



(51) International Patent Classification:
C23C 14/34 (2006.01)

(21) International Application Number:

PCT/US2016/037776

(22) International Filing Date:

16 June 2016 (16.06.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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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, DK, DM, DO, DZ,
EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR,
HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, 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.

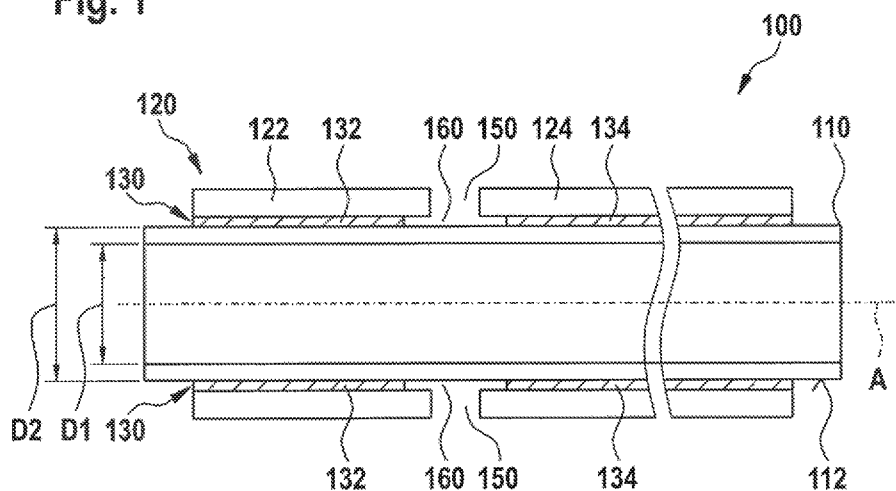
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, 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: APPARATUS FOR MATERIAL DEPOSITION ON A SUBSTRATE IN A VACUUM DEPOSITION PROCESS, SYSTEM FOR SPUTTER DEPOSITION ON A SUBSTRATE, AND METHOD FOR MANUFACTURE OF AN APPARATUS FOR MATERIAL DEPOSITION ON A SUBSTRATE

Fig. 1



(57) Abstract: The present disclosure provides an apparatus for material deposition on a substrate in a vacuum deposition process. The apparatus includes a target support, two or more target segments supported by the target support, wherein a first gap is provided between adjacent target segments of the two or more target segments, and two or more bonding layer portions, each bonding layer portion of the two or more bonding layer portions bonding a respective target segment of the two or more target segments to the target support, wherein bonding layer portions of adjacent target segments are separated from each other by a second gap larger than the first gap.



**APPARATUS FOR MATERIAL DEPOSITION ON A SUBSTRATE IN A
VACUUM DEPOSITION PROCESS, SYSTEM FOR SPUTTER DEPOSITION ON
A SUBSTRATE, AND METHOD FOR MANUFACTURE OF AN APPARATUS
FOR MATERIAL DEPOSITION ON A SUBSTRATE**

FIELD

[0001] Embodiments of the present disclosure relate to an apparatus for material deposition on a substrate in a vacuum deposition process, a system for sputter deposition on a substrate, and a method for manufacture of an apparatus for material deposition on a substrate in a vacuum deposition process. Embodiments of the present disclosure particularly relate to sputter sources, such as sputter cathodes or rotatable sputter cathodes.

BACKGROUND

[0002] Techniques for layer deposition on a substrate include, for example, sputter deposition, thermal evaporation, and chemical vapor deposition (CVD). A sputter deposition process can be used to deposit a material layer on the substrate, such as a layer of a conducting or an insulating material. During the sputter deposition process, a target having a target material to be deposited on the substrate is bombarded with ions generated in a plasma region to dislodge atoms of the target material from a surface of the target. The dislodged atoms can form the material layer on the substrate. In a reactive sputter deposition process, the dislodged atoms can react with a gas in the plasma region, for example, nitrogen or oxygen, to form an oxide, a nitride or an oxinitride of the target material on the substrate.

[0003] Coated substrates can be used, for example, in semiconductor devices and thin film batteries. As an example, substrates for displays can be coated using sputter deposition. Further applications include insulating panels, organic light emitting diode (OLED) panels, substrates with TFT, color filters or the like. Moreover, thin film batteries, such as lithium-ion batteries, are used in a growing number of applications, such as cell phones, notebooks and implantable medical devices.

[0004] For material deposition e.g. on large area substrates, large targets are beneficial. However, it can be challenging to make targets, such as ceramic targets, Indium Tin Oxide (ITO) targets, and Indium Gallium Zinc Oxide (IGZO) targets larger in size. As an example, the target can be provided with a segmented design, i.e. several segments of the target material can be fixed on a target support, for example, using a bonding material. However, at an interface or joint between neighboring segments, particles can be generated, leading to a reduction in quality of the material layer deposited on the substrate. Further, the bonding material can leak from the interface or joint between neighboring segments, e.g., when temperature changes occur, leading to the occurrence of arcing.

[0005] In view of the above, new apparatuses for material deposition on a substrate in a vacuum deposition process, systems for sputter deposition on a substrate, and methods for manufacture of an apparatus for material deposition on a substrate that overcome at least some of the problems in the art are beneficial. The present disclosure particularly aims at providing apparatuses, systems and methods that can avoid the occurrence of arcing and/or particle generation, e.g., at interfaces between neighboring target segments.

SUMMARY

[0006] In light of the above, an apparatus for material deposition on a substrate in a vacuum deposition process, a system for sputter deposition on a substrate, and a method for manufacture of an apparatus for material deposition on a substrate are provided. Further aspects, benefits, and features of the present disclosure are apparent from the claims, the description, and the accompanying drawings.

[0007] According to an aspect of the present disclosure, an apparatus for material deposition on a substrate in a vacuum deposition process is provided. The apparatus includes a target support, two or more target segments supported by the target support, wherein a first gap is provided between adjacent target segments of the two or more target segments, and two or more bonding layer portions, each bonding layer portion of the two or more bonding layer portions bonding a respective target segment of the two or more target segments to the target support, wherein bonding layer portions of adjacent target segments are separated from each other by a second gap larger than the first gap.

