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[Continued on next page]

- (54) **Title:** DEPOSITION SOURCE FOR SPUTTER DEPOSITION, DEPOSITION APPARATUS AND METHOD OF ASSEMBLING THE SOURCE

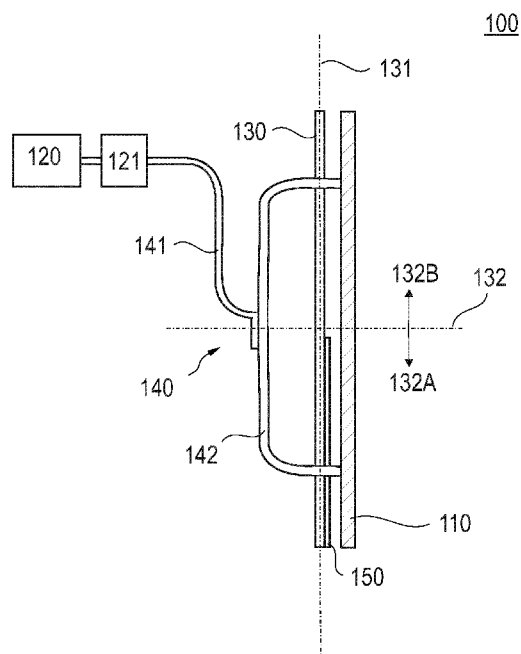


FIG. 2

- (57) **Abstract:** A deposition source (100) for sputter deposition in a vacuum chamber is described. The deposition source includes a target (110) for providing a material to be deposited during the sputter deposition; an RF power supply (120) for providing RF power to the target (110); a magnetron (130); a power connector assembly (140) connecting the RF power supply (120) with the target (110); a RF power return path assembly (166) for providing a return path from the target to the RF power supply, wherein the power connector assembly (140) and/or the return path assembly (166) has an asymmetric inductive and/or capacitive mass; and a plate (150) arranged at a side (132A, 132B) of the magnetron (130) for compensating the asymmetric inductive and/or capacitive mass.

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DEPOSITION SOURCE FOR SPUTTER DEPOSITION, DEPOSITION APPARATUS AND METHOD OF ASSEMBLING THE SOURCE

TECHNICAL FIELD

[0001] The present disclosure relates to a deposition source for sputter deposition, a sputtering apparatus, and a method of assembling for a deposition source. In particular, the present disclosure relates to a sputter deposition source for radio frequency (RF) sputtering in a vacuum chamber and an apparatus for radio frequency RF sputtering in a vacuum chamber.

BACKGROUND

[0002] Physical vapor deposition (PVD) processes gain increasing attention in some technical fields, e.g. display manufacturing. A good deposition rate can be obtained with sufficient layer characteristics for some PVD processes. For example, sputtering is employed for display manufacturing or other applications. Sputtering, e.g. magnetron sputtering is a technique for coating substrates, e.g. glass or plastic substrates. Sputtering generates a stream of coating material by sputtering a target through the use of plasma. In such a process, material is released from the surface of the target by collision with high-energy particles of the plasma. Sputtering is controllable by plasma parameters, such as pressure, power, gas, and a magnetic field. In a vacuum, the sputtered materials travel from the target toward one or more substrates or workpieces and adhere to the surface thereof. A wide variety of materials, including metals, semiconductors and dielectric materials can be sputtered to desired specifications. Magnetron sputtering has thus found acceptance in a variety of applications including semiconductor processing, optical coatings, food packaging, magnetic recording, and protective wear coatings.

[0003] Magnetron sputtering devices include a power supply for applying energy into a gas to strike and maintain a plasma, magnetic elements for controlling the motion of ions, and targets for providing coating material. Sputtering can be accomplished with a wide variety of devices having differing electrical, magnetic and mechanical configurations. The

configurations include sources of direct current (DC) or alternating current (AC) electromagnetic fields or radio frequency (RF) energy to produce the plasma. Particularly, non-conductive materials may be sputtered using RF sputtering methods.

[0004] RF-PVD is desired for a plurality of applications, e.g. sputtering of non-conductive materials. The functionality of sputtered coatings typically depends on the uniformity and the coating thickness. This thickness has to be within a predetermined range. In the production of coatings, it is desirable that the deposition rate at which the coating is effected lies within a predetermined tolerance range. In particular, process parameters such as plasma uniformity and deposition rate of a sputtering device have to be controlled thoroughly in the production process. However, conventional deposition sources and deposition apparatuses still have deficiencies with respect to the uniformity of a sputtered coating.

[0005] Accordingly, there is a continuing demand on providing improved deposition sources and deposition apparatuses.

SUMMARY

[0006] In view of the above, a deposition source for sputter deposition in a vacuum chamber, a sputtering apparatus, and a method of assembling a deposition source according to the independent claims are provided. Further advantages, features, aspects and details are apparent from the dependent claims, the description and drawings.

[0007] According to one aspect of the present disclosure, a deposition source for sputter deposition in a vacuum chamber is provided. The deposition source includes a target for providing a material to be deposited during the sputter deposition; a RF power supply for providing RF power to the target; a magnetron; a power connector assembly connecting the RF power supply with the target; a RF power return path assembly for providing a return path from the target to the RF power supply, wherein the power connector assembly and/or the return path assembly has an asymmetric inductive and/or capacitive mass; and a plate arranged at a side of the magnetron for compensating the asymmetric inductive and/or capacitive mass.

[0008] According to another aspect of the present disclosure, a sputtering apparatus is provided. The sputtering apparatus includes a vacuum chamber and a deposition source according to embodiments described herein.

[0009] According to a further aspect of the present disclosure a method of assembling a deposition source is provided. The method includes providing a deposition source including a target for providing a material to be deposited during the sputter deposition; an RF power supply for providing RF power to the target; a magnetron; and a power connector assembly connecting the RF power supply with the target; a RF power return path assembly providing a return path from the target to the RF power supply, wherein the power connector assembly and/or the return path assembly has an asymmetric inductive and/or capacitive mass; and arranging a plate at a side of the magnetron for compensating the asymmetric inductive and/or capacitive mass of the power connector assembly and/or the return path assembly.

