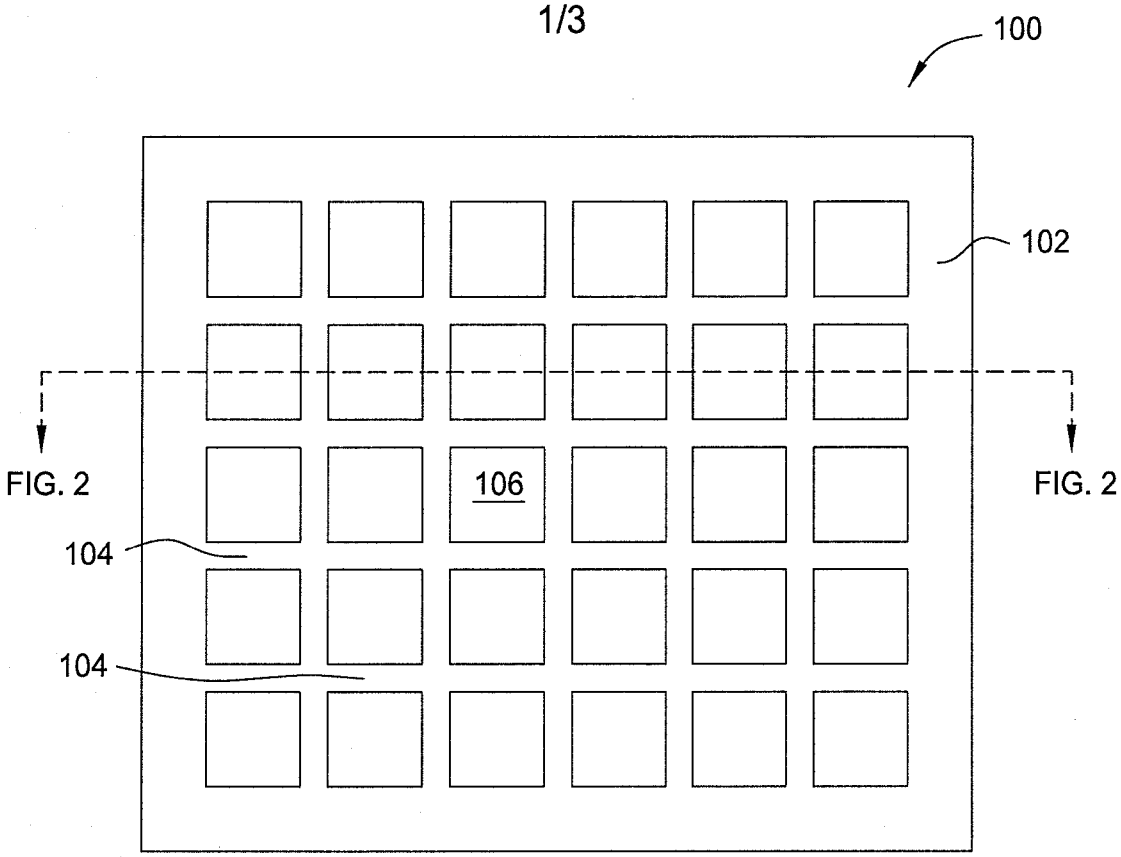

100
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FIG. 2
106
FIG. 2
104
104