[0008] According to another aspect of the present disclosure, a system for sputter deposition on a substrate is provided. The system includes a vacuum chamber, and one or more sputter deposition sources in the vacuum chamber, wherein at least one sputter deposition source of the one or more sputter deposition sources includes the apparatus for material deposition on a substrate in a vacuum deposition process according to the embodiments described herein.

[0009] According to a further aspect of the present disclosure, a method for manufacture of an apparatus for material deposition on a substrate is provided. The method includes bonding two or more target segments to a target support with a first gap between adjacent target segments using a respective bonding layer portion for each of the two or more target segments, wherein bonding layer portions of adjacent target segments are separated from each other by a second gap larger than the first gap.

[0010] Embodiments are also directed at apparatuses for carrying out the disclosed methods and include apparatus parts for performing each described method aspect. These method aspects may be performed by way of hardware components, a computer programmed by appropriate software, by any combination of the two or in any other manner. Furthermore, embodiments according to the disclosure are also directed at methods for operating the described apparatus. The methods for operating the described apparatus include method aspects for carrying out every function of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] 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. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

FIG. 1 shows a schematic cross-sectional view of an apparatus for material deposition on a substrate in a vacuum deposition process according to embodiments described herein;

- FIG. 2 shows a section of the apparatus of FIG. 1;
- FIGs. 3A and B show an effect of temperature changes on a bonding material layer;
- FIG. 4 shows a schematic view of a system for sputter deposition on a substrate according to embodiments described herein;
- FIG. 5 shows a flow chart of a method for manufacture of an apparatus for material deposition on a substrate according to embodiments described herein;
- FIG. 6A shows a schematic view of a filling device used in the manufacture of an apparatus for material deposition on a substrate in a vacuum deposition process according to embodiments described herein; and
- FIG. 6B shows a schematic view of a section of the apparatus of FIG. 6A with the filling device having been removed.

DETAILED DESCRIPTION OF EMBODIMENTS

[0012] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same components. Generally, only the differences with respect to individual embodiments are described. Each example is provided by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Further, features illustrated or described as part of one embodiment can be used on or in conjunction with other embodiments to yield yet a further embodiment. It is intended that the description includes such modifications and variations.

[0013] Targets can be provided with a segmented design in which several target segments of the target material are secured to a target support using a bonding material,

wherein a gap can be provided between adjacent target segments. However, particles can be generated at the gap that can reduce a quality of the deposition process. Further, the bonding material can appear at, or even come out from, the gap, leading to the occurrence of arcing.

[0014] The present disclosure provides spatially separated bonding layer portions of the bonding material, wherein each bonding layer portion is used to fix a respective target segment to a target support. The (second) gap by which adjacent bonding layer portions are spaced apart from each other, is larger than the (first) gap between adjacent target segments. In particular, the gap between the adjacent bonding layer portions can provide an undercut region or empty space between the target support and a portion of the respective target segment. Accordingly, even if there are temperature changes and a thermal expansion and contraction e.g. of the target support and/or the target segments, the bonding material does not come out of the gap between the adjacent target segments, which may for example prevent arcing. Further, the joint or interface between adjacent target segments can be provided substantially free of bonding material, which may for example reduce or even avoid particle generation.

[0015] FIG. 1 shows a schematic cross-sectional view of an apparatus 100 for material deposition on a substrate in a vacuum deposition process according to embodiments described herein. FIG. 2 shows a section of the apparatus 100 of FIG. 1.

[0016] The apparatus 100 includes a target support 110, two or more target segments 120 supported by the target support 110, and two or more bonding layer portions 130. Each bonding layer portion of the two or more bonding layer portions 130 bonds or secures a respective target segment of the two or more target segments 120 to the target support 110. A first gap 150 is provided between adjacent target segments of the two or more target segments 120. Bonding layer portions of adjacent target segments are separated from each other by a second gap 160 larger than the first gap 150.

[0017] According to some embodiments, which can be combined with other embodiments described herein, the apparatus 100 is a sputter cathode, such as a cylindrical sputter cathode or a planar sputter cathode. The following description is given with respect to a cylindrical design. However, the present disclosure is not limited thereto and the

embodiments of the present disclosure can be similarly implemented for a planar design. The sputter cathode includes the two or more target segments 120 as well as the target support 110, and can further include a magnet assembly for magnetron sputtering.

[0018] The target support 110 can be a cylindrical target support having an inner diameter D1 and an outer diameter D2. Likewise, the two or more target segments 120 can be cylindrical target segments having an inner diameter and an outer diameter. The inner diameter of the two or more target segments 120 can be larger than the outer diameter D2 of the target support 110. The diameter difference can correspond to a thickness of the two or more bonding layer portions 130. In some implementations, the target support 110 can be a backing tube, such as a cylindrical backing tube. The term “cylinder” can be understood as having a circular bottom shape and a circular upper shape and a curved surface area or shell connecting the upper circle and the little lower circle. The target support 110 can be made of a ceramic material.

[0019] The cylindrical target support can have an inner space defined by the inner diameter D1. In some implementations, the apparatus 100 can include a magnet assembly in the inner space for magnetron sputtering. The target support 110 can have a support surface 112, which can be an outer surface of the target support 110 e.g. defined by the outer diameter D2. The support surface 112 can be configured to support the two or more target segments 120 with the two or more bonding layer portions 130 being provided between the support surface 112 and the two or more target segments 120. According to some embodiments, the apparatus 100 can include cooling channels for cooling the magnet assembly inside the backing tube and/or for cooling the backing tube.

[0020] According to some embodiments, which can be combined with other embodiments described herein, the apparatus 100 can be rotatable around a rotational axis A, which can be a cylinder axis of the cylindrical target support. The rotatable apparatus can also be referred to as “rotatable sputter source” or “rotatable cathode”. Particularly during a deposition process, the rotational axis A can be substantially vertically oriented. “Substantially vertically” is understood particularly when referring to the axis orientation, to allow for a deviation from the vertical direction of 20° or below, e.g. of 10° or below.