[0010] The disclosure is also directed to an apparatus for carrying out the disclosed methods including apparatus parts for performing the methods. The method 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, the disclosure is also directed to operating methods of the described apparatus. The disclosure also includes a method 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 disclosure described herein can be understood in detail, a more particular description, 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 side view of a deposition source for sputter deposition in a vacuum chamber according to embodiments described herein;

FIG. 2 shows a schematic side view of a deposition source for sputter deposition in a vacuum chamber according to embodiments described herein;

FIG. 3 shows a schematic sectional view of a sputter deposition source for sputter deposition in a vacuum chamber according to embodiments described herein;

FIG. 4 shows a schematic perspective view from the rear side of a sputter deposition source according to embodiments described herein

FIG. 5 shows a sputter deposition apparatus according to embodiments described herein; and

FIG. 6 shows a block diagram illustrating a method of assembling a deposition source according to embodiments described herein.

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. In the following, 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] In the present disclosure, a “deposition source” may be understood as a deposition source for sputter deposition including a planar cathode having a target made of the material to be deposited on the substrate. For example, the target material can be selected from the group consisting of metal oxides like Al_2O_3 or SiO_2 as well as target materials including one or more element(s) selected of lithium, tantalum, molybdenum, niobium, titanium, manganese, nickel, cobalt, indium, gallium, zinc, tin, silver and copper. Particularly, the target material can be selected from the group consisting of lithium, cobalt, nickel, manganese.

[0014] In the present disclosure, an “RF power supply” may be understood as a power supply which is adapted for supplying alternating current that oscillates at radio frequencies. In particular, the term “RF power” as used herein refers to currents oscillating at an oscillation rate in a frequency range between 1 MHz to 300 GHz, particularly in a range between 2 MHz to 1 GHz, and particularly to alternating current (AC) power having a frequency of 13.56 MHz, particularly 27.12 MHz, more particularly 40.68 MHz or another multiple of 13.56 MHz. In a radio frequency (RF) sputtering apparatus, the plasma is struck and maintained by applying an RF electric field. For example sputtering of non-conductive materials or sputtering of materials of a high resistivity (e.g. 10^6 Ohm cm) can be conducted with RF sputtering.

[0015] When referring to RF power, RF power supplies, RF matchbox, and RF currents in the present disclosure, it is sometimes referred to the “hot path” and to the “return path”, respectively. In this regard, it is to be understood that the “return path” is comparable to the neutral conductor in an AC network, whereas the “hot path” is comparable to the conductor driving the power in an AC network.

[0016] In the present disclosure, an “inductive mass” may be understood as a mass including a conductive material in which a change in current flowing through the inductive mass can induced a voltage in the conductive material. An “asymmetric inductive mass” may be understood as an inductive mass in which a change in current flowing through the inductive mass induces an asymmetric voltage in the inductive mass. In particular, an “asymmetric inductive/capacitive mass” may be understood as an inductive mass having a first part in which the inductive and/or capacitive coupling is less compared to a second part of the inductive/capacitive mass. For example, the first part in which the inductive and/or capacitive coupling is less compared to a second part of the inductive mass may have a lower inductive/capacitive mass than the second part of the inductive/capacitive mass.

[0017] With exemplarily reference to FIG. 1, a deposition source 100 for sputter deposition in a vacuum chamber according to embodiments described herein includes a target 110 for providing a material to be deposited during the sputter deposition; an RF power supply 120 for providing RF power to the target 110; a magnetron 130; and a power

connector assembly 140 connecting the RF power supply 120 with the target 110, wherein the power connector assembly 140 has an asymmetric inductive and/or capacitive mass. Further, the deposition source 100 includes a plate 150 arranged at a side of the magnetron 130 for compensating the asymmetric inductive and/or capacitive mass. Accordingly, by providing a deposition according to embodiments described herein, a discharge asymmetry which is induced by an asymmetric inductive and/or capacitive mass of a power connector assembly may be compensated for which may be beneficial for achieving uniformity of a sputtered coating. In particular, by providing a deposition source 100 including a plate 150 as described herein, a shunt for influencing the magnetic field strength of the magnetron may be provided. Accordingly, the plasma density may beneficially be influenced in order to establish a uniform plasma density over the target. Further, by providing a deposition source including a plate as described herein, asymmetries in capacitive coupling of parts along the power feed-in path and the power return path may be compensated for. Moreover, by providing a deposition source including a plate as described herein, the target utilization within an RF-process may be improved, because inductive and capacitive asymmetries in the structural parts of the deposition system can be compensated for which may lead to asymmetric target erosion and limited target life time. Accordingly, by providing a deposition source including a plate as described herein asymmetric target erosion can be reduced or even avoided and the target life time can be increased.

[0018] As exemplarily shown in FIG. 2, according to embodiments which can be combined with other embodiments described herein, the magnetron 130 may extend along a longitudinal axis 131. As can be seen from FIG. 2, the asymmetric inductive and/or capacitive mass of the power connector assembly 140 may be asymmetric with respect to a first plane 132 perpendicularly bisecting the longitudinal axis 131 of the magnetron 130. Additionally or alternatively, the asymmetric inductive and/or capacitive mass of the power connector assembly 140 may be asymmetric with respect to a second plane including the longitudinal axis 131 of the magnetron 130, e.g. a vertical plane which lies in the paper plane of Fig. 2. In particular, the second plane may be perpendicular to the first plane 132. With exemplary reference to FIG. 2, according to embodiments which can be combined with other embodiments described herein, the plate 150 is arranged on a side of

the first plane 132 at which the asymmetric inductive and/or capacitive mass of the power connector assembly 140 has a lower inductive and/or capacitive mass. In the exemplarily embodiment shown in FIG. 2, the asymmetric inductive and/or capacitive mass of the power connector assembly 140 is lower on a first side 132A of the first plane 132 compared to a second side 132B of the first plane 132. For example, the first side 132A may be a bottom side of the first plane 132 and the second side 132B may be an upper side of the first plane 132, as shown in FIG. 2. Additionally or alternatively, for example in the case in which the asymmetric inductive and/or capacitive mass of the power connector assembly 140 may be asymmetric with respect to a second plane including the longitudinal axis 131 of the magnetron 130, the plate 150 is arranged on a side of the second plane at which the asymmetric inductive and/or capacitive mass has a lower inductive and/or capacitive mass.

