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(54) **SPUTTERING DEVICE AND SPUTTERING METHOD**

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C23C 14/54	(2006.01)
H01L 51/00	(2006.01)
C23C 14/00	(2006.01)
H01J 37/32	(2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC 204/192.13, 298.03

See application file for complete search history.

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(57) **ABSTRACT**

One or more embodiments of the present invention relate to a sputtering device and a sputtering method. By using the sputtering device according to the present embodiment, characteristics of a deposition layer formed at the organic light emitting display apparatus may be improved, thereby improving electric characteristics and image quality of the organic light emitting display apparatus may be improved.

18 Claims, 7 Drawing Sheets

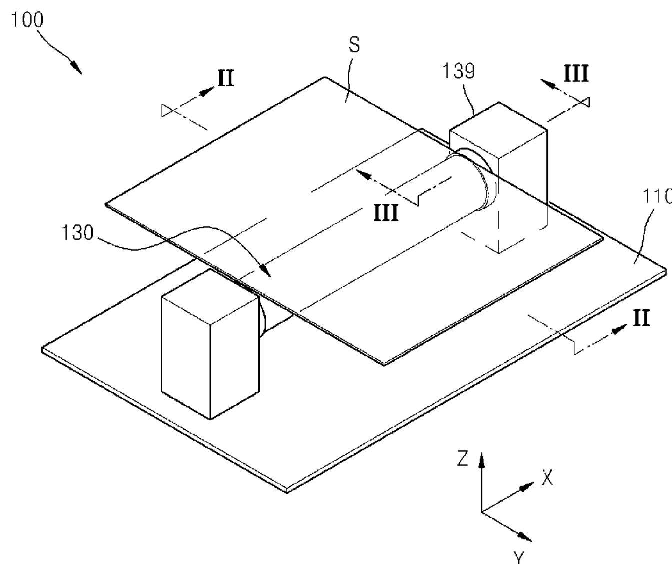


FIG. 1

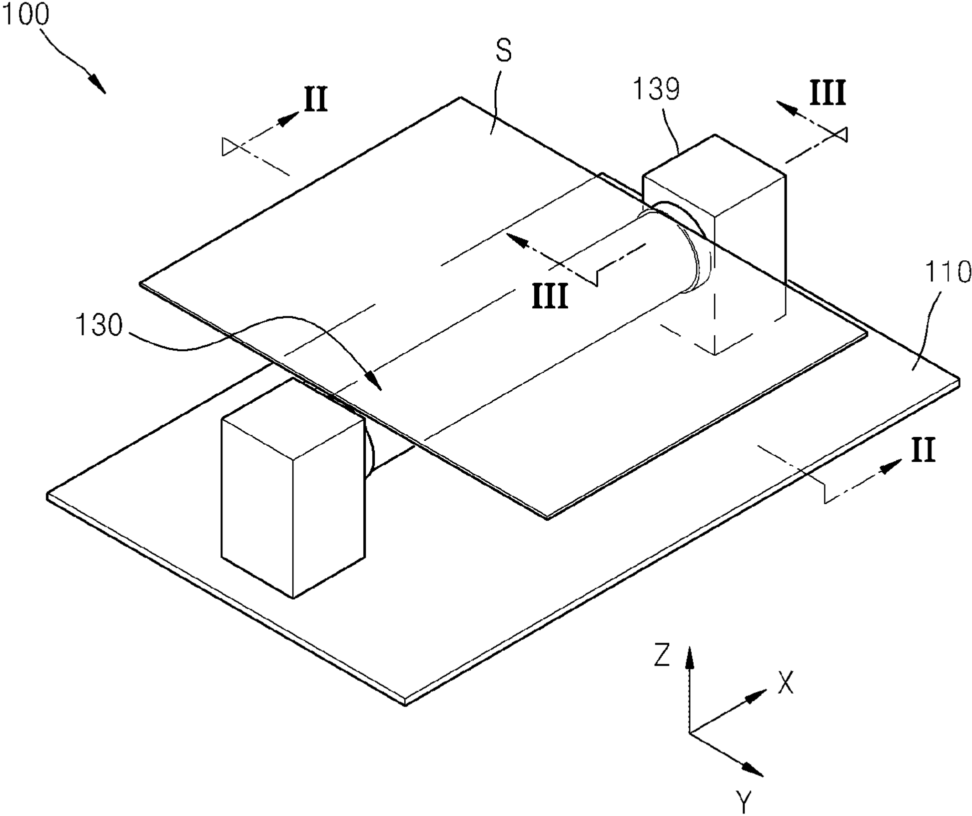


FIG. 2

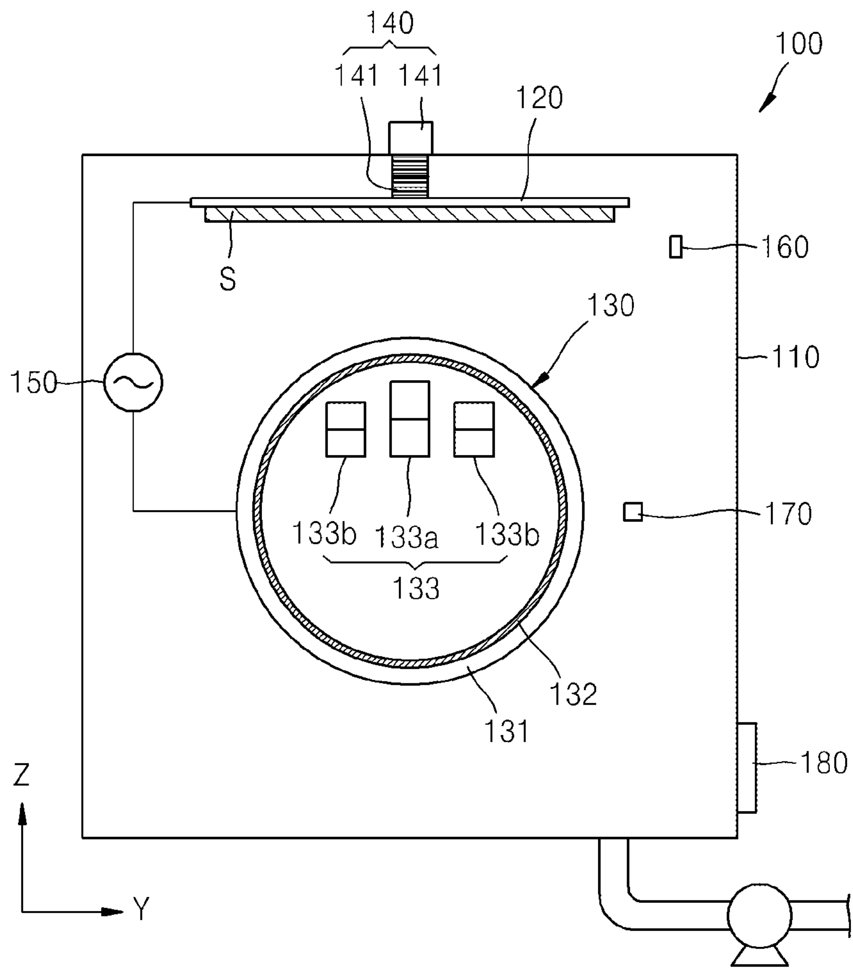


FIG. 3

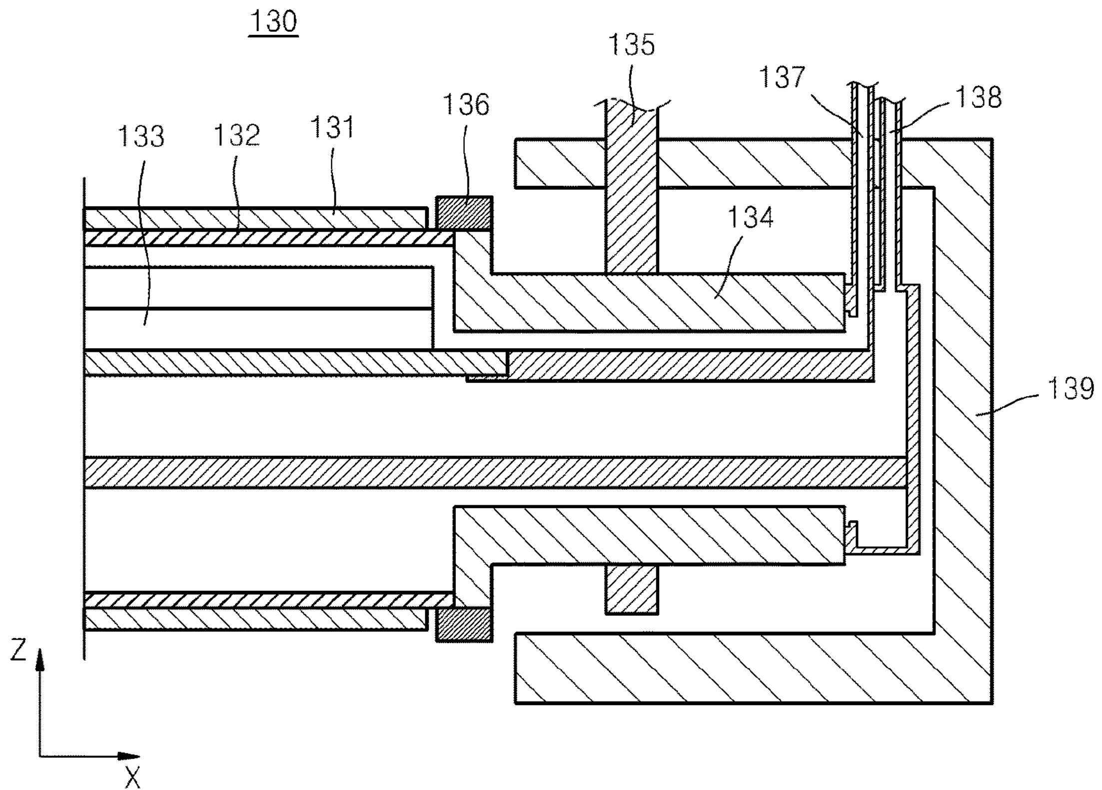


FIG. 4