[0021] The apparatus 100 has two or more target segments 120, such as a first target segment 122 and a second target segment 124. The two or more target segments 120 can also be referred to as “tiles” or “target tiles”. The two or more target segments 120 can be provided in the axial direction of the target support 110 adjacent to each other to form the (complete) target. The axial direction can be a direction parallel to the rotational axis A and/or a direction parallel to a longitudinal extension of the target support 110. The two or more target segments 120 can be configured to rotate around the rotational axis A during the sputtering process. In some implementations, the two or more target segments 120 can be four to eight or even more target segments. As an example, the apparatus 100 can have six target segments. The number of target segments can depend on the length in an axial direction of the target segments and/or target support 110 and the length of the complete target.

[0022] A length of the (complete) target constituted by the two or more target segments 120 can be in a range of between about 2 m and about 4 m, and can specifically be about 2.7 m. A length of the target support 110 can be larger than the length of the target. As an example, the length of the target support 110 can be about 3 m. A length of at least one, and specifically of all individual target segments of the two or more target segments 120 can be 300 mm or above, and can specifically be from 200 mm to 1500 mm, specifically from 400 to 135 mm, and more specifically from 400 mm to 600 mm. The target can be made of a material selected from the group consisting of a ceramic material, Indium Tin Oxide (ITO), Indium Gallium Zinc Oxide (IGZO), and any combination thereof.

[0023] The two or more target segments 120 are bonded to the target support 110, e.g., the support surface 112, by the two or more bonding layer portions 130. The two or more bonding layer portions 130 are provided between the two or more target segments 120 and the target support 110 to bond or fix the two or more target segments 120 to the target support 110. Each target segment of the two or more target segments 120 is bonded to the target support 110 using a respective one of the two or more bonding layer portions 130. As an example, the first target segment 122 is bonded to the target support 110 using a first bonding layer portion 132 and the second target segment 124 is bonded to the target support 110 using a second bonding layer portion 134.

[0024] According to some embodiments, a material of the two or more bonding layer portions 130 can be indium. The material of the two or more bonding layer portions 130 can also be referred to as “bonding material”. The two or more bonding layer portions 130 can have a thickness in a range of between 0.1 and 2 mm, specifically in a range of between 0.1 and 2 mm, specifically in a range of between 0.1 and 1.5 mm, and more specifically in a range of between 0.5 and 1.5 mm.

[0025] Two adjacent target segments of the two or more target segments 120 are separated from each other by the first gap 150. Two adjacent bonding layer portions of the two or more bonding layer portions 130 are separated from each other by the second gap 160 that is larger than the first gap 150. In other words, the first gap 150 is smaller than the second gap 160. As an example, the first target segment 122 and the second target segment 124 are separated from each other by the first gap 150 and the first bonding layer portion 132 and the second bonding layer portion 134 are separated from each other by the second gap 160. The dimensions of the first gap 150 and the second gap 160 can be defined at a reference temperature. The reference temperature can be approximately room temperature (e.g., 20°C) and/or the temperature of the apparatus 100 when no sputtering is conducted, i.e., when sputtering is off. It is to be understood that e.g. during sputtering the dimensions of the first gap 150 and the second gap 160 can change due to thermal expansion of at least one of the target support 110, the two or more target segments 120, and/or the two or more bonding layer portions 130. As an example, the two or more target segments 120 may equally expand to the left and the right. In some cases, an expansion of the target support 110 and an expansion of the two or more target segments 120 may be different. As an example, a temperature of the target support 110 and a temperature of the two or more target segments 120 may be different. Specifically, the target support 110 may be water cooled and a temperature rise during sputtering can be small. The two or more target segments 120 face the sputter plasma and a temperature rise during sputtering can be large.

[0026] In some implementations, the target support 110 has a longitudinal extension, e.g., along the rotational axis A. The first gap 150 and the second gap 160 can extend along the rotational axis A of the target support 110. A second extension G2 of the second gap 160 along the longitudinal extension of the target support 110 is larger than a first extension G1 of the first gap 150 along the longitudinal extension of the target support 110.

As an example, a length of the individual target segments along the longitudinal extension, e.g., the rotational axis A, can be larger than a length of the individual bonding layer portions along the longitudinal extension, e.g., the rotational axis A.

[0027] According to some embodiments, which can be combined with other embodiments described herein, the first gap 150 can have a size, such as the first extension G1, along the rotational axis A, in a range of between 0.1 mm and 3 mm, and specifically in a range of between 0.5 mm and 1.5 mm. In some implementations, the second gap 160 is at least 5%, specifically at least 10%, specifically at least 50%, and more specifically at least 100% larger than the first gap 150. As an example, when the first gap 150 is 1 mm, the second gap 160 can be 2 mm.

[0028] The second gap 160 provides an undercut region or non-filled space between the target support 110, e.g., the backing tube, and a portion of a respective target segment. Even if there are temperature changes and a thermal expansion/contraction of the target support 110 and/or the target segments occurs, the bonding material does not appear at, or even come out from, the first gap 150. Arcing can be prevented. Further, the joint or interface between adjacent target segments can be provided substantially free of bonding material, thus reducing or even avoiding particle generation.

[0029] In some implementations, the first gap 150 can be aligned or centered with respect to the second gap 160, or vice versa. No bonding material is present at the first gap 150. Specifically, the first gap 150 and the second gap 160 can be aligned or centered with respect to a plane perpendicular to the longitudinal extension, e.g., the rotational axis A, of the target support 110. The plane can be a center plane of the first gap 150 and the second gap 160. The first gap 150 and the second gap 160 can be substantially symmetrical with respect to the plane.

[0030] According to some embodiments, a combination of the first gap 150 and the second gap 160 forms a T-shape or an inverse T-shape in a cross-sectional plane of the target support 110. The cross-sectional plane can be a plane substantially parallel to the longitudinal extension of the target support 110, such as the rotational axis A. The rotational axis A can lie in the cross-sectional plane.