[0019] Accordingly, by providing a deposition source with a plate as described herein, a discharge asymmetry which is induced by the asymmetric inductive and/or capacitive mass of the power connector assembly may be compensated for. Further, by providing a deposition source with a plate as described herein inductive and/or capacitive mass asymmetries and capacitive coupling asymmetries in the power connector path (e.g. the power feed-in) as well as in the power return path (e.g. vacuum chamber body and return path to the matchbox/power supply) can be compensated for. This may be beneficial for achieving a uniform sputtered coating. In particular, by providing a deposition source including a plate as described herein, a shunt for influencing the magnetic field strength of the magnetron may be provided. Accordingly, the plasma density may beneficially be influenced in order to establish a uniform plasma density over the target.

[0020] According to embodiments which can be combined with other embodiments described herein, the plate 150 may be arranged over less than 50% of the length of the magnetron 130. For example, the plate 150 may be arranged over at least 10% of the length of the magnetron 130 and over less than 50% of the length of the magnetron 130. In particular, the plate 150 may be arranged over at least 20% of the length of the magnetron 130, more particularly over at least 30% of the length of the magnetron 130, and over less than 50% of the length of the magnetron 130. Preferably, as exemplarily shown in FIGS. 1 and 2, the plate 150 may be arranged over 35% or more of the length of

the magnetron 130 and over less than 50% of the length of the magnetron 130. According to embodiments which can be combined with other embodiments described herein, the plate 150 may be arranged on the magnetron, such that the plate extends from one end of the magnetron towards the middle of the magnetron, particularly towards the first plane 132, as exemplarily shown in FIG. 2. Accordingly, by providing a deposition source including a plate as described herein, a shunt for influencing the magnetic field strength of the magnetron may be provided. Accordingly, the plasma density may beneficially be influenced in order to establish a uniform plasma density over the target.

[0021] According to embodiments which can be combined with other embodiments described herein, the plate 150 may be a magnetic plate. Accordingly, the plate 150 can be attached to the magnetron 130 by magnetic force. For example, the plate 150 may be directly attached to the magnetron 130. Alternatively, the plate 150 may be coupled to the magnetron via connecting elements, for example a mounting plate and/or screws and/or pins. Accordingly, the plate for compensating the asymmetric inductive and/or capacitive mass can be easily arranged on or over the magnetron. This may be beneficial for the assembling of the deposition source.

[0022] According to embodiments which can be combined with other embodiments described herein, the plate 150 includes at least one material selected from the group consisting of: iron, magnetic steel, nickel-iron-alloy (FeNi), cobalt-iron alloy (FeCo), aluminum-iron alloy (FeAl), aluminum-silicon-iron alloy (FeAlSi), and ferrite. Accordingly, by providing a plate including a material as described herein, the plate may efficiently compensate for the asymmetric inductive and/or capacitive mass. Further, the plate may be attachable to the magnetron by magnetic force which may be beneficial for the assembling of the deposition source

[0023] According to embodiments which can be combined with other embodiments described herein, the plate 150 may have a thickness selected from a range between a lower limit of 0.5 mm, particularly a lower limit of 1 mm, more particularly a lower limit of 2 mm and an upper limit of 3 mm, particularly an upper limit of 4 mm, particularly an upper limit of 5 mm. In particular, the plate 150 may have a thickness of 1 mm. Accordingly, by providing a plate having a thickness as described herein, the plate may

efficiently compensate the asymmetric inductive and/or capacitive mass. Further, according to embodiments which can be combined with other embodiments described herein, the thickness of the plate may be selected such that an optimal compensation of the asymmetric inductive and/or capacitive mass of the power connector assembly can be achieved.

[0024] According to embodiments which can be combined with other embodiments described herein, the plate 150 may include a stack of at least two plates, e.g. a stack including a first plate and a second plate. For example, the first plate and the second plate may be arranged on top of each other. The first plate may have a first thickness selected from a range between a lower limit of 0.25 mm, particularly a lower limit of 0.5 mm, more particularly a lower limit of 1 mm and an upper limit of 1.5 mm, particularly an upper limit of 2 mm, particularly an upper limit of 2.5 mm. The second plate may have a second thickness selected from a range between a lower limit of 0.25 mm, particularly a lower limit of 0.5 mm, more particularly a lower limit of 1 mm and an upper limit of 1.5 mm, particularly an upper limit of 2 mm, particularly an upper limit of 2.5 mm. According to embodiments which can be combined with other embodiments described herein, the first plate and the second plate may have a different length. For example, the second plate which may be arranged over the first plate may be shorter than the first plate. Accordingly, by employing a stack of plates as described herein asymmetries in capacitive coupling of parts along the power feed-in path and the power return path may be compensated for. In particular, by employing a stack of plates, e.g. a stack of plates having different thickness and/or length, the compensation effect of the plate may be adapted, particularly optimized with respect to a desired compensation effect.

[0025] According to embodiments which can be combined with other embodiments described herein, the RF power supply 120 may be connected to the power connector assembly 140 via an impedance matching network, particularly a matchbox 121, as exemplarily shown in FIG. 2. Accordingly, a consistent load on the power supply can be ensured. Further, the matchbox may be beneficial for adapting the internal resistance of the power supply to the load impedance of the operating cathode. In order to provide for an optimal impedance matching, the matchbox may include adjustable capacitors for balancing purposes. Accordingly, embodiments of the deposition source as described

herein provide for maintaining a constant and optimal load on the power supply for power efficient operation of the deposition source.

[0026] According to embodiments which can be combined with other embodiments described herein, the power connector assembly 140 comprises a first power connector 141 connectable to a second power connector 142. As exemplarily shown in FIG. 2, the first power connector 141 may have an inductive and/or capacitive mass which is asymmetric with respect to the first plane 132. Additionally or alternatively, the first power connector 141 may have an inductive and/or capacitive mass which is asymmetric with respect to the second plane, as described herein. The second power connector 142 may have an inductive and/or capacitive mass which is symmetric with respect to the first plane 132. As exemplarily shown in FIGS. 1 and 2, the second power connector 142 may be connected to the target 110. The first power connector 141 may be connected to the second power connector 142 on one end of the first power connector 141 and to an RF power supply 120, for example via a matchbox 121, on the other end of the first power connector 141. Providing a power connector assembly including two or more separate power connectors may be beneficial for reducing the manufacturing costs. Further, the assembly of the deposition source may be facilitated.

