US 20140151216A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2014/0151216 A1**

(43) **Pub. Date: Jun. 5, 2014**

Sohn et al.

(54) **SPUTTERING APPARATUS AND METHOD OF MANUFACTURING DISPLAY SUBSTRATE USING THE SAME**

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**, Yongin-City (KR)

(72) Inventors: **Sang-Woo Sohn**, Yongin-Si (KR); **Hyung-Jun Kim**, Yongin-si (KR)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin-City (KR)

(21) Appl. No.: **13/900,231**

(22) Filed: **May 22, 2013**

(30) **Foreign Application Priority Data**

Dec. 3, 2012 (KR) 10-2012-0138996

Publication Classification

(51) **Int. Cl.**
H01L 21/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 21/02518*** (2013.01)
USPC **204/192.1**; 204/298.12; 204/298.13

(57) **ABSTRACT**

A sputtering apparatus includes a chamber. A substrate supporting part is disposed in the chamber. A plurality of targets face the substrate supporting part. A target supporting part is disposed under each of the targets to hold the target. A first ground part is disposed between two target supporting parts adjacent to each other and includes a cover separable therefrom. A second ground part is disposed between two target supporting parts adjacent to each other, except for where the first ground part is disposed.

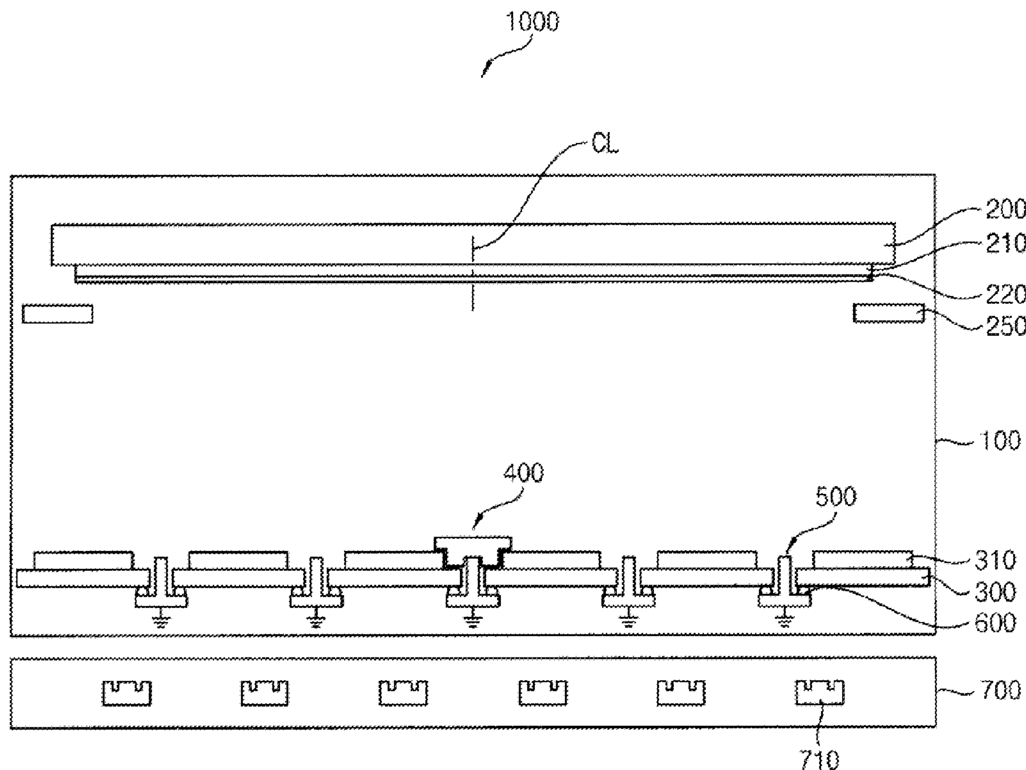


FIG. 1

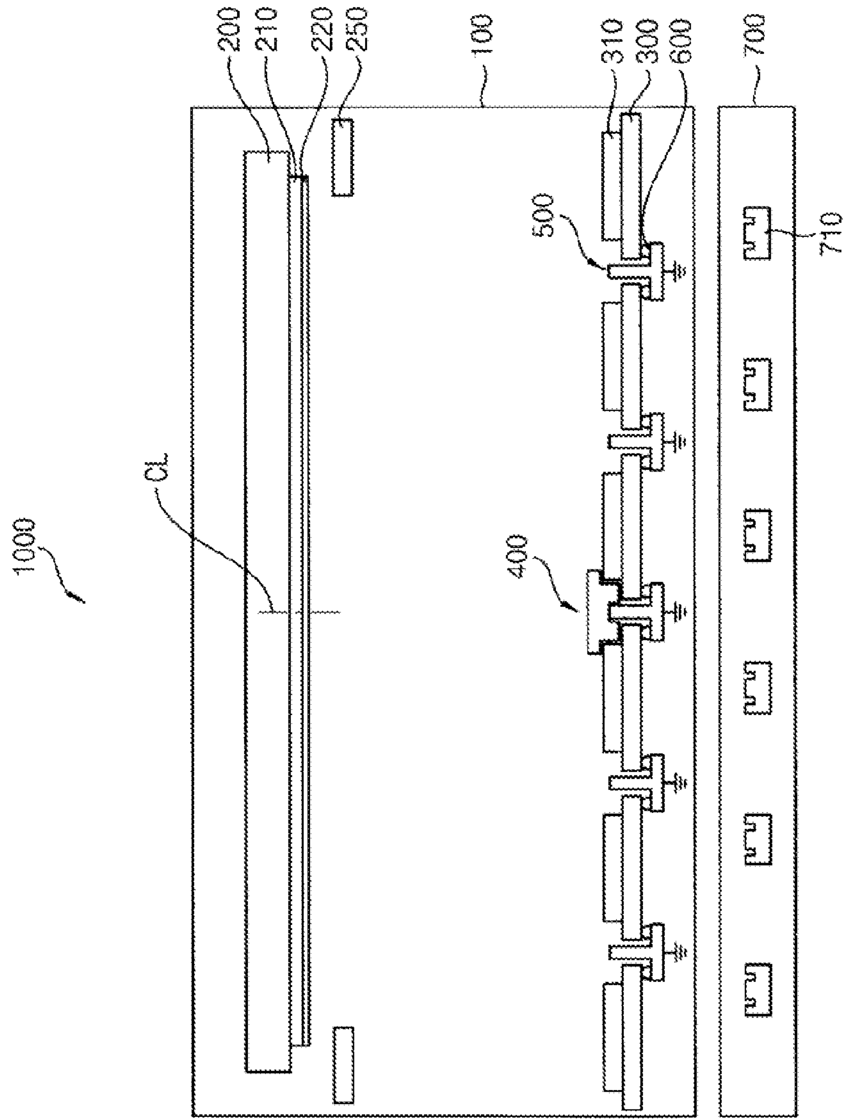


FIG. 2

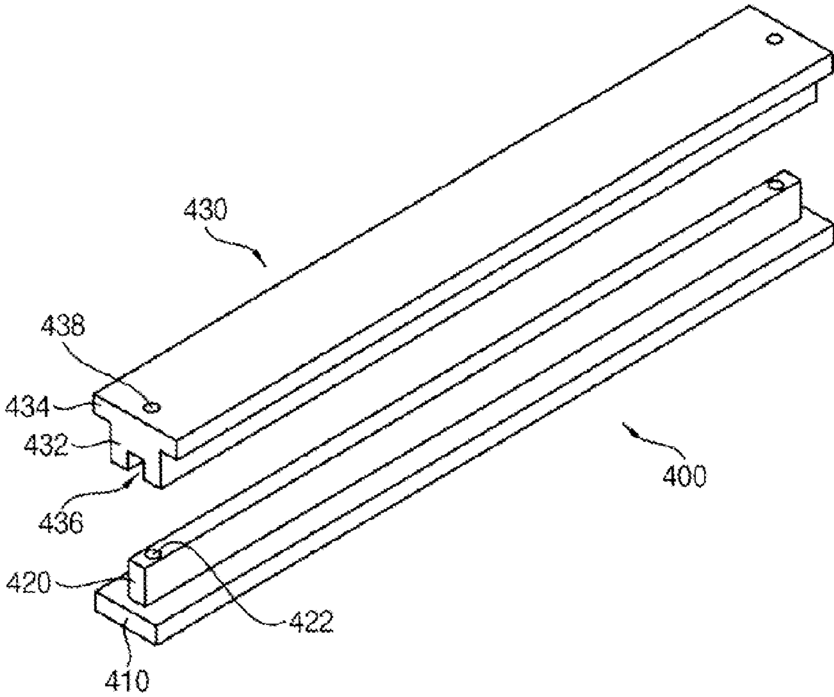


FIG. 3

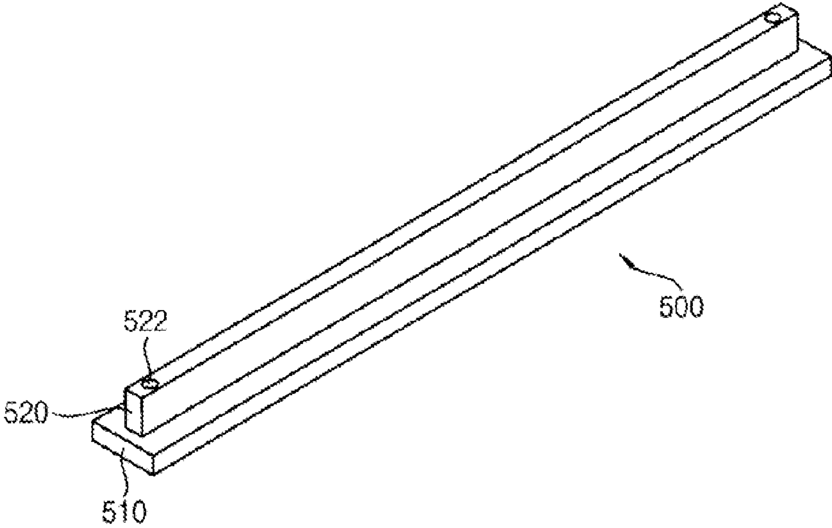


FIG. 4

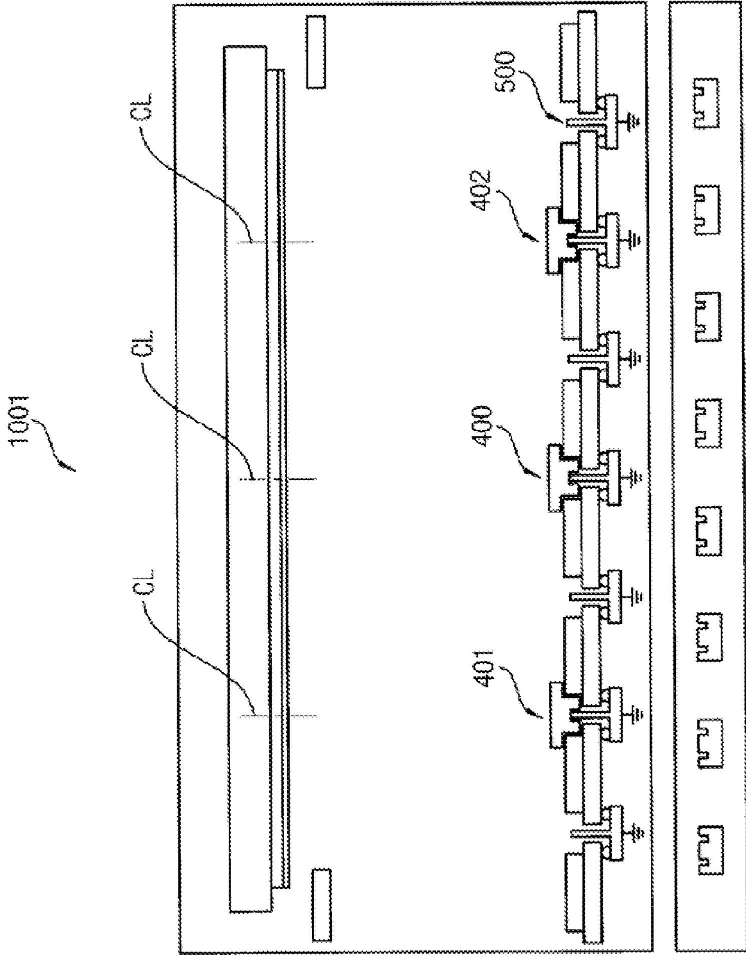


FIG. 5

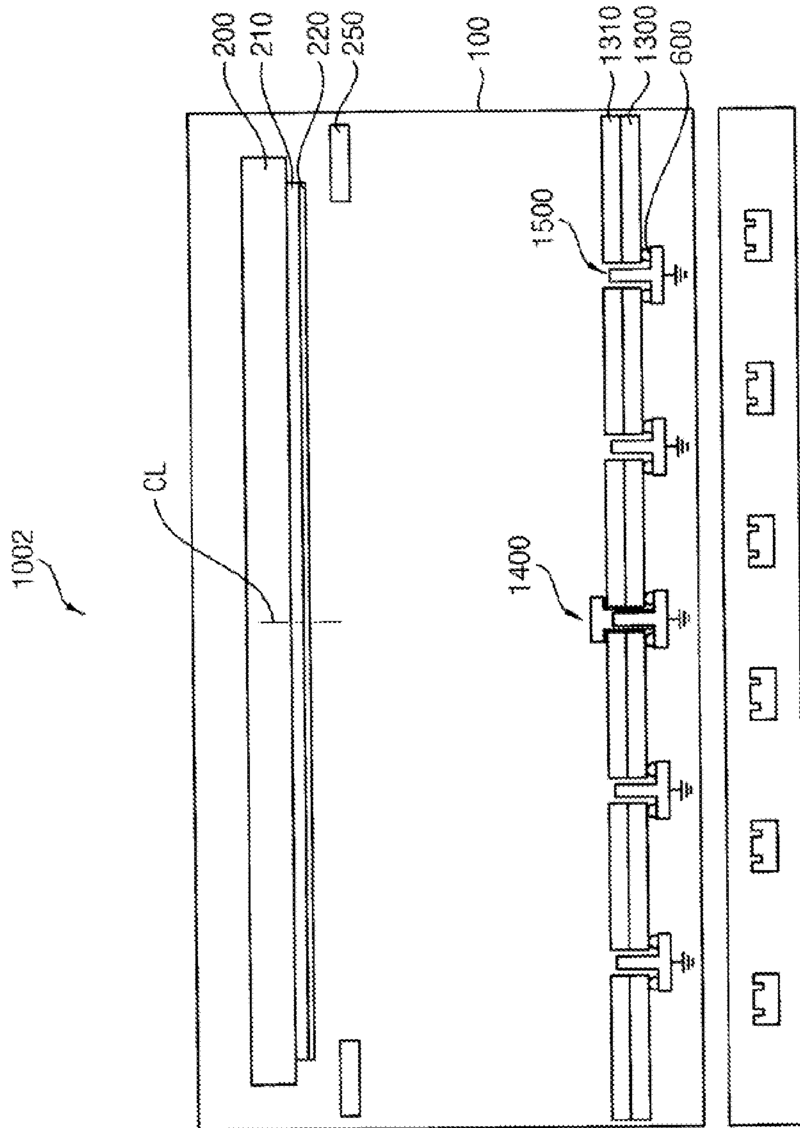


FIG. 6

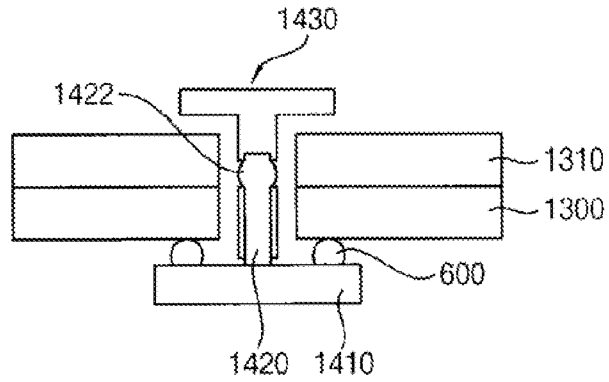


FIG. 7

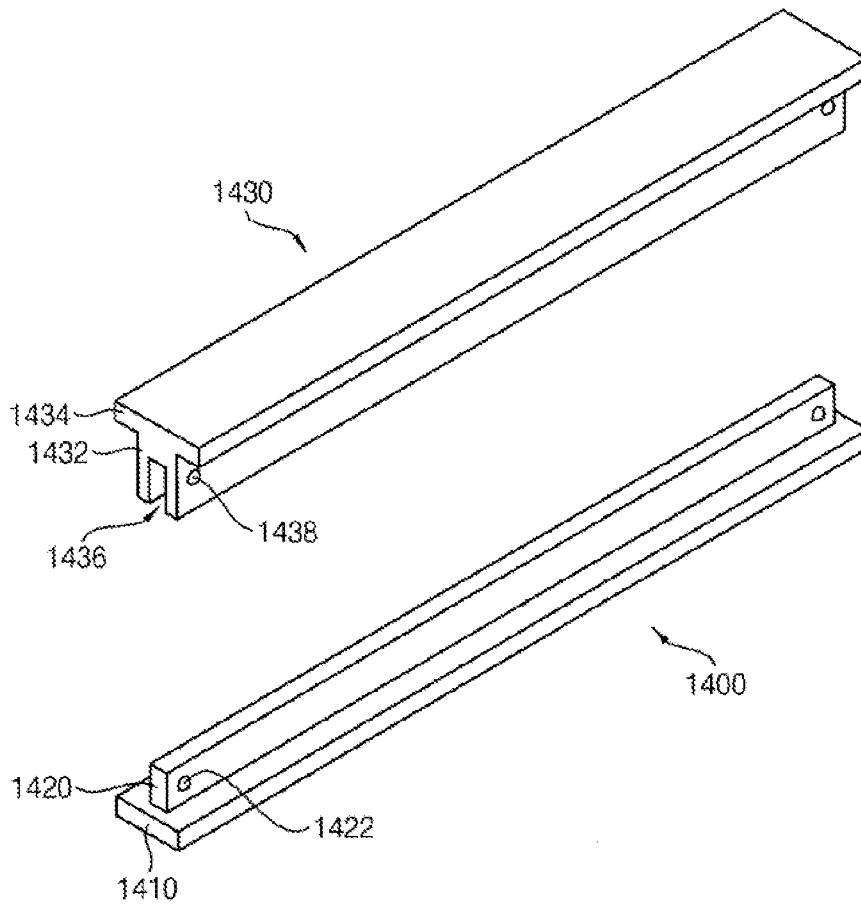


FIG. 8

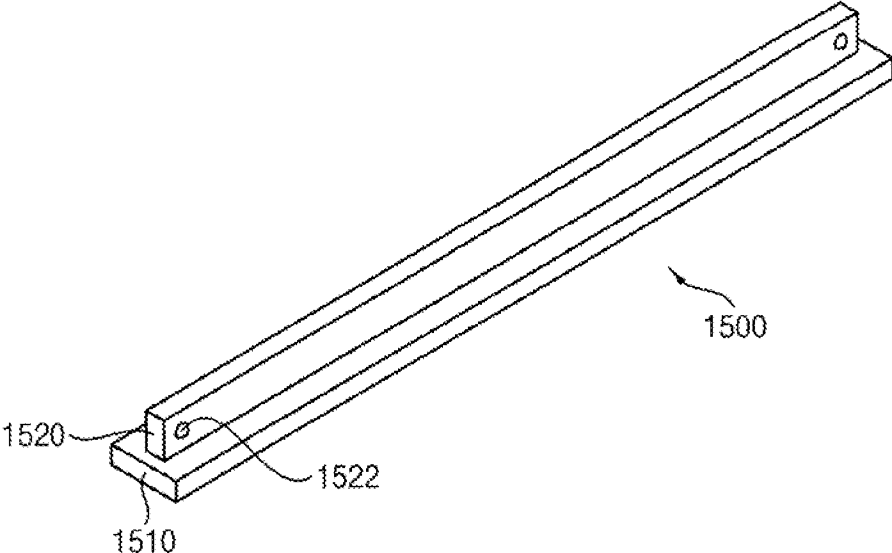


FIG. 9

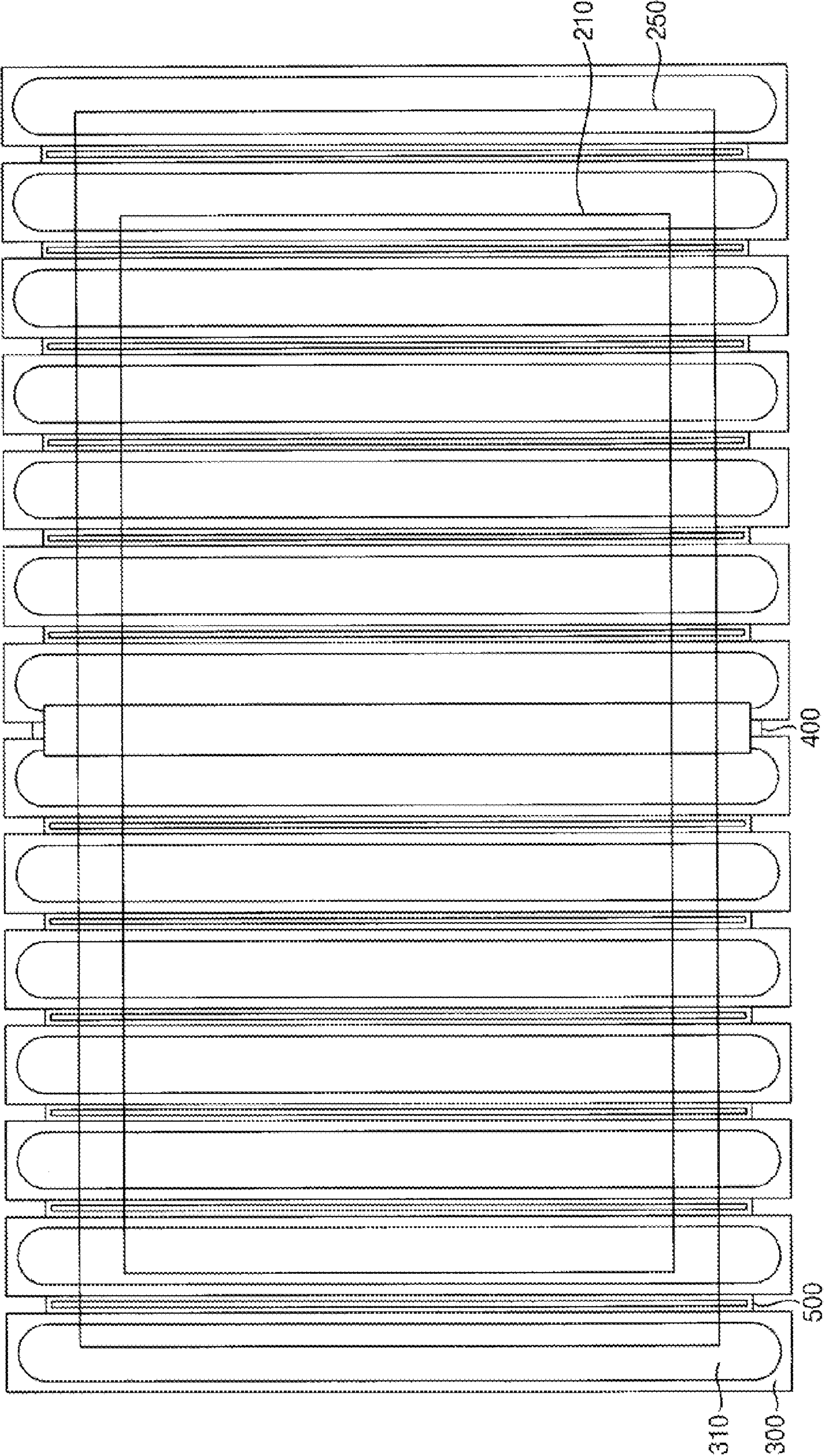
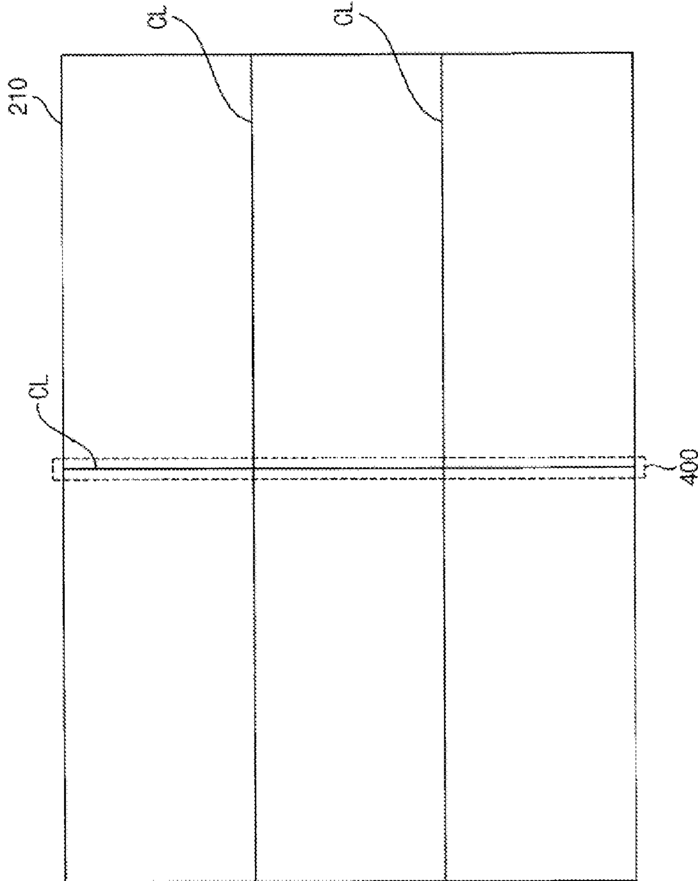