[0031] The term “gap” as used throughout the present disclosure can be understood in the sense that there is no filling material, such as bonding material or protective material, or any other element of the apparatus present within the gap. Specifically, no material such as bonding material or filling material is provided in the second gap 160. In other words, the first gap 150 and the second gap 160 can be empty spaces. However, it is to be understood that, although no material or other elements of the apparatus are present within the gaps, gases such as process gases can be present within the gaps during a sputtering process. Still, the gaps are considered to be un-filled or empty.

[0032] According to different embodiments, which can be combined with other embodiments described herein, the target material can be selected from the group consisting of: a ceramic, a metal, ITO, IZO, IGZO, AZO, SnO, AlSnO, InGaSnO, titanium, aluminum, copper, molybdenum, and combinations thereof. The target material is provided either by the material to be deposited on a substrate or by the material which is supposed to react with a reactive gas in the processing area to then be deposited on the substrate after reacting with the reactive gas.

[0033] FIGs. 3A and B show an effect of temperature changes on a bonding material layer for illustration of the effects and benefits that can be achieved using the embodiments of the present disclosure.

[0034] In sputter deposition processes, nodule creation can be reduced by elevating a target temperature during sputtering. In order to increase the target temperature, a target rotation speed may be decreased and/or a water flow e.g. of cooling water flowing through the backing tube can be decreased. Due to temperature changes of the target temperature, for instance when a new target is transferred into a sputtering chamber and sputtering is off such that the target temperature goes down quickly, the target gap (first gap) can expand and contract. Particularly when the bonding layer is provided as one continuous layer 330, bonding material can plastically come out from the target gap, as indicated with reference numeral 332 in FIG. 3B, leading to arcing and/or particle generation.

[0035] In order to prevent bonding material from coming out from the target gap, the bonding material can be recessed. In particular, the present disclosure provides the second gap that is larger than the first gap (target gap). Even when the target temperature changes,

no bonding material reaches the first gap, and arcing and/or particle generation can be reduced or even avoided.

[0036] FIG. 4 shows a schematic view of a system 400 for sputter deposition on a substrate 10 according to embodiments described herein. The system 400 can be configured for sputter deposition on the substrate 10.

[0037] According to some embodiments described herein, the system 400 includes a vacuum chamber 402 (also referred to as “vacuum deposition chamber”, “deposition chamber” or “vacuum processing chamber”), and one or more sputter deposition sources in the vacuum chamber, wherein at least one sputter deposition source of the one or more sputter deposition sources includes the apparatus for material deposition on a substrate in a vacuum deposition process according to the embodiments described herein.

[0038] As an example, the one or more sputter deposition sources can include a first sputter deposition source 480a and a second sputter deposition source 480b in the vacuum chamber 402. A substrate carrier 20 for supporting at least one substrate during a sputter deposition process can be transported into and through the vacuum chamber 402, and in particular through a deposition area. The first sputter deposition source 480a and the second sputter deposition source 480b can, for example, be rotatable cathodes having the two or more target segments according to the embodiments described herein.

[0039] As indicated in FIG. 4, further chambers can be provided adjacent to the vacuum chamber 402. The vacuum chamber 402 can be separated from adjacent chambers by a valve having a valve housing 404 and a valve unit 406. After the substrate carrier 20, with the at least one substrate thereon is inserted into the vacuum chamber 402 as indicated by the arrow, the valve unit 406 can be closed. The atmosphere in the vacuum chamber 402 can be individually controlled by generating a technical vacuum, for example with vacuum pumps connected to the vacuum chamber 402, and/or by inserting process gases in the deposition area in the vacuum chamber 402. According to some embodiments, process gases can include inert gases such as argon and/or reactive gases such as oxygen, nitrogen, hydrogen and ammonia (NH₃), Ozone (O₃), activated gases or the like.

[0040] According to some embodiments described herein, the system 400 can have an AC power supply 480 connected to the one or more sputter deposition sources. As an example, the first sputter deposition source 480a and the second sputter deposition source 480b can be connected to the AC power supply 480 such that the first sputter deposition source 480a and the second sputter deposition source 480b can be biased in an alternating manner. The one or more sputter deposition sources can be connected to the same AC power supply. In other embodiments, each sputter deposition source can have an AC power supply, respectively. In further embodiments, the system 400 can have one or more anodes and one or more DC power supplies for DC sputtering.

[0041] According to embodiments described herein, the sputter deposition process can be conducted as magnetron sputtering. As used herein, “magnetron sputtering” refers to sputtering performed using a magnet assembly, e.g., a unit capable of generating a magnetic field. Such a magnet assembly can consist of a permanent magnet. This permanent magnet can be arranged within a rotatable target or coupled to a planar target in a manner such that the free electrons are trapped within the generated magnetic field generated below the rotatable target surface. Such a magnet assembly can also be arranged coupled to a planar cathode.

[0042] The apparatuses and systems described herein can be used for vertical substrate processing. According to some implementations, the substrate carrier 20 is configured for holding the substrate 10 in a substantially vertical orientation. The term “vertical substrate processing” is understood to distinguish over “horizontal substrate processing”. For instance, vertical substrate processing relates to a substantially vertical orientation of the substrate carrier 20 and the substrate 10 during substrate processing, wherein a deviation of a few degrees, e.g. up to 10° or even up to 15°, from an exact vertical orientation is still considered as vertical substrate processing. The vertical direction can be substantially parallel to the force of gravity. As an example, the system 400 can be configured for layer deposition on a substantially vertically oriented substrate.

[0043] According to some embodiments, the substrate carrier 20 and the substrate 10 are static or dynamic during sputtering of the deposition material. According to some embodiments described herein, a dynamic sputter deposition process can be provided, e.g., for display manufacturing.

[0044] The embodiments described herein can be utilized for sputter deposition on large area substrates, e.g., for lithium battery manufacturing, electrochromic windows and/or display manufacturing. According to some embodiments, a large area substrate can be GEN 4.5, which corresponds to about 0.67 m² substrates (0.73x0.92m), GEN 5, which corresponds to about 1.4 m² substrates (1.1 m x 1.3 m), GEN 7.5, which corresponds to about 4.29 m² substrates (1.95 m x 2.2 m), GEN 8.5, which corresponds to about 5.7m² substrates (2.2 m x 2.5 m), or even GEN 10, which corresponds to about 8.7 m² substrates (2.85 m x 3.05 m). Even larger generations such as GEN 11 and GEN 12 and corresponding substrate areas can similarly be implemented.