FIG. 1

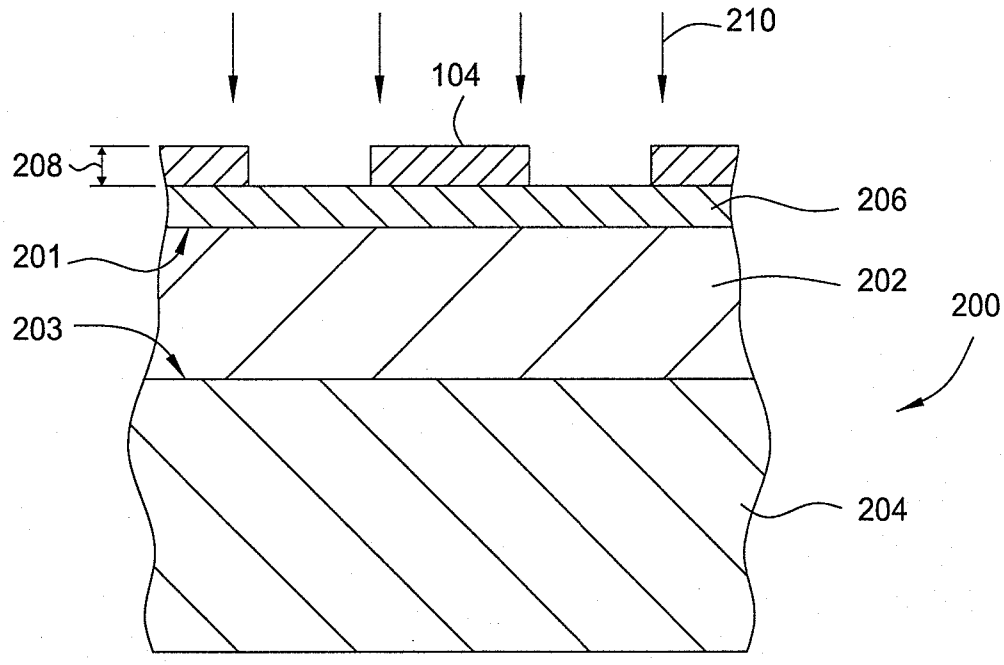

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FIG. 2

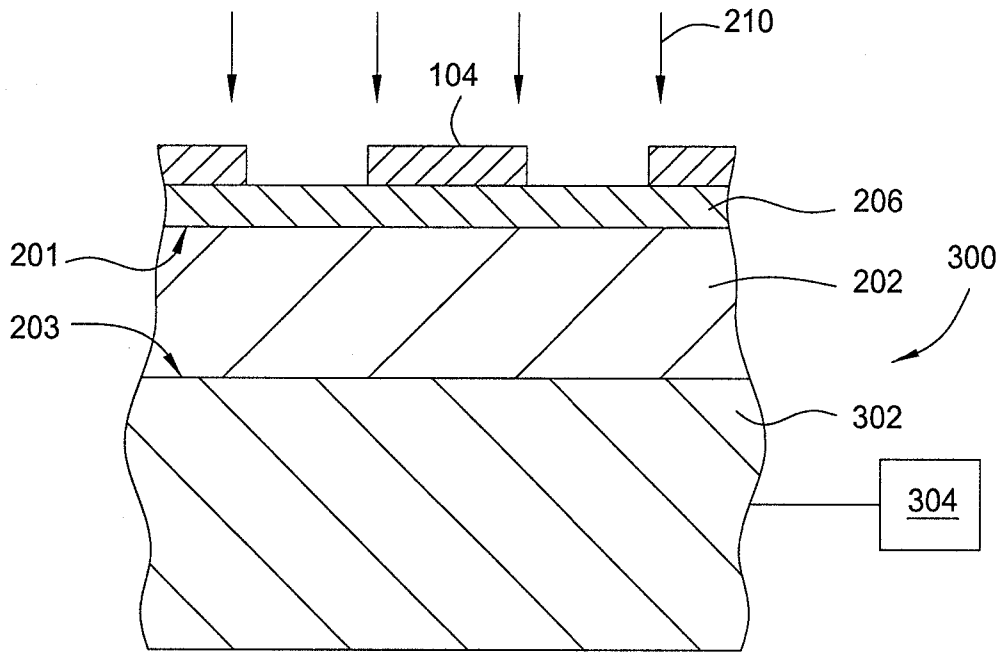

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FIG. 3

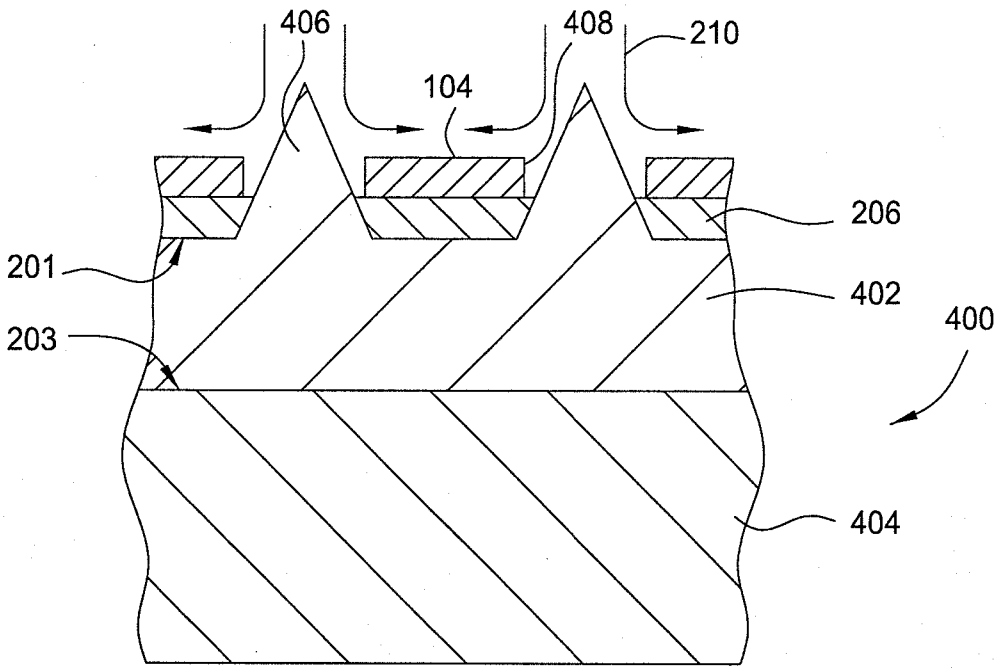

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FIG. 4

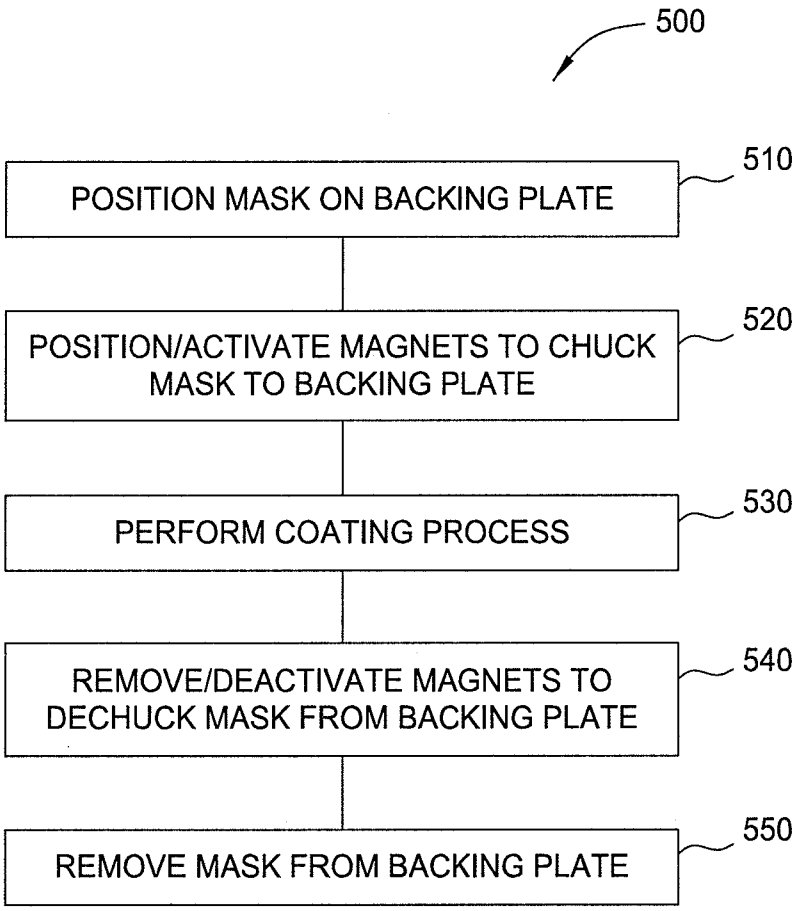

500
POSITION MASK ON BACKING PLATE
510
POSITION/ACTIVATE MAGNETS TO CHUCK MASK TO BACKING PLATE
520
PERFORM COATING PROCESS
530
REMOVE/DEACTIVATE MAGNETS TO DECHUCK MASK FROM BACKING PLATE
540
REMOVE MASK FROM BACKING PLATE
550

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

B05C 13/00(2006.01)i; B05C 13/02(2006.01)i; B05D 1/02(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)

B05C; B05D

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)

DWPI,CNABS: magnet,magnetic, magnetism, ferromagnet, electromagnet, fasten, hold, chuck, mask, yttrium oxide, detonation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1861833 A (APPLIED FILMS GMBH & CO KG) 15 November 2006 (2006-11-15) see claims 1, 2, 4, 7 and 10	1-20
X	CN 1854909 A (APPLIED FILMS GMBH & CO KG) 01 November 2006 (2006-11-01) see claims 1-20	1-20
A	US 2010080891 A1 (CANON ANELVA CORP) 01 April 2010 (2010-04-01) the whole document	1-20
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A	US 2013174780 A1 (YOU SUK-BEOM ET AL.) 11 July 2013 (2013-07-11) the whole document	1-20

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

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Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2015	**28 September 2015**

Name and mailing address of the ISA/CN	Authorized officer
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Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62084940**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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				KR	100755352	B1	04 September 2007
				CN	1824826	A	30 August 2006
				JP	2006233286	A	07 September 2006
				TW	200637051	A	16 October 2006
US	2013174780	A1	11 July 2013	KR	20130081528	A	17 July 2013