FIG. 10



SPUTTERING APPARATUS AND METHOD OF MANUFACTURING DISPLAY SUBSTRATE USING THE SAME

[0001] This application claims priority to Korean Patent Application No. 10-2012-0138996, filed on Dec. 3, 2012, the entire contents of which are incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] Exemplary embodiments of the invention relate to a sputtering apparatus, and more particularly, to a sputtering apparatus and a method of manufacturing a display substrate using the sputtering apparatus.

DISCUSSION OF THE RELATED ART

[0003] Generally, a liquid crystal display (LCD) device has various characteristics such as being thin, being lightweight, having low power consumption, etc. Thus, LCD devices have been widely used in computer monitors, notebook computer displays, cellular telephones, etc. The LCD device includes an LCD panel displaying an image by manipulating an optical transmissivity of liquid crystal within the LCD device and a backlight assembly disposed under the LCD panel to provide light to the LCD panel. The LCD panel includes a substrate having a thin film formed thereon.

[0004] The thin film may be formed by a sputtering process. According to the sputtering process, plasma, which includes target ions from a target disposed in a chamber, is generated. The substrate is then exposed to the plasma so that deposition material is deposited on the substrate.

[0005] As the size of LCD devices have increases, the substrate of the LCD display has also increased in size. Thus, the size of the sputtering target has increased accordingly. Rather than using a single larger target, a plurality of divided targets may be used. However, it may be difficult to ensure thin film uniformity on the portion of the substrate that corresponds to the region where the multiple divided targets meet each other. Thus, problems with an uneven thickness of the thin film and problems with spot or stains corresponding to the portion between the targets may be caused.

SUMMARY

[0006] One or more exemplary embodiment of the invention provides a sputtering apparatus capable of forming a thin film having uniform thickness and reduced irregularity.

[0007] One or more exemplary embodiments of the invention also provide method of manufacturing a display substrate using the sputtering apparatus.

[0008] According to an exemplary embodiment of the invention, a sputtering apparatus includes a chamber. A substrate supporting part is disposed in the chamber. A plurality of targets face the substrate supporting part. A target supporting part is disposed under each of the targets to hold the target. A first ground part is disposed between two target supporting parts adjacent to each other. The first ground part comprises a cover that is separable therefrom. A second ground part is disposed between two target supporting parts adjacent to each other, except for where the first ground part is disposed.

[0009] In an exemplary embodiment, the first ground part may include a base plate extending along a longitudinal direction of the target. A wall extends perpendicular to the base plate from the base plate.

[0010] In an exemplary embodiment, the cover of the first ground part may include a cover body disposed on the wall, and a cover protrusion protruding from the cover body. The cover protrusion may overlap a portion of the target adjacent to the first ground part.

[0011] In an exemplary embodiment, the cover body of the cover may have a fixing groove combined with the wall.

[0012] In an exemplary embodiment, a first combining portion may be formed at the wall of the first ground part. A second combining portion may be formed at the cover body of the cover. The cover may be fixed to the wall by a combination of the first combining portion and the second combining portion.

[0013] In an exemplary embodiment, the cover body may extend between two targets adjacent to each other and may also extend between two target supporting parts adjacent to each other.

[0014] In an exemplary embodiment, the second ground part may include a base plate extending plate extending along a longitudinal direction of the target, and a wall extending perpendicular to the base plate and extending from the base plate. The base plate and the wall of the second ground part may have a shape substantially the same as the base plate and the wall of the first ground part.

[0015] In an exemplary embodiment, a first combining portion may be formed at the wall. A second combining portion may be formed at the cover. The first combining portion and second combining portion may be combined together. A third combining portion may be formed at the second ground part. The second ground part may have substantially the same shape of the first ground part excluding the cover.

[0016] In an exemplary embodiment, the sputtering apparatus may further include an insulation element disposed between the first or second ground part and the target supporting part insulating the first or second ground part from the target supporting part.

[0017] In an exemplary embodiment, the sputtering apparatus may further include a mask disposed between the target and the target supporting part and defining a sputtering area.

[0018] In an exemplary embodiment, the target may include an oxide semiconductor material.

[0019] In an exemplary embodiment, the oxide semiconductor material may include zinc oxide (ZnO), zinc tin oxide (ZTO), zinc indium oxide (ZIO), indium oxide (InO), titanium oxide (TiO), indium gallium zinc oxide (IGZO), or indium zinc tin oxide (IZTO).

[0020] In an exemplary embodiment, a substrate may be held on the substrate supporting part. A thin film may be formed on the substrate by deposition of a deposition material that includes in the target. A cutting line may be formed on the substrate. The cutting line may correspond to the first ground part.

[0021] In an exemplary embodiment, the first ground part may be disposed between two target supporting parts. The two target supporting parts may be disposed at a center of the sputtering apparatus.

[0022] In an exemplary embodiment, the sputtering apparatus includes a third ground part having a shape substantially the same as the first ground part, and a fourth ground part having a shape substantially the same as the first ground part. The third ground part may be spaced apart form the first ground part by at least two targets. The fourth ground part may be spaced apart form the first ground part by at least two targets.

[0023] In an exemplary embodiment, a substrate may be held on the substrate supporting part. A thin film may be formed on the substrate by deposition of a deposition material that includes in the target. Cutting lines may be formed on the substrate. The cutting lines may correspond to the first, third and fourth ground parts, respectively.

[0024] In an exemplary embodiment, the number of the targets may be 14. The first ground part may be disposed between those of the targets that are disposed at a center. The number of the second ground parts may be 12.

[0025] In an exemplary embodiment, a width of the target supporting part may be substantially the same as a width of the target.