[0045] The term "substrate" as used herein shall embrace inflexible substrates, e.g., plates, and flexible substrates such as a web or a foil. As an example, the substrate can have a thickness of less than 1 mm, specifically less than 0.1 mm, and more specifically less than 50 μ m. According to some embodiments, the substrate can be made from any material suitable for material deposition. For instance, the substrate can be made from a material selected from the group consisting of glass (for instance soda-lime glass, borosilicate glass etc.), metal, polymer, ceramic, compound materials, carbon fiber materials, mica or any other material or combination of materials which can be coated by a deposition process.

[0046] FIGs. 5, 6A and 6B illustrate a manufacturing process of the apparatus according to the embodiments described herein. In particular, FIG. 5 shows a flow chart of a method 500 for manufacture of the apparatus for material deposition on a substrate in a vacuum deposition process according to embodiments described herein.

[0047] The method 500 includes bonding the two or more target segments to the target support 110 with the first gap 150 between adjacent target segments using a respective bonding layer portion for each of the two or more target segments (block 510). Bonding layer portions of adjacent target segments are separated from each other by the second gap 160 larger than the first gap 150. As an example, the first target segment 122 is bonded to the target support 110 by the first bonding layer portion 132 and the second target segment 124 is bonded to the target support 110 by the second bonding layer portion 134.

[0048] In some implementations, a target segment or a plurality of target segments are positioned with respect to the target support 110 such that a clearance or space is provided between the support surface of the target support 110 and the target segment(s). The clearance or space can correspond to a layer thickness of the bonding layer portions, and can be about 1 mm. Bonding material, such as indium, can be poured into the clearance e.g. via the first gap 150 to bond the target segment(s) to the target support 110. As an example, the manufacturing process can take place in an oven. In particular, a temperature within the oven can be above a melting point of the bonding material, e.g. 156°C for indium, and liquid bonding material can be filled into the space between the target segment(s) and the target support 110. A temperature can then be decreased to cure or solidify the bonding material for securing the target segment(s) to the target support 110.

[0049] In some implementations, the two or more target segments are sequentially, i.e., segment by segment, bonded to the target support 110. As an example, the first target segment 122 can be positioned with respect to the target support 110 and the clearance between the first target segment 122 and the target support 110 can be filled with bonding material. Thereafter, the second target segment 124 can be positioned with respect to the target support 110 and the first target segment 122 such that the first gap 150 is provided between the first target segment 122 and the second target segment 124. As an example, a spacer can be provided between the first target segment 122 and the second target segment 124 to define the first gap 150. The clearance between the second target segment 124 and the target support 110 can then be filled with the bonding material. In this way, the apparatus can be manufactured by successively bonding the two or more target segments to the target support 110.

[0050] In further implementations, the two or more target segments are simultaneously bonded to the target support 110. As an example, the two or more target segments, such as the first target segment 122 and the second target segment 124, can be positioned with respect to the target support 110 and with respect to each other. The clearance between the two or more target segments and the target support 110 can then be filled with bonding material, e.g., via the first gap(s) between the adjacent target segments.

[0051] According to some embodiments, the bonding of the two or more target segments includes a bonding of the two or more target segments to the target support 110 with the

first gap 150 being provided between adjacent target segments using the bonding material between the two or more target segments and the target support 110 (block 510), and a removing of some of the bonding material through the first gap 150 to form the second gap 160. In some implementations, the removing of the bonding material can employ etching. As an example, an etching solution can be poured into the first gap 150 to create the second gap 160. The etching can also remove residual bonding material from the first gap 150, and particularly from side walls of the target segments that define the respective first gap 150. In some implementations, the etching solution can be nitric acid. In particular, the nitric acid can etch indium and does substantially not etch e.g. the ITO of the target.

[0052] According to some embodiments, as explained with respect to FIGs. 6A and B, the second gap 160 and optionally the first gap 150 between adjacent target segments can be created by providing a filling device 600 corresponding to the shape of the second gap 160 and optionally the first gap 150. FIG. 6A shows a schematic view of the filling device 600 used in the manufacture of the apparatus. FIG. 6B shows a schematic view of a section of the apparatus of FIG. 6A with the filling device 600 having been removed after the bonding process.

[0053] As an example, the method includes providing the filling device 600 for the first gap 150 and the second gap 160 during the bonding of the two or more target segments. The two or more target segments can be sequentially or simultaneously bonded to the target support as described earlier while using the filling device 600 between adjacent target segments. The filling device(s) can be removed, e.g., pulled out, after the bonding process of the two or more target segments has been completed.

[0054] A shape of the filling device 600 can at least partially correspond to the shape of the first gap 150 and the second gap 160. Specifically, the filling device 600 can be ring-shaped in the case of a cylindrical target support. In some implementations, the filling device 600, such as the ring-shaped filling device, has a T-shape or an inverse T-shape. As an example, the filling device 600 is a T-shaped gasket. The T-shape or inverse T-shape can be defined in a plane parallel to a center axis of the ring-shaped filling device with the center axis lying in said plane. The filling device 600 can be made of a synthetic material, such as Polytetrafluorethylen (Teflon®).

[0055] According to embodiments described herein, the method for manufacture of an apparatus for material deposition on a substrate in a vacuum deposition process can be conducted by means of computer programs, software, computer software products and the interrelated controllers, which can have a CPU, a memory, a user interface, and input and output devices being in communication with the corresponding components of the apparatus for processing a large area substrate.