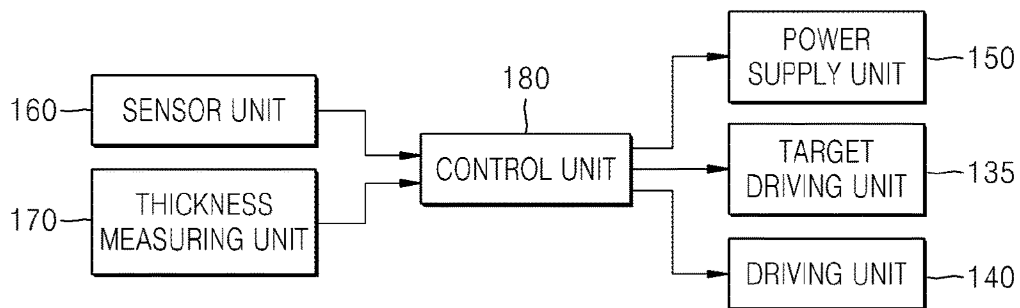


FIG. 5

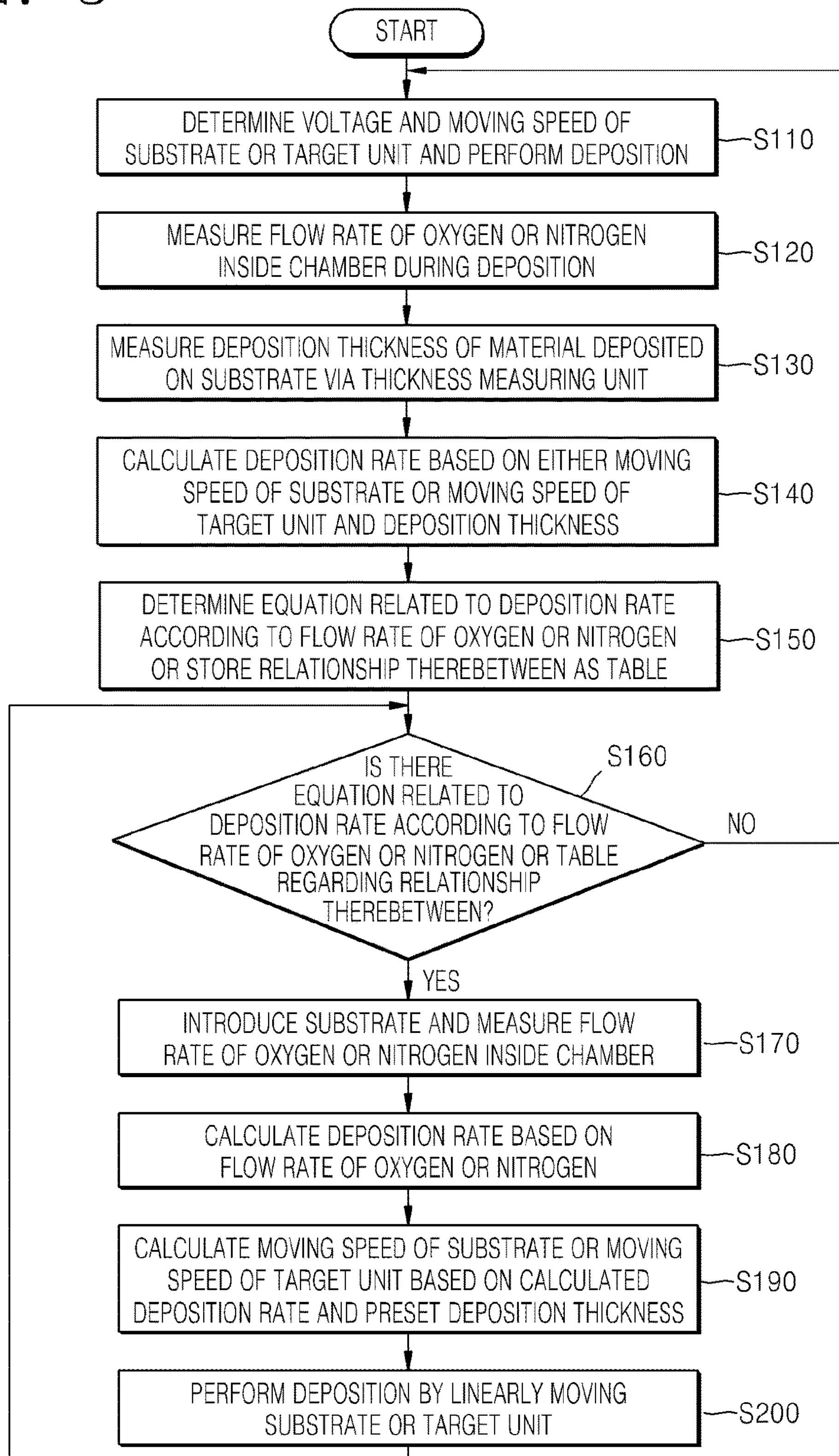


FIG. 6

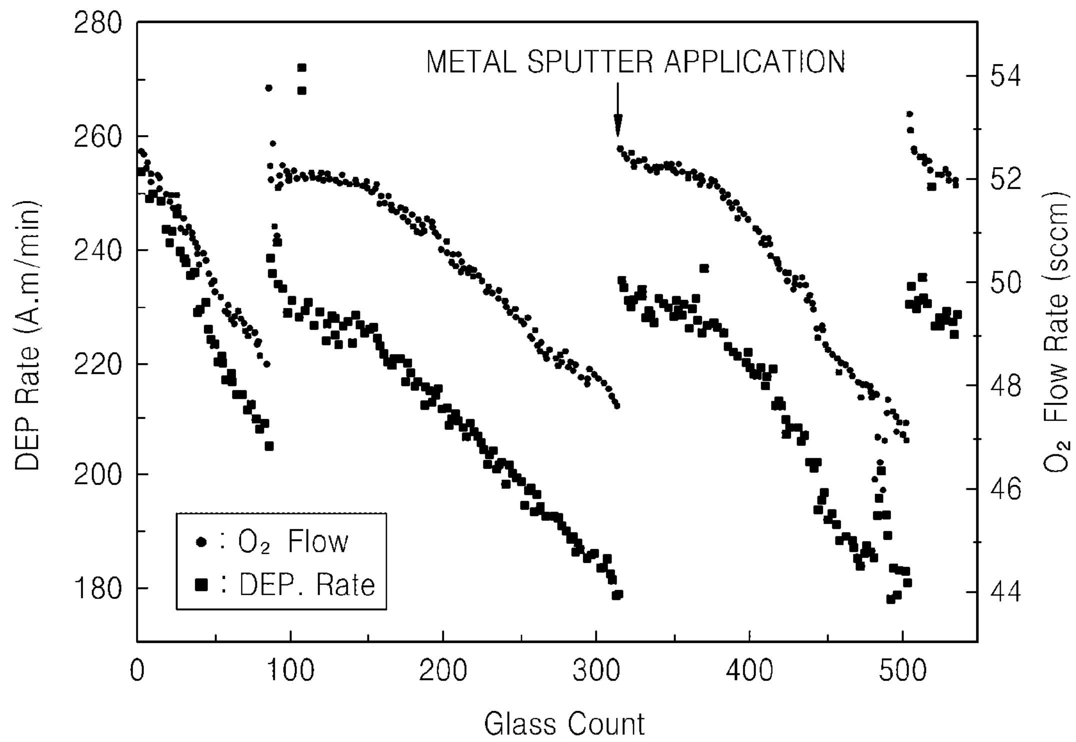


FIG. 7

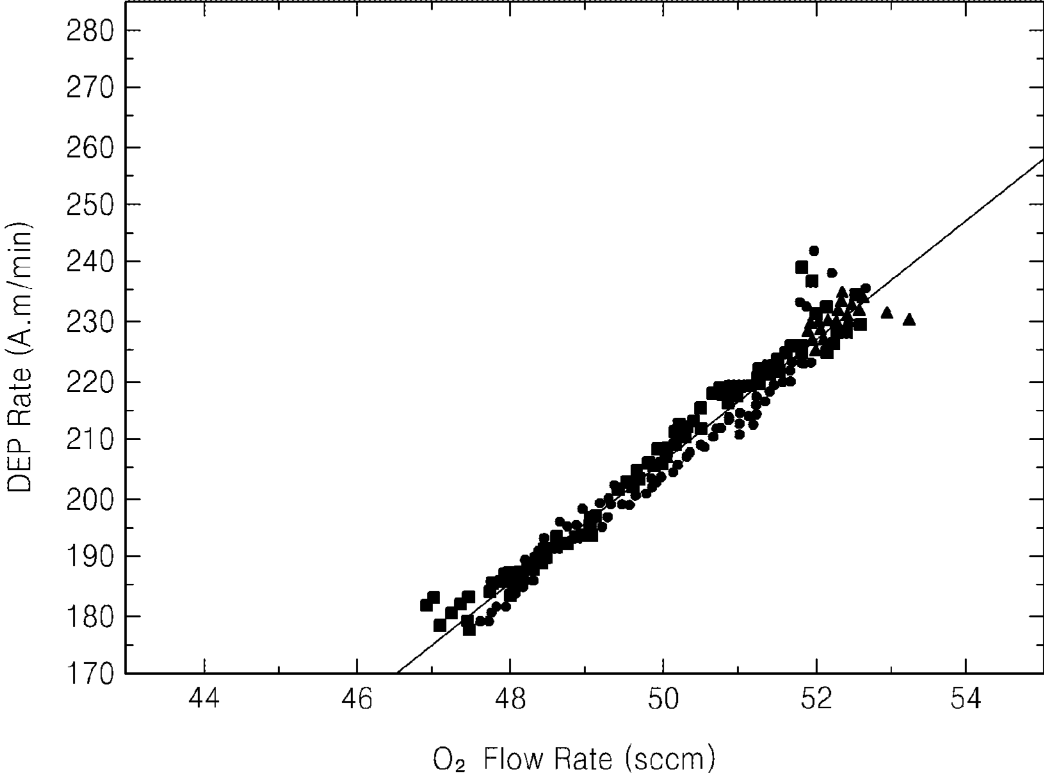


FIG. 8

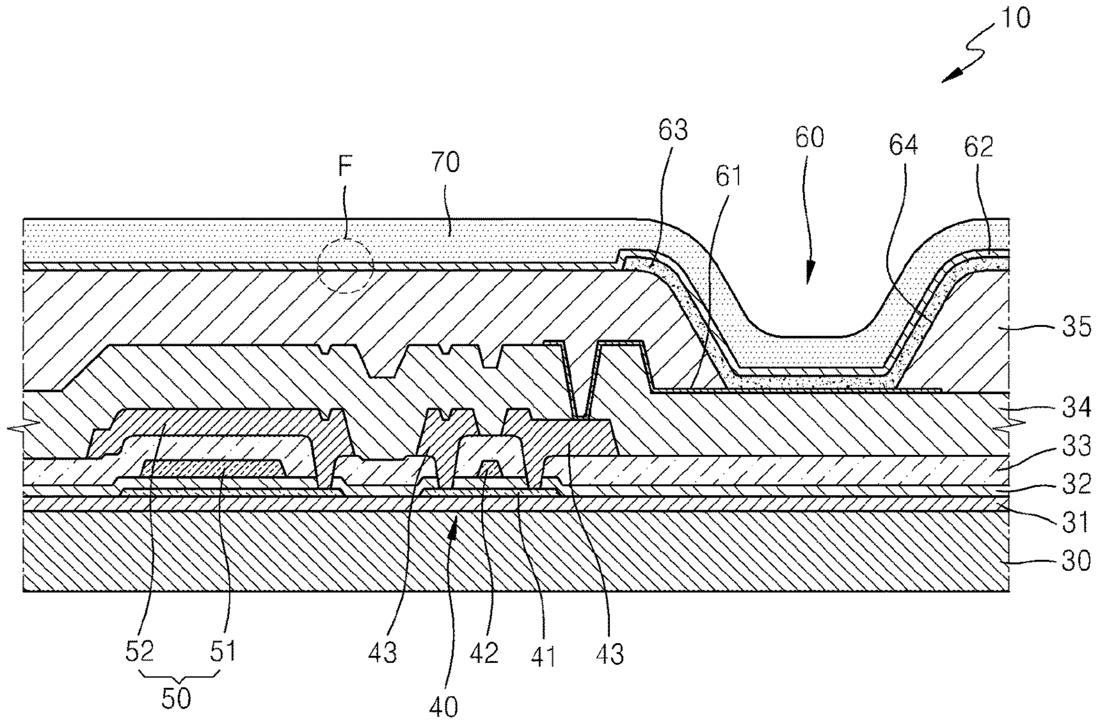
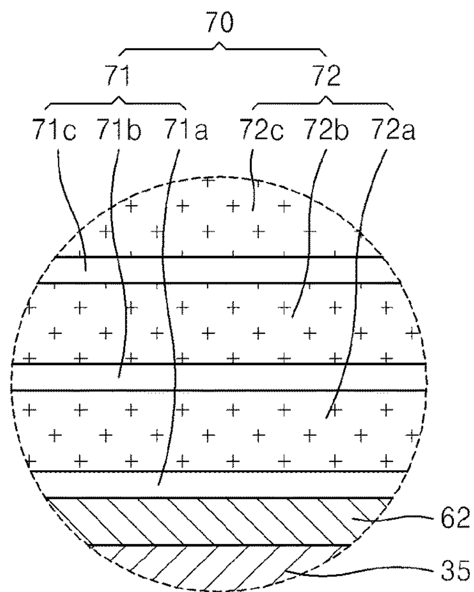