[0027] In FIG. 3, a schematic sectional view of a sputter deposition source according to embodiments described herein is shown. According to embodiments described herein, the sputter deposition source 100 includes a target 110 and a magnetron 130. The magnetron may be a magnet assembly, for example provided by permanent magnets, in order to confine the plasma during sputter deposition. According to embodiments which can be combined with other embodiments described herein, the magnetron 130 can be configured to be movable in at least one direction over the surface of the target 110, as exemplarily indicated by the arrow in FIG. 3. Accordingly, the race track on the target can be beneficially influenced, for example in order to increase the amount of target material that can be used before the target needs to be exchanged.

[0028] With exemplary reference to FIG. 3, according to embodiments which can be combined with other embodiments described herein, the “hot” RF path for providing the RF power from the RF power supply 120 to the target 110 can be provided by a junction

bridge 143 which is arranged and configured to couple the first power connector 141 and the second power connector 142. According to embodiments which can be combined with other embodiments described herein, the second power connector 142 may be connected to the target 110 via a target backing plate 111, as exemplarily shown in FIG. 3. For example, the second power connector 142 may be symmetrical connected to a target backing plate 111 of the target 110 for providing RF power to the target 110. The first power connector 141 for connecting the second power connector with the power supply, for example via a matchbox, may be provided by a sheet-metal. According to embodiments which can be combined with other embodiments described herein, the first power connector 141 may be connectable to the junction bridge 143, for example by screws or pins.

[0029] As exemplarily shown in FIG. 3, according to embodiments which can be combined with other embodiments described herein, the return-path may be provided by an RF power return path assembly 166, for example including one or more conductor rods 160. According to yet further implementations, the conductor rods can be connected to a return-path RF power collection sheet-metal 161. According to yet further implementations, which can be combined with other embodiments described herein, the return-path RF power collection sheet-metal 161 can be connected to a first power supply sheet-metal and to a second power supply sheet-metal in order to provide the return path for the RF currents to the matchbox and/or the power supply.

[0030] FIG. 4 shows a schematic perspective view from the rear side of a sputter deposition source according to embodiments described herein. As exemplarily shown in FIG. 4, a matchbox 121 may be provided which can be connected to a wall portion 102 of the vacuum chamber. The matchbox 121 may be connected to the first power connector 141. Further, the matchbox 121 may be connected to one or more power supply sheet-metals, such as a first power supply sheet-metal 163 as shown in FIGS. 3 and 4, for providing a defined return path for the RF currents. According to embodiments which can be combined with other embodiments described herein, the wall portion 102 to which the matchbox 121 may be connected can be a door of the deposition source 100 connected to the vacuum chamber. In FIG. 4, the door 103 is shown in an open position. As exemplarily indicated by the arrow in FIG. 4, the door can be closed.

[0031] With exemplarily reference to FIG. 4, according to embodiments which can be combined with other embodiments described herein, the first power connector 141 may be pivotable around a pivot axis 144 which may be parallel to the longitudinal axis 131 of the magnetron for opening and closing a contact between the first power connector 141 and the second power connector 142, as exemplarily show in FIG. 4. For example, the first power connector 141 may be connected or attached to the door 103 of the deposition source 100. As shown in FIG. 4, the second power connector 142 may be arranged at the backside of the target 110. According to embodiments which can be combined with other embodiments described herein the junction bridge 143 may be connected with the second power connector 142, as exemplarily shown in FIG. 4. Alternatively, the junction bridge may be a part of the second power connector 142 or the first power connector 141. For example the second power connector 142 or the first power connector 141 may include the junction bridge 143, particularly in form of a one-piece structure.

[0032] FIG. 5 shows an apparatus 200 for sputter deposition in a vacuum chamber 201. The vacuum chamber 201 can be evacuated through a flange 204, as exemplarily shown in FIG. 5. Additionally, further flanges may be provided at other positions of the vacuum chamber. As exemplarily shown in FIG. 5, the substrate 202 to be coated with material from the target 110 may be supported by a substrate support 210. With exemplary reference to FIG. 5, the apparatus 200 for sputter deposition may include one or more sputter deposition sources, e.g. two deposition sources as shown in FIG. 5. For example, the sputter deposition sources may be provided above the substrate 202 in order to sputter the material of the target 110 from the top downwards. Alternatively, the sputter deposition arrangement may be bottom-up.

[0033] According to further embodiments which can be combined with other embodiments described herein, the substrate 202 may be arranged vertically in an apparatus for sputter deposition. For example, the substrate may be oriented essentially vertically, i.e. with a deviation from the vertical arrangement of $\pm 10^\circ$. Accordingly, in such a vertical arrangement, the sputter deposition sources may be arranged at or adjacent a side wall of the apparatus 200. Further, the substrate 202 may be supported by rollers or in a carrier, which is supported by rollers or another transportation and/or support system.

[0034] As schematically shown in in FIG. 5, each of the sputter deposition sources 100 may include a power supply, particularly an RF power supply 120. The power supply may be connected to a matchbox 121. The matchbox 121 may provide the RF power via various connectors, for example a first power connector 141 and/or a second power connector 142 and/or a junction bridge 143, to the target 110. Further, a defined RF return path may be provided by conductor rods 160, which can be connected to a return-path RF power collection sheet-metal 161, as exemplarily shown in FIG. 5. The sputter deposition sources 100 may further include a magnetron 130. According to embodiments, which can be combined with other embodiments described herein, the magnetron 130 can be configured to be movable in at least one direction over the surface of the target 110, as exemplarily indicated by the arrow in FIG. 5.