[0056] The present disclosure provides spatially separated bonding layer portions of the bonding material, wherein each bonding layer portion is used to fix a respective target segment to a target support. The (second) gap, wherein adjacent bonding layer portions are spaced apart from each other is larger than the (first) gap between adjacent target segments. In particular, the gap between the adjacent bonding layer portions can provide an undercut region or empty space between the target support and a portion of the respective target segment. Accordingly, even if there are temperature changes and a thermal expansion and contraction e.g. of the target support and/or the target segments, the bonding material does not come out of the gap between the adjacent target segments, which may for example prevent arcing. Further, the joint or interface between adjacent target segments can be provided substantially free of bonding material, which may for example reduce or even avoid particle generation.

[0057] While the foregoing is directed to embodiments of the 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.

CLAIMS

1. An apparatus for material deposition on a substrate in a vacuum deposition process, comprising:

a target support;

two or more target segments supported by the target support, wherein a first gap is provided between adjacent target segments of the two or more target segments; and

two or more bonding layer portions, each layer portion of the two or more bonding layer portions bonding a respective target segment of the two or more target segments to the target support,

wherein bonding layer portions of adjacent target segments are separated from each other by a second gap larger than the first gap.

2. The apparatus of claim 1, wherein the target support has a longitudinal extension, and wherein a second extension of the second gap along the longitudinal extension of the target support is larger than a first extension of the first gap along the longitudinal extension of the target support.

3. The apparatus of claim 1 or 2, wherein the target support is selected from the group consisting of a cylindrical target support, a backing tube, and any combination thereof.

4. The apparatus of any one of claims 1 to 3, wherein the first gap and the second gap extend along a rotational axis of the target support.

5. The apparatus of any one of claims 1 to 4, wherein the second gap is at least 5% or at least 10% larger than the first gap.

6. The apparatus of any one of claims 1 to 5, wherein the second gap provides an undercut region between the target support and a portion of a respective target segment.

7. The apparatus of any one of claims 1 to 6, wherein a combination of the first gap and the second gap forms a T-shape or an inverse T-shape in a cross-sectional plane of the target support.
8. The apparatus of any one of claims 1 to 7, wherein no material is provided in the second gap.
9. A system for sputter deposition on a substrate, comprising:
- a vacuum chamber; and
 - one or more sputter deposition sources in the vacuum chamber, wherein at least one sputter deposition source of the one or more sputter deposition sources includes the apparatus of any one of claims 1 to 8.
10. A method for manufacture of an apparatus for material deposition on a substrate, the method comprising:
- bonding two or more target segments to a target support with a first gap between adjacent target segments using a respective bonding layer portion for each of the two or more target segments,
 - wherein bonding layer portions of adjacent target segments are separated from each other by a second gap larger than the first gap.
11. The method of claim 10, further including:
- providing a filling device for the first gap and the second gap during the bonding of the two or more target segments.
12. The method of claim 11, further including:
- removing the filling device after the bonding of the two or more target segments.
13. The method of claim 11 or 12, wherein the filling device is a T-shaped gasket.

14. The method of claim 10, wherein the bonding of the two or more target segments includes:

bonding the two or more target segments to the target support with the first gap being provided between adjacent target segments using a bonding material between the two or more target segments and the target support,

removing some of the bonding material through the first gap to form the second gap.

15. The method of claim 14, wherein the removing of the bonding material includes an etching of the bonding material to form the second gap.

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Fig. 1

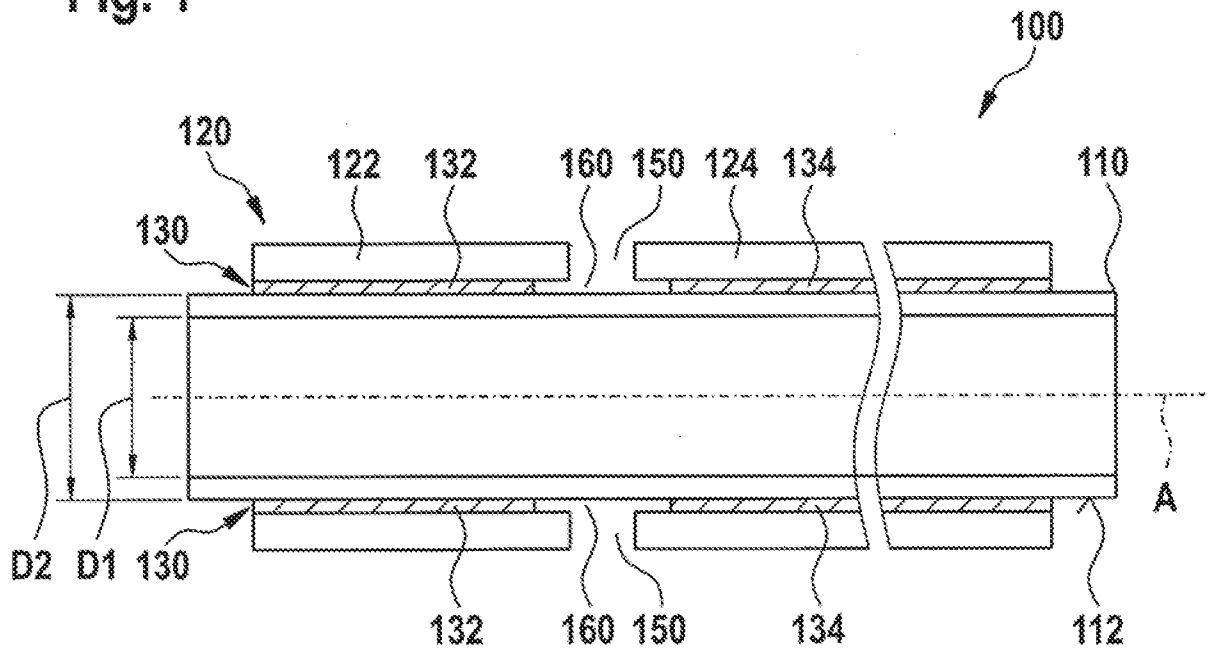
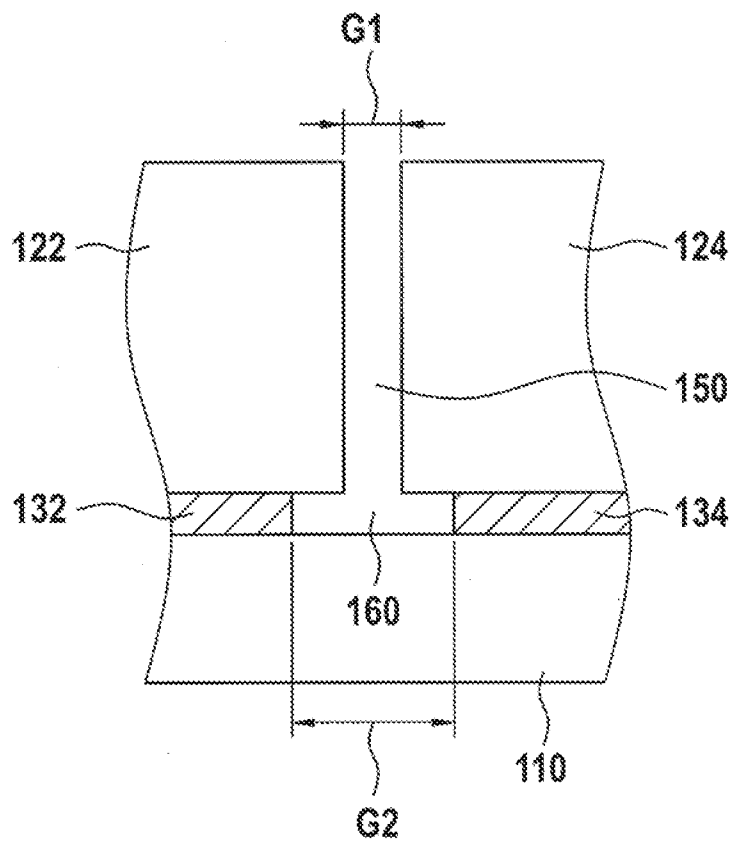