FIG. 9



SPUTTERING DEVICE AND SPUTTERING METHOD

RELATED APPLICATIONS

This application claims the benefit of Korean Patent Application No. 10-2014-0003607, filed on Jan. 10, 2014, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

One or more embodiments of the present invention relate to a sputtering device and a sputtering method.

2. Description of the Related Art

Semiconductor devices, display devices, and any number of other electronic devices include a plurality of thin-films. Various methods are used to form such thin-films, including deposition methods.

Such deposition methods include sputtering, chemical vapor deposition (CVD), atomic layer deposition (ALD), etc.

Among display devices, organic light emitting devices features a wide viewing angle, excellent contrast, and a fast response, and are thus being spotlighted as next-generation display devices.

An organic light emitting device includes a first electrode and a second electrode facing each other, an intermediate layer, which includes an emission layer and is arranged between the first and second electrodes, and one or more thin-films. In such a case, sputtering may be used to form thin-films of an organic light emitting device.

The sputtering method may be performed in various manners. For example, a thin-film may be formed on a substrate by moving the substrate while a target unit is stopped or by revolving a cylindrical target unit.

SUMMARY

A sputtering device and a sputtering method are provided.

Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

According to one aspect, a sputtering device includes a chamber; a supporting unit, which is arranged inside the chamber and supports a substrate; a target unit, which is arranged inside the chamber to face the supporting unit; a driving unit, which is connected to either the supporting unit or the target unit and linearly moves either the supporting unit or the target unit to which it is connected; a power supply unit, which applies a voltage between the target unit and the supporting unit, between the target unit and the chamber, or between the target unit and the substrate; a sensor unit, which measures at least one of a flow rate of oxygen and a flow rate of nitrogen inside the chamber; a thickness measuring unit, which measures a thickness of a material deposited on the substrate; and a control unit, which controls the driving unit to be driven according to preset values to deposit the material on the substrate to a preset first target thickness, controls the power supply unit to form a preset voltage to deposits the material on the substrate, calculates a deposition rate of the deposited material from either a moving speed of the substrate or a moving speed of the target unit and a deposition thickness of the deposited material measured by the thickness measuring unit, and calculates and stores a relationship between the at least one of the flow rate of oxygen and the flow rate of nitrogen measured by the sensor unit during a deposition of the deposited material and the deposition rate.

The deposition rate of the deposited material may be calculated by multiplying either the moving speed of the substrate or the moving speed of the target unit by the thickness of the deposited material.

The control unit may store the deposition rate of the deposited material according to either the flow rate of oxygen or the flow rate of nitrogen.

The relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material may be a linear relationship.

The control unit may calculate the deposition rate corresponding to either the flow rate of oxygen or the flow rate of nitrogen inside the chamber that is measured by the sensor unit after deposition is completed with respect to at least one substrate.

The control unit may calculate the moving speed of the substrate or the moving speed of the target unit according to a preset second target thickness from the calculated deposition rate.

The control unit may deposit the material on the substrate while controlling the driving unit to move the substrate or the target unit at the calculated moving speed.

According to another aspect, a sputtering method includes introducing a substrate into a chamber, the substrate supported by a supporting unit and facing a target unit, supplying oxygen or nitrogen into the chamber, applying a voltage to one from among between the supporting unit and the target unit, between the chamber and the target unit, and the substrate and the target unit, and performing a deposition to a preset first target thickness; measuring and storing either a flow rate of the oxygen or a flow rate of the nitrogen while the deposition is being performed and storing either a moving speed of the supporting unit or a moving speed of the target unit; and calculating a deposition rate of the material based on either the moving speed of the supporting unit or the moving speed of the target unit and a thickness of the material deposited on the substrate.