[0035] In FIG. 6 a block diagram illustrating a method of assembling a deposition source according to embodiments described herein is shown. According to embodiments, the method includes providing 310 a deposition source. The deposition includes a target 110 for providing a material to be deposited during the sputter deposition; an RF power supply 120 for providing RF power to the target 110; a magnetron 130; and a power connector assembly 140 connecting the RF power supply 120 with the target 110, wherein the power connector assembly 140 has an asymmetric inductive and/or capacitive mass. Further, the method includes arranging 320 a plate 150 at a side of the magnetron 130 for compensating the asymmetric inductive and/or capacitive mass of the power connector assembly 140. Accordingly, by arranging a plate as described herein, a shunt for influencing the magnetic field strength of the magnetron may be provided. Accordingly, the plasma density may beneficially be influenced in order to establish a uniform plasma density over the target. This may be beneficial for achieving a uniform coating by sputtering.

[0036] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include arranging the plate on a side of a first plane 132 at which the asymmetric inductive and/or capacitive mass 140 has a lower inductive and/or capacitive mass. As exemplarily shown in FIG. 2, the first plane 132 may perpendicularly bisect the longitudinal axis 131 of the magnetron 130. With exemplary reference to FIG. 2, the

asymmetric inductive and/or capacitive mass of the power connector assembly 140 may be lower on a first side 132A of the first plane 132 compared to a second side 132B of the first plane 132. Accordingly, by arranging a plate at a side of the magnetron as described herein, a discharge asymmetry which may be induced by the asymmetric inductive and/or capacitive mass of the power connector assembly may be compensated. This may be beneficial for achieving a uniform coating by sputtering.

[0037] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include coupling the plate 150 to the magnetron 130 by magnetic force. For example, the plate 150 may be directly attached to the magnetron 130. Alternatively, the plate 150 may be coupled to the magnetron via connecting elements, for example a mounting plate and/or screws and/or pins.

[0038] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include employing a plate which includes at least one material selected from the group consisting of: iron, magnetic steel, nickel-iron-alloy (FeNi), cobalt-iron alloy (FeCo), aluminum-iron alloy (FeAl), aluminum-silicon-iron alloy (FeAlSi), and ferrite. Accordingly, by employing a plate including a material as described herein, the plate may efficiently compensate the asymmetric inductive and/or capacitive mass. Further, the plate may be attachable to the magnetron by magnetic force which may be beneficial for the assembly of the deposition source

[0039] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include employing a plate having a thickness selected from a range between a lower limit of 0.5 mm, particularly a lower limit of 1 mm, more particularly a lower limit of 2 mm and an upper limit of 3 mm, particularly an upper limit of 4 mm, particularly an upper limit of 5 mm. Accordingly, by employing a plate having a thickness as described herein, the plate may efficiently compensate for the asymmetric inductive and/or capacitive mass of the connector assembly. Further, according to embodiments which can be combined with other embodiments described herein, the thickness of the plate may be

selected such that an optimal compensation of the asymmetric inductive and/or capacitive mass of the power connector assembly can be achieved.

[0040] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include stacking at least two plates, e.g. stacking a second plate onto a first plate. For example, stacking at least two plates may include arranging the second plate onto the first plate. The first plate may have a first thickness as described herein and the second plate may have a second thickness as described herein. According to embodiments which can be combined with other embodiments described herein, the first plate and the second plate may have a different length. For example, the second plate may be shorter than the first plate. Accordingly, by employing a stack of plates as described herein asymmetries in capacitive coupling of parts along the power feed-in path and the power return path may be compensated for. In particular, by employing a stack of plates, e.g. a stack of plates having different thickness and/or length, the compensation effect of the plate may be adapted, particularly optimized with respect to a desired compensation effect.

[0041] According to embodiments of the method of assembling a deposition source which can be combined with other embodiments described herein, arranging 320 the plate 150 may include arranging the plate over less than 50% of the length of the magnetron 130. For example, arranging 320 the plate 150 may include arranging the plate over at least 10% of the length of the magnetron 130, particularly over at least 20% of the length of the magnetron 130, more particularly over at least 30% of the length of the magnetron 130, and over less than 50% of the length of the magnetron 130. Preferably, arranging 320 the plate 150 may include arranging the plate over 35% or more of the length of the magnetron 130 and over less than 50% of the length of the magnetron 130. According to embodiments which can be combined with other embodiments described herein, arranging 320 the plate 150 may include arranging the plate on the magnetron, such that the plate extends from one end of the magnetron towards the middle of the magnetron, particularly towards a first plane 132 perpendicularly bisecting the longitudinal axis 131 of the magnetron 130, as exemplarily shown in FIG. 2.

[0042] Accordingly, by arranging a plate at a side of the magnetron as described herein, a discharge asymmetry which may be induced by an asymmetric inductive and/or capacitive mass of a power connector assembly may be compensated for. In particular, by arranging a plate as described herein, a shunt for influencing the magnetic field strength of the magnetron may be provided. Accordingly, the plasma density may beneficially be influenced in order to establish a uniform plasma density over the target. This may be beneficial for providing a uniform coating on a substrate by sputtering, particularly by using a deposition source as described herein.

CLAIMS

1. A deposition source (100) for sputter deposition in a vacuum chamber, comprising:
 - a target (110) for providing a material to be deposited during the sputter deposition;
 - a RF power supply (120) for providing RF power to the target (110);
 - a magnetron (130);
 - a power connector assembly (140) connecting the RF power supply (120) with the target (110);
 - a RF power return path assembly (166) for providing a return path from the target to the RF power supply, wherein the power connector assembly (140) and/or the return path assembly (166) has an asymmetric inductive and/or capacitive mass; and
 - a plate (150) arranged at a side of the magnetron (130) for compensating the asymmetric inductive and/or capacitive mass.
2. The deposition source (100) according to claim 1, wherein the magnetron (130) extends along a longitudinal axis (131), wherein the asymmetric inductive and/or capacitive mass is asymmetric with respect to a first plane (132) perpendicularly bisecting the longitudinal axis (131) of the magnetron (130) and/or wherein the asymmetric inductive and/or capacitive mass is asymmetric with respect to a second plane including the longitudinal axis (131) of the magnetron (130); and wherein the plate (150) is arranged on a side of the first plane (132) and/or the second plane at which the asymmetric inductive and/or capacitive mass (140) has a lower inductive and/or capacitive mass.
3. The deposition source (100) according to claim 1 or 2, wherein the plate (150) is arranged over at least 10% and less than 50% of the length of the magnetron (130).
4. The deposition source (100) according to any of claims 1 to 3, wherein the plate (150) is a magnetic plate which is attached to the magnetron (130) by magnetic force.