Fig. 2



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Fig. 3A

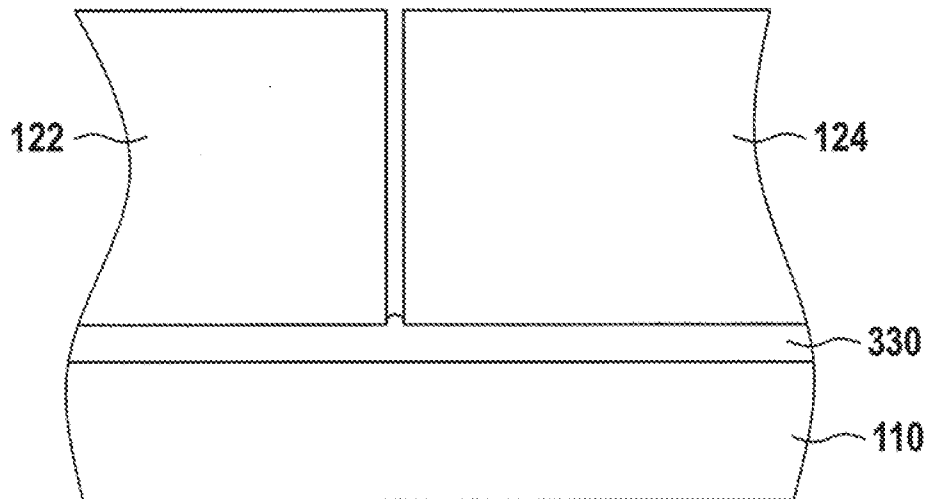


Fig. 3B

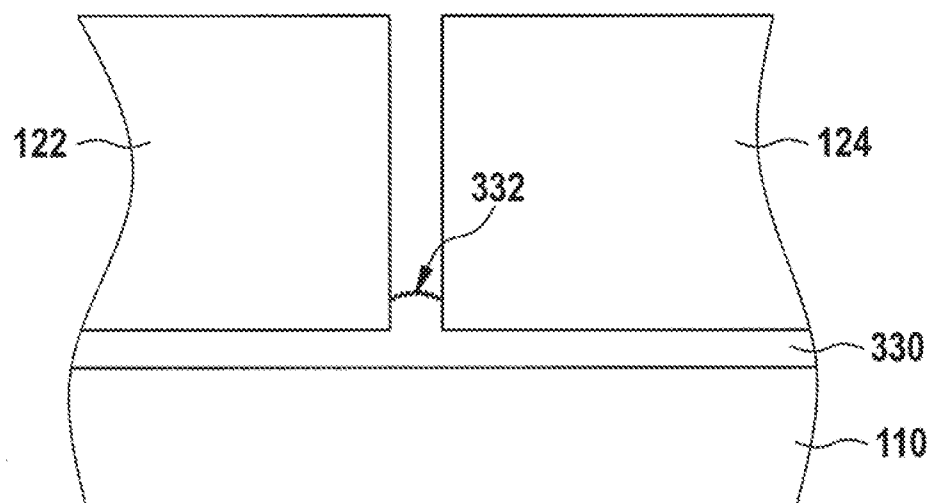
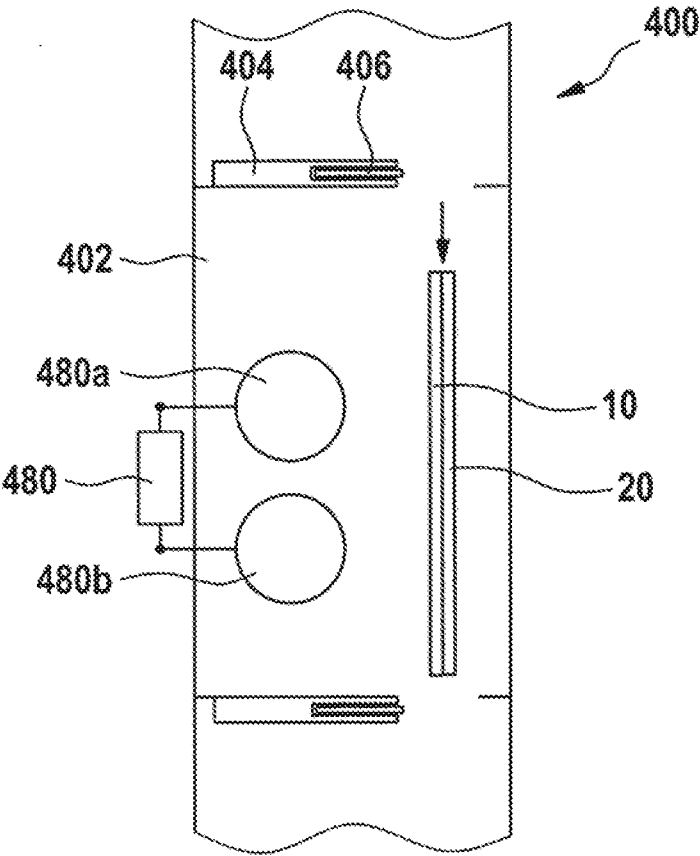