The deposition rate of the deposited material may be calculated by multiplying either the moving speed of the substrate or the moving speed of the target unit by the thickness of the deposited material.

The sputtering method may further include calculating and storing a relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material.

The relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material may be a linear relationship.

Either the flow rate of oxygen or the flow rate of nitrogen and the deposition of the material corresponding thereto may be stored in the form of a table.

The sputtering method may further include, when the above-stated operations are completed and a substrate is introduced into the chamber, measuring flow rate of oxygen or flow rate of nitrogen inside the chamber.

The sputtering method may further include determining the deposition rate corresponding to the measured flow rate of oxygen or flow rate of nitrogen.

The sputtering method may further include calculating either the moving speed of the substrate or the moving speed of the target unit based on a preset second target thickness and the deposition rate and depositing the material on the substrate while moving the substrate or the target unit.

The sputtering method may further include repeating the introducing, supplying, applying, measuring and storing, storing, and calculating processes for a plurality of substrates.

The sputtering method further includes determining whether there is data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen.

The sputtering method further includes, if there is no data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen, securing data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen by repeating the introducing, supplying, applying, easruign and storing, storing, and calculating processes.

These general and specific embodiments may be implemented by using a system, a method, a computer program, or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. **1** is a diagram showing a sputtering device according to an embodiment;

FIG. **2** is a sectional view, taken along a line II-II of FIG. **1**;

FIG. **3** is a sectional view, taken along a line III-Ill of FIG. **1**;

FIG. **4** is a block diagram showing a flow of controlling the sputtering device shown in FIG. **1**;

FIG. **5** is a flowchart showing a sequence of controlling the sputtering device shown in FIG. **1**;

FIG. **6** is a graph showing deposition rates according to the number of substrates in the sputtering device shown in FIG. **1**;

FIG. **7** is a graph showing deposition rates according to fluxes of oxygen of the sputtering device shown in FIG. **1**;

FIG. **8** is a sectional view showing an organic light emitting display apparatus manufactured by using the sputtering device shown in FIG. **1**; and

FIG. **9** is a sectional view showing the portion F of FIG. **8** in closer detail.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present description.

It will be understood that although the terms "first", "second", etc. may be used herein to describe various components, these components should not be limited by these terms. These components are only used to distinguish one component from another.

As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

It will be further understood that the terms "comprises" and/or "comprising" used herein specify the presence of stated features or components, but do not preclude the presence or addition of one or more other features or components.

It will be understood that when a layer, region, or component is referred to as being "formed on" another layer, region, or component, it can be directly or indirectly formed on the other layer, region, or component. That is, for example, intervening layers, regions, or components may be present.

Sizes of elements in the drawings may be exaggerated for convenience of explanation. In other words, because sizes and thicknesses of components in the drawings are arbitrarily illustrated for convenience of explanation, the following embodiments are not limited thereto.

In the following examples, the x-axis, the y-axis and the z-axis are not limited to three axes of the rectangular coordinate system, and may be interpreted in a broader sense. For example, the x-axis, the y-axis, and the z-axis may be perpendicular to one another, or may represent different directions that are not perpendicular to one another.

When a certain embodiment may be implemented differently, a specific process order may be performed differently from the described order. For example, two consecutively described processes may be performed substantially at the same time or performed in an order opposite to the described order.

FIG. **1** is a diagram showing a sputtering device **100** according to an embodiment. FIG. **2** is a sectional view, taken along a line II-II of FIG. **1**. FIG. **3** is a sectional view, taken along a line III-Ill of FIG. **1**.

Referring to FIGS. **1** through **3**, the sputtering device **100** may include a chamber **110** in which a space is formed. Here, various gases may be introduced into the chamber **110**. For example, argon (Ar) may be introduced into the chamber **110** from the exterior of the chamber and may form plasma during deposition, and oxygen (O_2) or nitrogen (N_2) may be supplied from the exterior of the chamber and may determine properties of a layer deposited on a substrate S.

The sputtering device **100** may include a supporting unit **120**, which is arranged inside the chamber **110** and supports the substrate S. Here, the supporting unit **120** may support the substrate S to face downward or upward in the chamber **110**. For convenience of explanation, descriptions will be given below regarding a case where the supporting unit **120** supports the substrate S to face downward in the chamber **110**.

The supporting unit **120** prevents movement or oscillation of the substrate S while a deposition is being performed to the substrate S. The supporting unit **120** may include a clamp (not shown). Furthermore, for absorption between the supporting unit **120** and the substrate S, the supporting unit **120** may include one or more absorption holes. Furthermore, the supporting unit **120** may be formed of a material with high thermal resistance and high durability to prevent deformations and damages due to heat during a deposition.