[0026] According to an exemplary embodiment of the invention, a method of manufacturing a display substrate includes forming a thin film on a substrate using a sputtering apparatus, and cutting a cutting line of the substrate. The cutting line corresponds to the first ground part. The sputtering apparatus includes a chamber. A substrate supporting part is disposed in the chamber. A plurality of targets face the substrate supporting part. A target supporting part is disposed under each of the targets to hold the target. A first ground part is disposed between two target supporting parts adjacent to each other and comprising a cover separable therefrom. A second ground part is disposed between two target supporting parts adjacent to each other, except for where the first ground part is disposed.

[0027] In an exemplary embodiment, the thin film may include an oxide semiconductor material.

[0028] According to an exemplary embodiment of the present invention, the sputtering apparatus includes a first ground part including a cover having T-shape and a second ground part, so that the sputtering apparatus may maintain a potential to generate plasma, and remove unwanted particles during sputtering process. Thus, the unwanted particles may be deposited on a surface of the cover, and the cover may be easily separated from a wall of the first ground part so that the cover may be washed.

[0029] In addition, a plurality of display substrates is formed by cutting a cutting line of the substrate. The cutting line corresponds to the first ground part. Spots or stains may be formed on a portion of the substrate to which the first ground part corresponds. However, the substrate may be cut along the cutting line, so that quality of the display substrate may be maintained.

[0030] In addition, when the width of the target is substantially the same as the width of the target supporting part, the size of the target may be maximized so that the thin film may be uniform. Thus, a distance between the target supporting parts adjacent to each other may be minimized, so that a portion of the thin film to which a portion between the targets corresponds, may be minimized. Thus, thickness of the thin film may be uniform.

[0031] In addition, the cover body of the cover may be disposed between two target supporting parts adjacent to each other, as well as between two targets adjacent to each other. Thus, the width of the cover may be minimized, so that thickness of the thin film may be uniform.

[0032] In addition, the second ground part may be substantially the same as the base plate, the wall and the first combining portion of the first ground part. Thus, the cover of the first ground part may be combined with the second ground part, as desired. Therefore, the position of the cover may be changed according to the position of the cutting line.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The above and other features of the invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

[0034] FIG. **1** is a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention;

[0035] FIG. **2** is a perspective view illustrating a first ground part of FIG. **1**;

[0036] FIG. **3** is a perspective view illustrating a second ground part of FIG. **1**;

[0037] FIG. **4** is a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention;

[0038] FIG. **5** a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention;

[0039] FIG. **6** is a enlarged cross-sectional view of part of a first ground part of FIG. **5**;

[0040] FIG. **7** is a perspective view illustrating a first ground part of FIG. **5**;

[0041] FIG. **8** is a perspective view illustrating a second ground part of FIG. **5**;

[0042] FIG. **9** is a plan view illustrating a sputtering apparatus according to an exemplary embodiment of the invention; and

[0043] FIG. **10** is a plan view of a substrate of FIG. **9** illustrating a cutting line.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0044] It will be understood that when an element or layer is referred to as being "on" or "connected to" another element or layer, the element or layer can be directly on or connected to another element or layer or intervening elements or layers. Like numbers may refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0045] Hereinafter, the invention will be explained in detail with reference to the accompanying drawings.

[0046] FIG. **1** is a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention.

[0047] Referring to FIG. **1**, the sputtering apparatus **1000** includes a chamber **100**, a substrate supporting part **200**, a target supporting part **300**, a target **310**, a first ground part **400**, a second ground part **500** and a magnetic assembly **700**.

[0048] The chamber **100** provides a space to form a thin film **220** on a substrate **210** by a sputtering process. For the sputtering process, the inside of the chamber **100** may be maintained at a vacuum or negative pressure. Alternatively, or additionally, the chamber **100** may be filled with a noble gas. For example, the noble gas argon (Ar), helium (He), neon (Ne), krypton (Kr) or xenon (Xe). For example, a pressure of argon (Ar) in the chamber **100** may be about 1 to 100 mTorr.

[0049] The substrate supporting part **200** is disposed inside of the chamber **100** and may hold the substrate **210**. For example, the substrate supporting part **200** may hold the substrate **210** through vacuum absorption. In addition, the substrate supporting part **200** may hold the substrate **210** using a clip disposed around boundaries of the substrate **210**.

In addition, the substrate supporting part **200** may hold the substrate **210** through a sliding combination.

[0050] The substrate **210** may be a display substrate of a liquid crystal display panel. The thin film **220** formed on the substrate **210** may be a wiring of the display substrate. In addition, or alternatively, the thin film **220** may be an oxide semiconductor layer of the display substrate. The oxide semiconductor layer includes an oxide semiconductor. For example, the oxide semiconductor may include zinc oxide (ZnO), zinc tin oxide (ZTO), zinc indium oxide (ZIO), indium oxide (InO), titanium oxide (TiO), indium gallium zinc oxide (IGZO), or indium zinc tin oxide (IZTO).

[0051] The target supporting part **300** is disposed in the chamber **100** and faces the substrate supporting part **200**. A plurality of target supporting parts may be disposed in the chamber **100**. In an enlarged display substrate, the target **310** becomes bigger, and a plurality of the targets having a greater number of targets may be disposed in consideration of a size of the substrate **210**. Therefore sputtering efficiency and management efficiency may be increased. Accordingly, a plurality of target supporting parts **300** may be disposed. The target supporting parts **300** are spaced apart from each other and disposed side by side.

[0052] The target **310** is disposed on the target supporting part **300**, and faces the substrate **210** that is held on the substrate supporting part **200**. The target **310** may consist of a deposition material which is deposited on the substrate **210**. The target **310** may include an oxide semiconductor as the deposition material. For example, the oxide semiconductor may include zinc oxide (ZnO), zinc tin oxide (ZTO), zinc indium oxide (ZIO), indium oxide (InO), titanium oxide (TiO), indium gallium zinc oxide (IGZO), or indium zinc tin oxide (IZTO).

[0053] A plurality of targets **310** may be disposed according to the size of the substrate **210**. The targets are spaced apart from each other and are disposed side by side. The target **310** is consumed by the sputtering process, so that the target **310** may be replaceable. The target **310** may have a size smaller than that of the target supporting part **300** in a plan view. Thus, the target **310** need not be disposed on a boundary of the target supporting part **300**.

[0054] A plasma power may be applied to the target **310** through the target supporting part **300**. The plasma power includes an RF voltage. The substrate supporting part **200** may include conductive material. The substrate supporting part **200** may be electrically connected to the target **310**, and the RE voltage may be applied thereto. In addition, the substrate supporting part **200** may be electrically connected to an external ground terminal and a reference voltage of the RF voltage may be set.

[0055] The RF voltage may cause a plasma discharge by being applied to the chamber **100** through the substrate supporting part **200** and the target supporting part **300**.

[0056] A mask **250** may be disposed between the substrate **210** and the target **310**, to define a shape of the deposition material which is deposited on the substrate **210**. For example, the mask **250** may expose a portion of the substrate **210** on which the thin film **220** is formed.

[0057] The first ground part **400** or the second ground part **500** is disposed between the target supporting parts **300** (or the targets **300**) adjacent to each other.

[0058] The first ground part **400** is disposed between the two target supporting parts **300** which are disposed at a center of the sputtering apparatus. Thus, the first ground part **400** is disposed at a center of an array of the targets **310**. The first ground part **400** is spaced apart from the target supporting part **300** and the target **310** which are adjacent to the first ground part **400**. An insulation element **600** may be disposed between the target supporting part **300** and the first ground part **400** configured to prevent from being short to the target supporting part **300**. Detailed explanation about the first ground part **400** will be mentioned at FIG. **2**.

[0059] The insulation element **600** may include a resin having thermal resistance. The insulation element **600** may be a plurality of protrusions disposed on the first ground part **400**. In addition, the insulation element **600** may have a plate shape.

[0060] The second ground part **500** is disposed between the target supporting parts **300**, except for where the first ground part **400** is disposed. The second ground part **500** is spaced apart from the target supporting part **300** and the target **310**. An insulation element **600** may be disposed between the target supporting part **300** and the second ground part **500** and may be configured to prevent the formation of a short circuit to the target supporting part **300**. A detailed explanation about the second ground part **500** will be provided below with reference to FIG. **3**.