Fig. 4



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Fig. 5

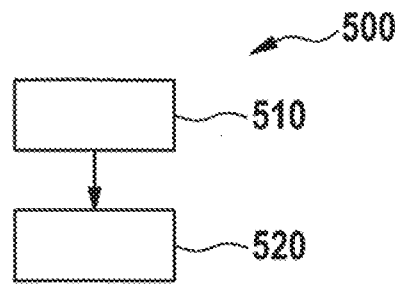


Fig. 6A

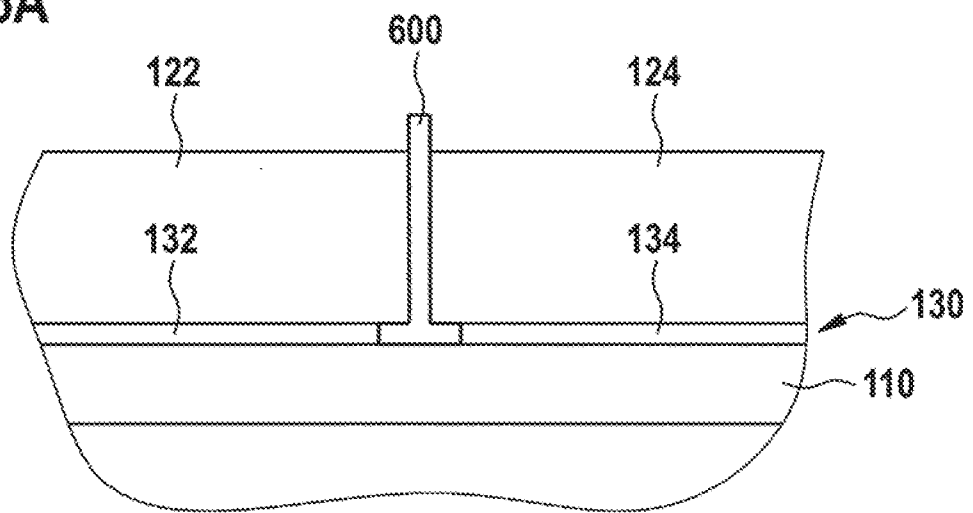
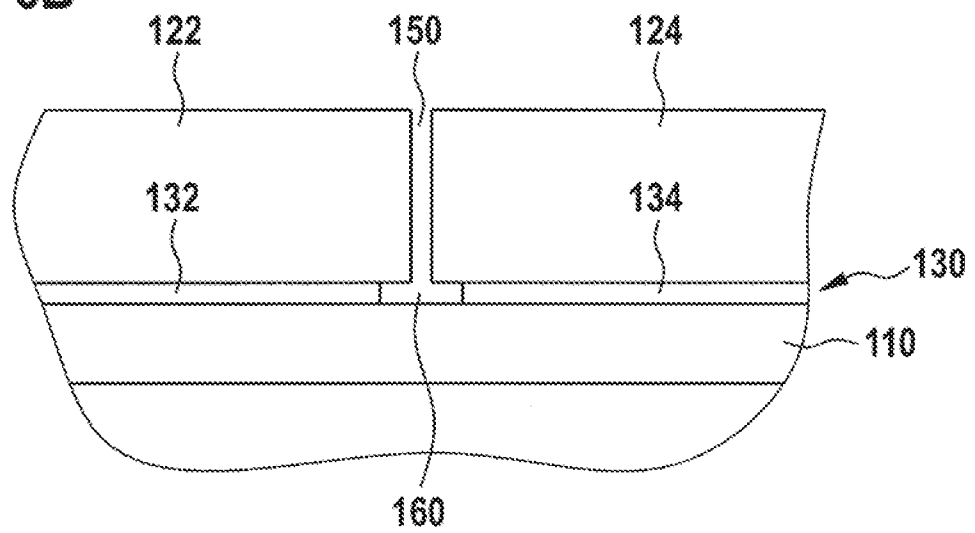


Fig. 6B



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/037776**A. CLASSIFICATION OF SUBJECT MATTER****C23C 14/34(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)

C23C 14/34; C23C 14/00; H01J 37/34; C23C 14/54; C23C 14/32; C23C 14/08

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: sputter target, segment, piece, bonding, gap, backing, support

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2009-0085675 A (MITSUI KINZOKU KOREA CO., LTD.) 07 August 2009 See paragraphs [0062], [0079], [0084], [0085]; claim 1; and figures 1(b), 6, 7.	1-3, 10-15
A	US 2014-0110254 A1 (INFINEON TECHNOLOGIES AG) 24 April 2014 See paragraph [0034]; and figure 7b).	1-3, 10-15
A	US 2011-0031117 A1 (KIM et al.) 10 February 2011 See paragraphs [0047]-[0050]; and figure 3.	1-3, 10-15
A	US 2007-0074969 A1 (SIMPSON et al.) 05 April 2007 See paragraph [0027]; and figure 5.	1-3, 10-15
A	US 2015-0279636 A1 (APPLIED MATERIALS, INC.) 01 October 2015 See paragraphs [0029]-[0034]; and figure 1.	1-3, 10-15



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

"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

09 March 2017 (09.03.2017)

Date of mailing of the international search report

09 March 2017 (09.03.2017)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US2016/037776**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 4-9
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/037776

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