5. The deposition source (100) according to any of claims 1 to 4, wherein the plate (150) comprises at least one material selected from the group consisting of: iron, magnetic steel, nickel-iron-alloy (FeNi), cobalt-iron alloy (FeCo), aluminum-iron alloy (FeAl), aluminum-silicum-iron alloy (FeAlSi), and ferrite.
6. The deposition source (100) according to any of claims 2 to 5, wherein the power connector assembly (140) comprises a first power connector (141) connectable to a second power connector (142), wherein the first power connector (141) has an inductive and/or capacitive mass which is asymmetric with respect to the first plane (132) and/or the second plane, and wherein the second power connector (141) has an inductive and/or capacitive mass which is symmetric with respect to the first plane (132) and/or second plane.
7. The deposition source (100) according to claim 6, wherein the deposition source comprises a wall portion (102) of the vacuum chamber to which the first power connector (141) is attached, and wherein the second power connector (141) is connected to the target (110).
8. The deposition source (100) according to claim 6 or 7, wherein the second power connector (141) comprises a junction bridge (143).
9. The deposition source (100) according to any of claims 6 to 8, wherein the second power connector (141) is connected to the target (110) via a target backing plate (111).
10. The deposition source (100) according to any of claims 7 to 9, wherein the wall portion (121) is a door of the deposition source (100) connected to the vacuum chamber.
11. The deposition source (100) according to any of claims 1 to 10, wherein the RF power supply (120) is connected to the power connector assembly (140) via a matchbox (121).

12. The deposition source (100) according to claim 2, wherein the plate (150) is arranged over at least 10% and less than 50% of the length of the magnetron (130), wherein the plate (150) comprises a stack of at least two plates having a thickness from 0.25 mm to 2.5 mm, wherein the power connector assembly (140) comprises a first power connector (141) connectable to a second power connector (142), wherein the first power connector (141) is pivotable around a pivot axis (144) which is parallel to the longitudinal axis (131) of the magnetron for opening and closing a contact between the first power connector (141) and the second power connector (142).

13. A sputtering apparatus (200), comprising a vacuum chamber (210) and a deposition source (100) according to any of claims 1 to 12.

14. A method of assembling a deposition source (300) comprising:

- providing (310) a deposition source comprising a target (110) for providing a material to be deposited during the sputter deposition; a RF power supply (120) for providing RF power to the target (110); a magnetron (130); and a power connector assembly (140) connecting the RF power supply (120) with the target (110); a RF power return path assembly (166) providing a return path from the target to the RF power supply, wherein the power connector assembly (140) and/or the return path assembly (166) has an asymmetric inductive and/or capacitive mass; and

- arranging (320) a plate (150) at a side of the magnetron (130) for compensating the asymmetric inductive and/or capacitive mass of the power connector assembly (140) and/or the return path assembly (166).

15. The method according to claim 14, wherein arranging (320) the plate (150) comprises coupling the plate (150) to the magnetron (130) by magnetic force.