[0061] The insulation element **600** is substantially the same as the insulation element disposed between the first ground part **400** and the target supporting part **300**.

[0062] The first and second ground parts **400** and **500** prevent the targets **310** and the target supporting part **310** from shorting. In addition, first and second ground parts **400** and **500** may be connected to an external ground terminal to maintain a potential for forming plasma. In addition, the first and second ground parts **400** and **500** may be connected to the external ground terminal to ground unwanted electrons accumulated as a result of the plasma discharge.

[0063] The magnetic assembly **700** includes magnetic elements **710** disposed under each of the target **310**. The magnetic elements **710** establish a magnetic field between the substrate **220** and the target **310** and are configured to prevent the breakaway of electrons as a result of the plasma discharge. The magnetic elements **710** may uniformly move to change the magnetic field.

[0064] The substrate **210** on which the thin film **220** is formed, may be turned into a display substrate through a plurality of processes. Thereafter, the substrate **210** may be cut into a specific size. For example, the substrate **210** may be cut along a cutting line CL which is formed at a center of the substrate **210**. The cutting line CL may correspond to a portion on which the first ground part **400** is disposed.

[0065] RF voltage is applied to the target **310**. Secondary electrons may accumulate at a surface of the target **310** as a result of the RF voltage. The secondary electrons may crash with particles of the noble gas which is injected into the chamber **100**. The secondary electrons may exchange momentum to the particle of the noble gas, so that the plasma is formed from the target **310**. Breakaway of the secondary electrons may be prevented by the magnetic assembly **700**.

[0066] FIG. **2** is a perspective view illustrating a first ground part of FIG. **1**.

[0067] Referring to FIG. **2**, the first ground part **400** includes a base plate **410**, a wall **420** and a cover **430**.

[0068] The base plate **410** extends along a longitudinal direction of a target (**320** of FIG. **1**). The wall **420** extends from the base plate **410** in a direction perpendicular to the base plate **410**. The base plate **410** and the wall **420** may

include a metal material which has a relatively high corrosion resistance and a relatively high thermo resistance. For example, the base plate **410** and the wall **420** may include stainless steel. Although not shown in figures, the wall **420** may be divided into a plurality of walls along a longitudinal direction. The wall **420** may be fixed to the base plate **410** by a bolt. In addition, the wall **420** may be fixed to the base plate **410** by a welding or hook assembly.

[0069] The cover **430** includes a cover body **432** and a cover protrusion **434**. The cover **430** is disposed on the wall **420**. The cover protrusion **434** protrudes from the cover body **432**, and overlaps with a boundary of the target (**310** of FIG. **1**).

[0070] A fixing groove **436** is formed under the cover body **432** of the cover **430** and fixes the cover **430** on the wall **420**. The wall **420** is inserted into the fixing groove **436**, so that the cover **430** may be fixed on the wall **420**. The cover **430** may be combined to the wall **420** in a various ways. For example, the cover **430** and the wall **420** may be combined through screw (not shown) and screw hole **438** and **422** formed on the cover **430** and the wall **420**, respectively. In addition, the cover **430** may be fixed to the wall **420** by hook assembly or slide assembly.

[0071] With the sputtering process, unwanted particles may be deposited on the cover **430**. The cover **430** may be easily separated form the wall **420**, so that the cover **430** may be washable. When the deposition material includes the oxide semiconductor, the unwanted particles, which are unnecessary to form the thin film **220**, may be mostly deposited on the cover **430**. The cover **430** includes the cover protrusion **434** overlapping with a boundary of the target **310**, so that the unwanted particles may be mostly deposited on a surface of the cover protrusion **434**. For example, when the target **310** includes the oxide semiconductor, the unwanted particles may be deposited on a boundary of the substrate **210** corresponding to the boundary of the target **310**. In this case, the cover **430** may prevent the unwanted particles from being deposited on the substrate **210**.

[0072] In addition, an upper width of the cover **430** is wider than that of the second ground part **500**, so that the sputtering apparatus may better maintain the potential for forming plasma.

[0073] FIG. **3** is a perspective view illustrating a second ground part of FIG. **1**.

[0074] Referring to FIG. **3**, the second ground part **500** includes a base plate **510**, and a wall **520**.

[0075] The base plate **510** extends along a longitudinal direction of a target (**320** of FIG. **1**). The wall **520** extends perpendicular to the base plate **510** on the base plate **510**. The base plate **510** and the wall **520** may include a metal material which has a relatively high corrosion resistance and a relatively high thermo resistance. For example, the base plate **510** and the wall **520** may include stainless steel. Although not shown in figures, the wall **520** may be divided into a plurality of walls along a longitudinal direction. The wall **520** may be fixed to the base plate **510** by a bolt. In addition, the wall **420** may be fixed to the base plate **510** by a welding or hook assembly.

[0076] A screw hole **522** may be formed on the wall **520** of the second ground part **500**. Thus, the base plate **510** and the wall **420** may be substantially the same as the base plate **410** and the wall **420** of the first ground part **400**. Thus, the cover **430** of the first ground part **400** may be combined to the second ground part **500**.

[0077] Referring again to FIGS. **1** to **3**, the sputtering apparatus **1000** includes the first ground part **400** including the cover **430** having T-shape and the second ground part **500**. A plurality of display substrates is formed by cutting the substrate **210** along the cutting line CL of the substrate **210** which corresponds to the first ground part **400**. Spots or stains may be formed on a portion of the substrate **210** to which the first ground part **400** corresponds. However, the substrate **210** may be cut along the cutting line CL, so that quality of the display substrate may be maintained.

[0078] FIG. **4** is a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention.

[0079] Referring to FIG. **4**, the sputtering apparatus **1001** is substantially the same as a sputtering apparatus **1000** of FIG. **1**, except for a third ground part **401** and a firth ground part **402**. Thus, any further detailed descriptions concerning the same elements as those occurring in FIG. **1** will be omitted.

[0080] A first ground part **400**, a second ground part **500**, the third ground part **401** or the fourth ground part **402** is disposed between target supporting parts **300** (or targets **300**) adjacent to each other.

[0081] The first ground part **400** includes a cover (**430** of FIG. **2**). The first ground part **400** is disposed between the two target supporting parts **300** which are disposed at a center of the sputtering apparatus. The first ground part **400** is substantially the same as the first ground part **400** of FIGS. **1** and **2**, so that any further detailed descriptions concerning the same elements will be omitted.

[0082] The third ground part **401** includes a cover (**430** of FIG. **2**). The third ground part **401** is spaced apart from the first ground part **400** by at least two targets **310**. The third ground part **401** may have a shape substantially the same as the first ground part **400**, so that any further detailed descriptions concerning the same elements will be omitted.

[0083] The fourth ground part **402** includes a cover (**430** of FIG. **2**). The fourth ground part **402** is spaced apart from the first ground part **400** by at least two targets **310**. The fourth ground part **402** may have a shape substantially the same as the first ground part **400**, so that any further detailed descriptions concerning the same elements will be omitted.

[0084] The second ground part **500** is disposed where the first ground part **400**, the third ground part **401** or the fourth ground part **402** is not disposed. The second ground part **500** is substantially the same as the second ground part **500** of FIGS. **1** to **3**, so that any further detailed descriptions concerning the same elements will be omitted.

[0085] A plurality of display substrates is formed by cutting the substrate **210** along a cutting line CL of the substrate **210** which corresponds to the first ground part **400**, the third ground part **401** and the fourth ground part **402**. Spots or stains may be formed on a portion of the substrate **210** to which the first ground part **400**, the third ground part **401** and the fourth ground part **402** correspond. However, the substrate **210** may be cut along the cutting line CL, so that quality of the display substrate may be maintained.

[0086] FIG. **5** a cross-sectional view illustrating a sputtering apparatus according to an exemplary embodiment of the invention.