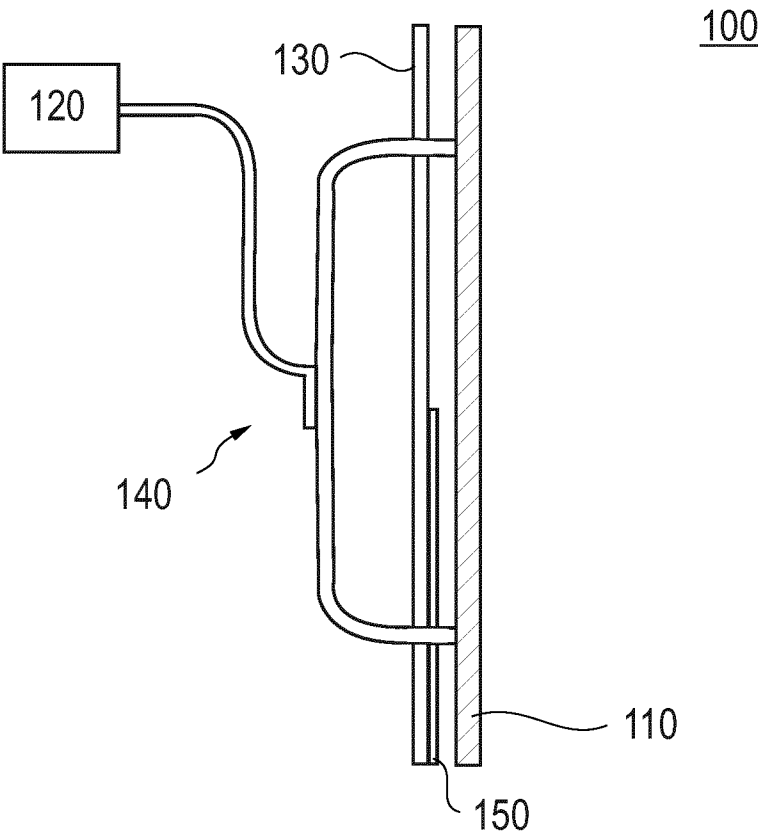


FIG. 1

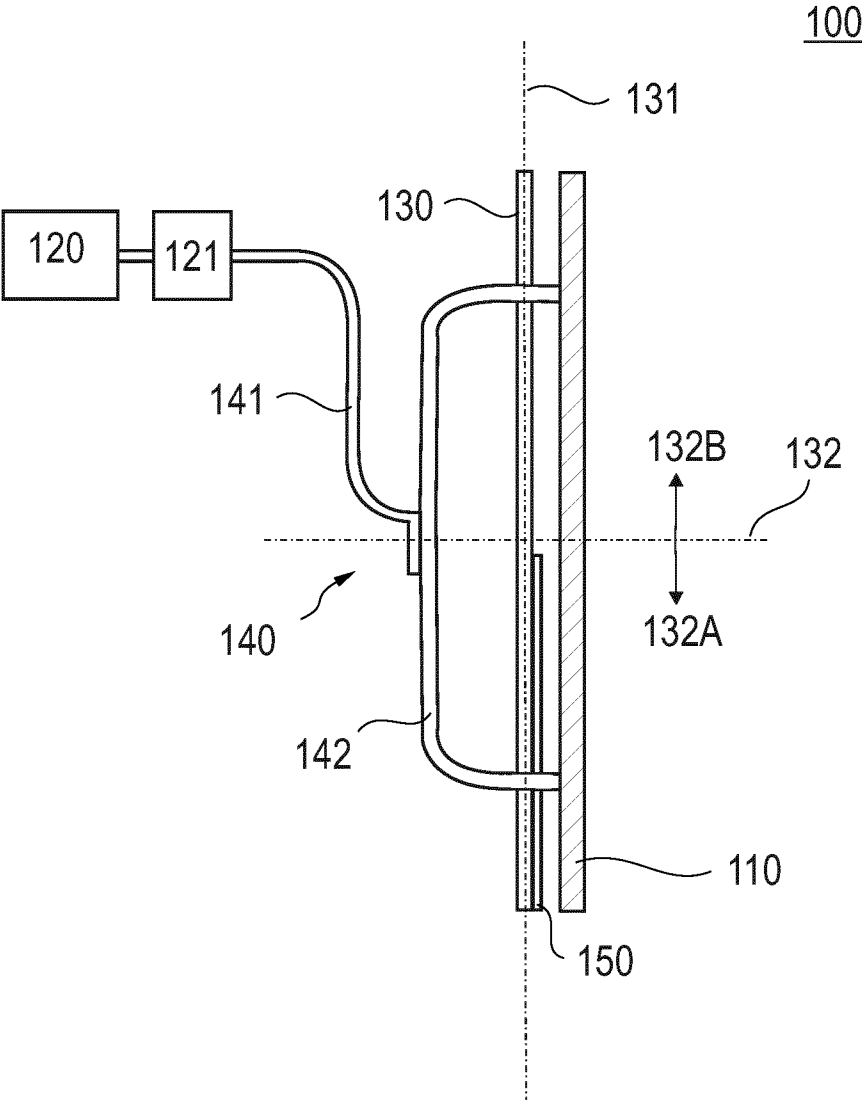


FIG. 2

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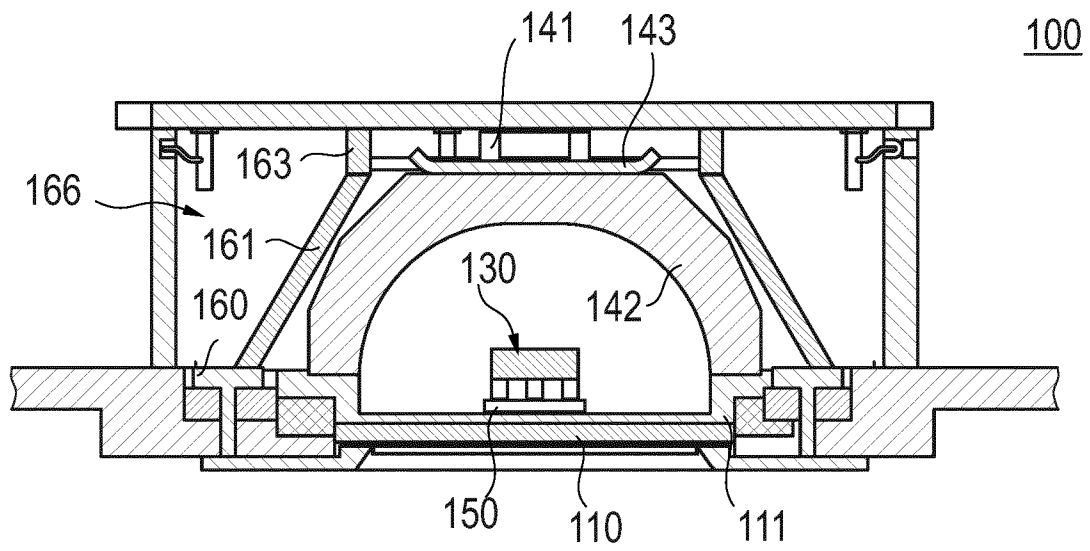