[0087] Referring to FIG. **5**, the sputtering apparatus **1002** is substantially the same as a sputtering apparatus **1000** of FIG. **1**, except for a target supporting part **1300**, a target **1310**, and a first ground part **1400**. Thus, any further detailed descriptions concerning the same elements will be omitted.

[0088] The target supporting part **1300** is disposed facing a substrate supporting part in the chamber **100**. A plurality of the target supporting parts **1300** may be disposed in the chamber **100**. The target supporting parts **1300** are spaced apart from each other and are disposed side by side.

[0089] The target **1310** is disposed on the target supporting part **1300**, and faces the substrate which is held on the substrate supporting part. The target **1310** may include a deposition material which is deposited on the substrate. Thus, the deposition material is deposited on the substrate to form a thin film. Each od a plurality of the targets **1310** are spaced apart from each other and are disposed side by side. The target **1310** may have a size substantially the same as that of the target supporting part **1300** in a plan view. A width of the target **1310** is substantially the same as a width of the target supporting part **1300**, so that the size of the target **1310** may be enlarged while the thin film is uniform. Thus, a distance between the target supporting parts **1300** adjacent to each other may be minimized, so that a portion of the thin film to which a portion between the targets **1300** corresponds, may be minimized. Thus, the thickness of the thin film may be uniform.

[0090] The first ground part **1400** is disposed between the two target supporting parts **1300** which are disposed at a center of the sputtering apparatus. Thus, the first ground part **1400** is disposed at a center of an array of the targets **1310**. An insulation element **600** may be disposed between the target supporting part **1300** and the first ground part **1400** and may be configured to prevent the target supporting part **1300** from shorting. A detailed explanation of the first ground part **1400** is provided below with reference to FIGS. **6** and **7**.

[0091] The second ground part **1500** is disposed between the target supporting parts **1300**, except for where the first ground part **1400** is disposed. An insulation element **600** may be disposed between the target supporting part **1300** and the second ground part **1500** and may be configured to prevent the second ground part **1300** from being shorted to the target supporting part **1300**. A detailed explanation of the second ground part **1500** is provided below with respect to FIG. **8**.

[0092] FIG. **6** is an enlarged cross-sectional view of part of a first ground part of FIG. **5**. FIG. **7** is a perspective view illustrating a first ground part of FIG. **5**.

[0093] Referring to FIGS. **6** and **7**, the first ground part **1400** includes a base plate **1410**, a wall **1420** and a cover **1430**. The first ground part **1400** is substantially the same as the first ground part **400** of FIG. **2**, except for a first combining portion **1422**, a second combining portion **1438** and a fixing groove **1436**. Thus, any further detailed descriptions concerning the same elements will be omitted.

[0094] The base plate **1410** extends along a longitudinal direction of a target. The wall **1420** extends perpendicular to the base plate **1410** from the base plate **1410**. The first combining portion **1422** is formed on the wall **1420**. The first combining portion **1422** is combined with the second combining portion **1438** of the cover **1430**, so that the cover **1430** may be fixed on the wall **1420**. For example, the first combining portion **1422** may be a protrusion formed on a side of the wall **1420**, and the second combining portion **1438** may be a hole formed on a cover body **1432** of the cover **1430**.

[0095] The cover **1430** includes a cover body **1432** and a cover protrusion **1434**. The cover **430** is disposed on the wall **420**. The cover protrusion **1434** protrudes from the cover body **1432**, and overlaps with a boundary of the target.

[0096] The fixing groove **1436** is formed under the cover body **1432** of the cover **1430** to fix the cover **1430** on the wall **1420**. The wall **1420** is inserted into the fixing groove **1436**, so that the cover **1430** may be fixed on the wall **1420**.

[0097] The cover body **1432** of the cover **1430** may be disposed between two target supporting parts adjacent to each other, as well as between two targets adjacent to each other, comparing to the cover **430** of FIG. **2**. Accordingly, although a thickness of a portion of the cover body **1420**, which forms the fixing groove **1436**, is relatively small, the fixing groove **1436** may have a sufficient depth, so that the cover **1430** may be firmly fixed on the wall **1420**.

[0098] A second combining part **1438** may be formed on the cover body **1432** of the cover **1430**. The second combining part **1438** is combined with the first combining part **1422** to combine the cover **1430** with the wall **1420**. For example, the first combining part **1422** may be a protrusion formed on a side of the wall **1420**, and the second combining part **1438** may be a hole formed through the cover body **1432** of the cover **1430**.

[0099] The cover **1430** may be easily separated form the wall **1420**, so that the cover **1430** may be washable. When the deposition material includes the oxide semiconductor, the unwanted particles which are unnecessary to form a thin film may be mostly deposited on the cover **1430**. The cover **1430** includes the cover protrusion **1434** overlapping with a boundary of the target **1310**, so that the unwanted particles may be mostly deposited on a surface of the cover protrusion **1434**.

[0100] According to an exemplary embodiment, a size of the target may be maximized, and a width of the cover may be minimized, so that the thin film may have a uniform thickness.

[0101] FIG. **8** is a perspective view illustrating a second ground part of FIG. **5**.

[0102] Referring to FIG. **8**, the second ground part **1500** includes a base plate **1510** and wall **1520**. The second ground part **1500** is substantially the same as the second ground part **500** of FIG. **3**, except for a first combining part **1522**. Thus, any further detailed descriptions concerning the same elements will be omitted.

[0103] The base plate **1510** extends along a longitudinal direction of a target. The wall **1520** extends perpendicular to the base plate **1510** from the base plate **1510**. The first combining portion **1522** is formed on the wall **1520**. The first combining portion **1522** may be substantially the same as the first combining portion **1422** of the first ground part **1400**. Thus, the second ground part **1500** may be substantially the same as the base plate **1410**, the wall **1420** and the first combining portion **1422** of the first ground part **1400**. Thus, the cover **1430** of the first ground part **1400** may be combined with the second ground part **1500**, as desired.

[0104] FIG. **9** is a plan view illustrating a sputtering apparatus according to an exemplary embodiment of the invention. FIG. **10** is a plan view of a substrate of FIG. **9** illustrating a cutting line.

[0105] Referring to FIGS. **9** and **10**, the sputtering apparatus is substantially the same as the sputtering apparatus **1000** of FIG. **1**, except for the number of targets **310** and an array of a first ground part **400** and a second ground part **500**. Thus, any further detailed descriptions concerning the same elements will be omitted.

[0106] A plurality of targets **310** corresponding to a substrate **210** is disposed. Both ends of each of the target **310** may have rounded edges. The targets **310** are spaced apart from each other. The first or ground part **400** or **500** may be disposed between the targets.

[0107] A target supporting part **300** is disposed under each of the targets **310**. A size of the target supporting part **300** may be the same as or bigger than that of the target **310** in a plan view. The target supporting parts **300** are separated from each other. The first or ground part **400** or **500** may be disposed between the target supporting parts.

[0108] The first ground part **400** is disposed between the two target supporting parts **300** which are disposed at a center of the sputtering apparatus. The second ground part **500** is disposed between the target supporting parts **300**, except for where the first ground part **400** is disposed.

[0109] A mask **250** may determine a shape of the thin film formed on the substrate **210**. The mask **250** exposes a portion of the substrate **210** on which the thin film is formed. The mask **250** may have an opening bigger than the substrate **210** in a plan view. The substrate **210** may be disposed in the mask **250** in a plan view.

[0110] After the thin film is formed on the substrate **210**, the substrate **210** may be cut into a plurality of display substrates. The substrate **210** may be cut along a cutting line CL. At least one of the cutting lines CL may correspond to the first ground part **400**. Thus, the cutting line CL may be formed at a portion of the substrate **210** which corresponds to the first ground part **400**.

[0111] Although one cutting line CL is shown as being disposed corresponding to the first ground part **400**, when the sputtering apparatus includes a plurality of the first ground parts **400**, a plurality of cutting lines corresponds to each of the first ground parts may be formed.