FIG. 3

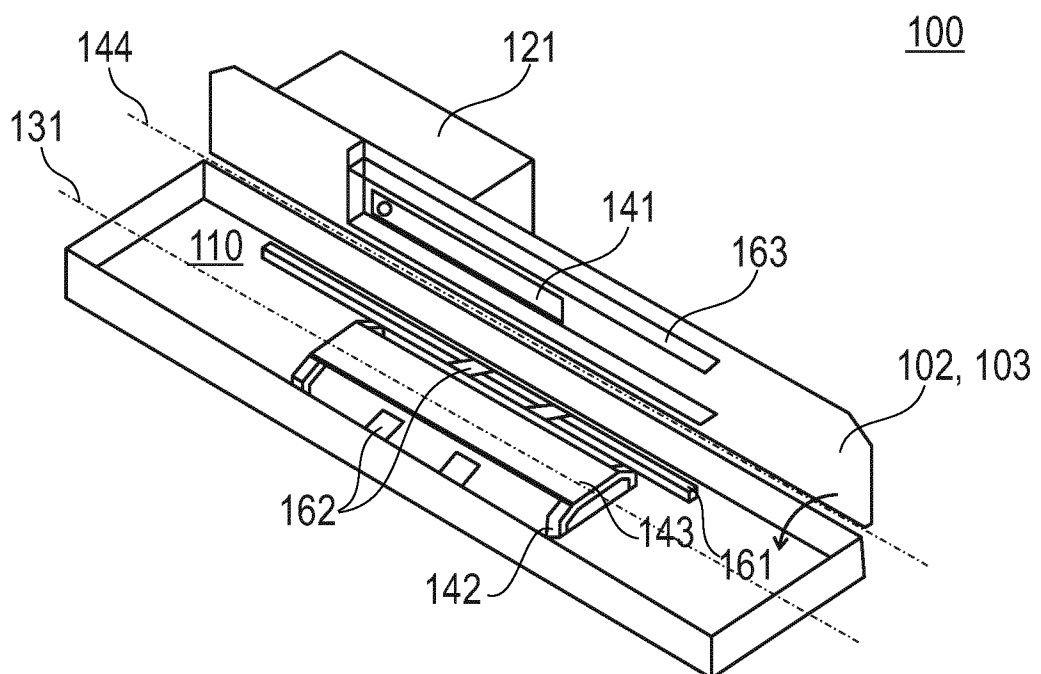


FIG. 4

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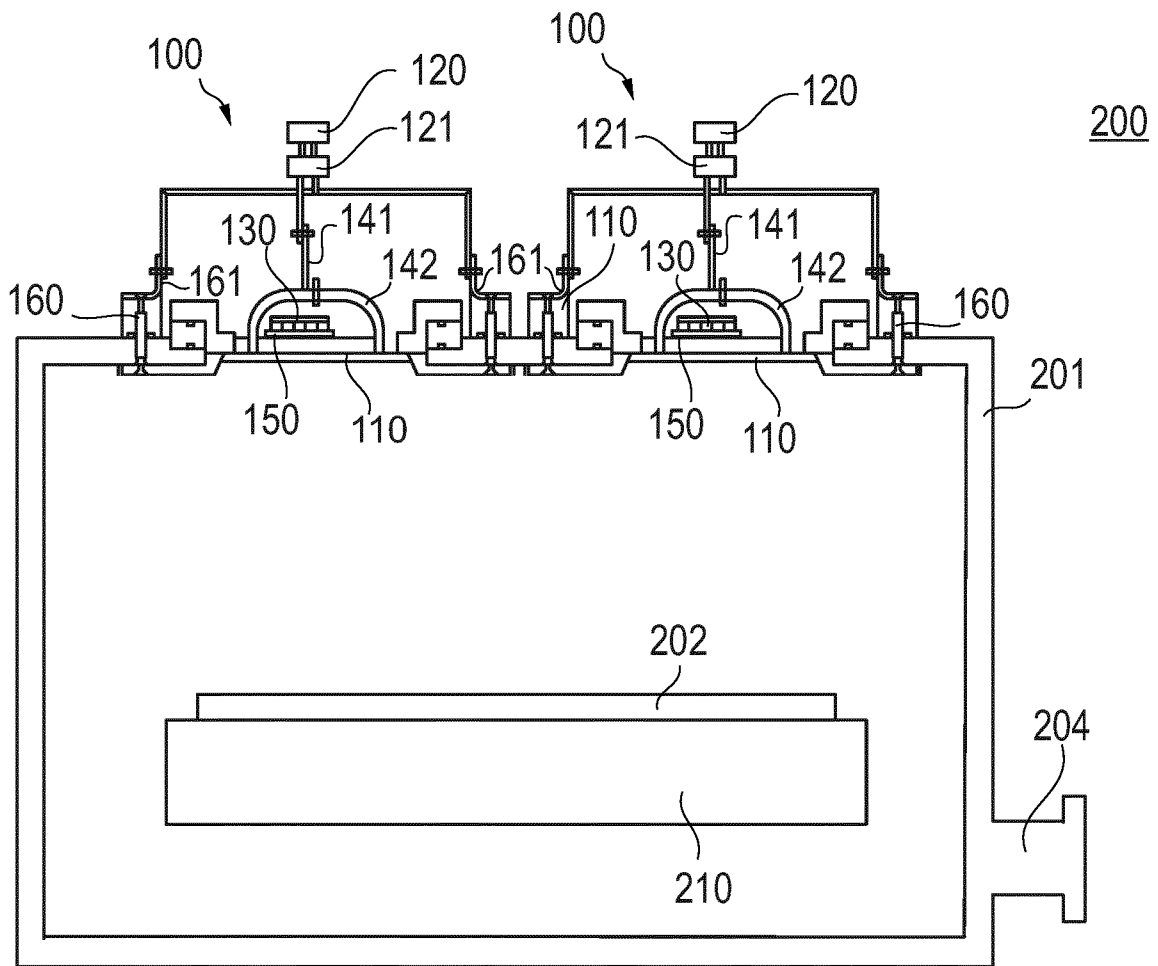


FIG. 5

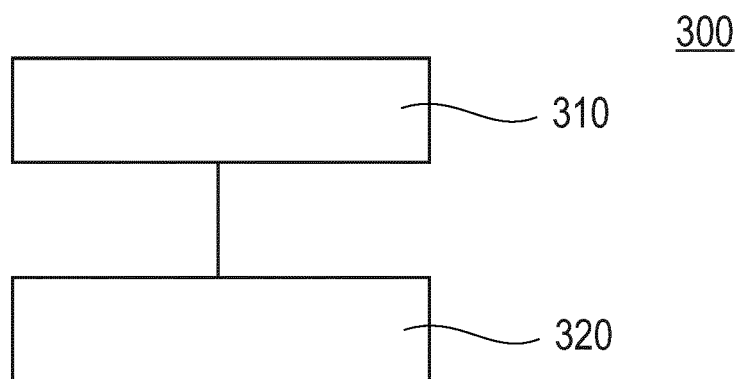


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2015/065369

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H01J37/34 C23C14/35
 ADD.

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)
 H01J C23C

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)

EPO-Internal, WPI Data, COMPENDEX, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/090990 A1 (COX MICHAEL S [US]) 19 April 2012 (2012-04-19)	1,2, 5-11,13, 14
A	abstract; figures 1,2 paragraphs [0001], [0004], [0025] - [0038]	4
Y	WO 2008/057105 A1 (APPLIED MATERIALS INC [US]; STOWELL MICHAEL W [US]; RUSKE MANFRED [DE]) 15 May 2008 (2008-05-15) abstract; figures 5-7 paragraphs [0002], [0004], [0007] - [0009], [0020] - [0025] ----- -/-	1,2, 5-11,13, 14



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

24 February 2016

Date of mailing of the international search report

04/03/2016

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/065369

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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