[0112] The cover **430** of the first ground part **400** may remove unwanted particles and maintain plasma potential during the sputtering process. The first ground part **400** overlaps a portion of the target **310**, so that thin film formed on the substrate **210** may have spot or stain thereon. According to an exemplary embodiment of the present invention, the cutting line CL is formed at a portion of the substrate **210** which corresponds to the first ground part **400** where spots or stains may form, and the cutting line CL is cut away, so that quality of finished products may be maintained.

[0113] Although one first ground part **400** might be disposed only at a center of the targets **310**, a plurality of first ground parts may be disposed, and a plurality of cutting lines corresponding to each of the first ground parts may be formed on the substrate **210**.

[0114] A sputtering apparatus includes a chamber. A substrate supporting part is disposed in the chamber. A plurality of targets face the substrate supporting part. A target supporting part is disposed under each of the targets to hold the target. A first ground part is disposed between two target supporting parts adjacent to each other. The first ground part comprises a cover separable therefrom. A second ground part is disposed between two target supporting parts adjacent to each other, except for where the first ground part is disposed. A method of manufacturing a display substrate may include a step of forming a thin film on a substrate, and a step of cutting a portion corresponding to the first ground part to form the display substrate. The sputtering apparatus may be the sputtering apparatus **100** of FIG. **1**.

[0115] The thin film may be an oxide semiconductor layer. The oxide semiconductor layer includes an oxide semiconductor. For example, the oxide semiconductor may include zinc oxide (ZnO), zinc tin oxide (ZTO), zinc indium oxide (ZIO), indium oxide (InO), titanium oxide (TiO), indium gallium zinc oxide (IGZO), or indium zinc tin oxide (IZTO).

[0116] A portion corresponding to the first ground part is cut away to form the display substrate, so that quality of the display substrate may be maintained.

[0117] According to an exemplary embodiment of the present invention, the sputtering apparatus includes a first ground part including a cover having T-shape and a second ground part, so that the sputtering apparatus may maintain potential to generate plasma, and remove unwanted particles during sputtering process. Thus, the unwanted particles may be deposited on a surface of the cover, and the cover may be easily separated from a wall of the first ground part to wash the cover.

[0118] In addition, a plurality of display substrates is formed by cutting a cutting line of the substrate. The cutting line corresponds to the first ground part. Spots or stains may be formed on a portion of the substrate to which the first ground part corresponds. However, the substrate may be cut along the cutting line, so that quality of the display substrate may be maintained.

[0119] In addition, when a width of the target is substantially the same as a width of the target supporting part, the size of the target may be maximized configured so that the thin film may be uniform. Thus, a distance between the target supporting parts adjacent to each other may be minimized, so that a portion of the thin film to which a portion between the targets corresponds, may be minimized. Thus, thickness of the thin film may be uniform.

[0120] In addition, the cover body of the cover may be disposed between two target supporting parts adjacent to each other, as well as between two targets adjacent to each other. Thus, the width of the cover may be minimized, so that thickness of the thin film may be uniform.

[0121] In addition, the second ground part may be substantially the same as the base plate, the wall and the first combining portion of the first ground part. Thus, the cover of the first ground part may be combined with the second ground part, as desired. Therefore, position of the cover may be changed according to position of the cutting line.

[0122] The foregoing is illustrative of the invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of the invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of the invention.

What is claimed is:

1. A sputtering apparatus comprising:

a chamber;

a substrate supporting part disposed in the chamber;

a plurality of targets disposed within the chamber and facing the substrate supporting part;

a plurality of target supporting parts, each of the plurality of target supporting parts disposed under a corresponding target of the plurality of targets, the target supporting part configured to hold the plurality of targets;

a first ground part disposed between a first two adjacent target supporting parts of the plurality of target supporting parts, the first ground part comprising a removable cover; and

a plurality of second ground parts, each of which is disposed between adjacent target supporting parts of the plurality of target supporting parts, except for between the first two adjacent target supporting parts where the first ground part is disposed.

2. The sputtering apparatus of claim **1**, wherein the first ground part comprises a base plate extending along a longitudinal direction of the target; and

a wall extending perpendicular to the base plate from the base plate.

3. The sputtering apparatus of claim **2**, wherein the cover of the first ground part comprises a cover body disposed on the wall, and a cover protrusion protruding from the cover body, the cover protrusion overlapping a portion of a target of the plurality of targets adjacent to the first ground part.

4. The sputtering apparatus of claim **3**, wherein the cover body of the cover has a fixing groove combined with the wall.

5. The sputtering apparatus of claim **4**, wherein a first combining portion is formed at the wall of the first ground part, a second combining portion is formed at the cover boy of the cover, and the cover is fixed to the wall by combination of the first combining portion and the second combining portion.

6. The sputtering apparatus of claim **4**, wherein the cover body extends between a first two adjacent targets adjacent of the plurality of targets that correspond to the first two adjacent target supporting parts.

7. The sputtering apparatus of claim **2**, wherein the second ground part comprises a base plate extending plate extending along a longitudinal direction of the target; and

a wall extending perpendicular to the base plate from the base plate, and

wherein the base plate and the wall of the second ground part has a shape substantially the same as the base plate and the wall of the first ground part.

8. The sputtering apparatus of claim **7**, wherein a first combining portion is formed at the wall, a second combining portion is formed at the cover, the first combining portion and second combining portion are combined together,

a third combining portion is formed at the second ground part, the second ground part is substantially the same as a shape of the first ground part excluding the cover.

9. The sputtering apparatus of claim **1**, further comprising an insulation element disposed between the first or second ground part and the target supporting part to insulate the first or second ground part from the target supporting part.

10. The sputtering apparatus of claim **1**, further comprising a mask disposed between the plurality of targets and the plurality of target supporting parts, the mask defining a sputtering area.

11. The sputtering apparatus of claim **1**, wherein the plurality of targets comprise an oxide semiconductor material.

12. The sputtering apparatus of claim **11**, wherein the oxide semiconductor material comprises zinc oxide (ZnO), zinc tin oxide (ZTO), zinc indium oxide (ZIO), indium oxide (InO), titanium oxide (TiO), indium gallium zinc oxide (IGZO), or indium zinc tin oxide (IZTO).

13. The sputtering apparatus of claim **1**, wherein a substrate is held on the substrate supporting part, a thin film is formed on the substrate by deposition of a deposition material that includes in the target, and

a cutting line is formed on the substrate, the cutting line running through a center of the first ground part.

14. The sputtering apparatus of claim **1**, wherein the first two target supporting parts are disposed at a center of the sputtering apparatus.

15. The sputtering apparatus of claim **1**, further comprising:

a third ground part having a shape substantially the same as the first ground part, the third ground part spaced apart form the first ground part by at least two targets of the plurality of targets, and

a fourth ground part having a shape substantially the same as the first ground part, the fourth ground part spaced apart form the first ground part by at least two targets of the plurality of targets.

16. The sputtering apparatus of claim **15**, wherein a substrate is held on the substrate supporting part, a thin film is formed on the substrate by deposition of a deposition material, and

cutting lines are formed on the substrate, the cutting lines correspond to the first, third and fourth ground parts, respectively.

17. The sputtering apparatus of claim **1**, wherein the plurality of the targets includes 14 targets, the first the two adjacent targets are centered among the plurality of targets, and there are 12 ground parts within the plurality of second ground parts.

18. The sputtering apparatus of claim **1**, wherein the width of the target supporting part is substantially the same as width of each target of the plurality of targets.

19. A method of manufacturing a display substrate, comprising:

forming a thin film on a substrate using a sputtering apparatus, the sputtering apparatus comprising a chamber, a substrate supporting part disposed in the chamber, a plurality of targets facing the substrate supporting part, a target supporting part disposed under each of the plurality of targets, a first ground part disposed between a first two adjacent target supporting parts of the plurality of target supporting parts, the first ground part comprising a removable cover, and a plurality of second ground parts, each of which is disposed between adjacent target supporting parts of the plurality of target supporting parts, except for between the first two adjacent target supporting parts where the first ground part is disposed; and

cutting a cutting line of the substrate, the cutting line running through a center of the first ground part and forming the display substrate.

20. The method of claim **19**, wherein the thin film comprises an oxide semiconductor material.

* * * * *