The sputtering device **100** may include a target unit **130**, which is arranged inside the chamber **110** so as to face the supporting unit **120**. For example, if the supporting unit **120** is arranged in the upper portion of the chamber **110**, the target unit **130** may be arranged in the lower portion of the chamber **110**, or vice versa. For convenience of explanation, descriptions will be given below regarding a case where the target unit **130** is arranged in the lower portion of the chamber **110**.

The target unit **130** may be formed in any of various shapes. For example, the target unit **130** may be formed to have a plate-like shape. According to another embodiment,

the target unit **130** may be formed to have a cylindrical shape. According to another embodiment, the target unit **130** may be formed to have a polygonal column-like shape.

The target unit **130** may or may not include a magnet member. Here, if the target unit **130** includes the magnet member, the magnet member may form a magnetic field and control path and distribution of plasma, thereby controlling deposition efficiency. For convenience of explanation, descriptions will be given below regarding a case where the target unit **130** is formed to have a cylindrical shape and the target unit **130** includes the magnet member.

The target unit **130** may be rotatably installed. For example, the target unit **130** may include a cylindrical target **131** and a backing plate **132** supporting the cylindrical target **131**. Here, the backing plate **132** has a shape similar to that the cylindrical target **131**, which has a hollow cylinder-like shape, where the backing plate **132** may be arranged inside the cylindrical target **131** and support the cylindrical target **131**. Furthermore, the backing plate **132** may maintain the temperature of the cylindrical target **131** at a constant temperature during a deposition, and power may be applied to the backing plate **132** by a power supply unit **150** described below. For example, an alternating current (AC) power or a direct current (DC) power may be applied to the backing plate **132**, and the backing plate **132** may function as a cathode. Therefore, the cylindrical target **131** connected to the backing plate **132** may function as a cathode. Of course, the cylindrical target **131** may be employed without the backing plate **132**. In this case, power may be applied to the cylindrical target **131**.

The target unit **130** may include a magnet member **133** arranged inside the cylindrical target **131**. The magnet member **133** may have a shape extending in the lengthwise direction of the cylindrical target **131**. The magnet member **133** may not rotate while the cylindrical target **131** is rotating during a deposition. In other words, the magnet member **133** may not be connected to the cylindrical target **131** and the backing plate **132**.

The magnet member **133** may form a magnetic field for controlling plasma discharge. For example, the magnet member **133** may include a first magnet member **133***a* and second magnet members **133***b* arranged at two opposite sides of the first magnet member **133***a*. Here, the first magnet member **133***a* and the pair of second magnet members **133***b* are arranged to have opposite polarities. As a result, a magnetic field formed by the magnet member **133** may be concentrated at a portion of the cylindrical target **131**, and thus plasma discharge may be controlled to be concentrated at a portion of the cylindrical target **131**.

The backing plate **132** and the cylindrical target **131** may be rotated by a driving shaft **134**. In detail, the driving shaft **134** may be connected to a target driving unit **135**, such as a driving belt, and receive driving power, thereby revolving the backing plate **132** and the cylindrical target **131**. Here, the power supply unit **150** described below is connected to the driving shaft **134**, and power may be applied to the backing plate **132** via the driving shaft **134**.

The driving shaft **134** is formed to extend from two opposite ends of the backing plate **132** and may be accommodated by a housing **139**. Furthermore, the backing plate **132** and the driving shaft **134** may be connected and fixed to each other via a backing tube **136**. However, the present disclosure is not limited thereto, and the backing plate **132** and the driving shaft **134** may be integrated as a single unit without the backing tube **136**.

A cooling fuild introducing pipe **137** and a cooling fuild draining pipe **138** are formed at the housing **139**, and the cooling fuild introducing pipe **137** and the cooling fuild draining pipe **138** may be connected to the interior of the cylindrical target unit **130** and circulate a cooling fuild. Therefore, heat generated by the cylindrical target **131** during a deposition is absorbed to the cooling fluid via the backing plate **132**, thereby maintaining the cylindrical target **131** at a constant temperature. As a result, efficiency of a sputtering operation may be improved.

The sputtering device **100** may include a driving unit **140**, which is connected to either the supporting unit **120** or the target unit **130** and linearly moves either the supporting unit **120** or the target unit **130**. Here, the driving unit **140** may linearly move either the supporting unit **120** or the target unit **130** to penetrate through the chamber **110**. Furthermore, the driving unit **140** may reciprocate either the supporting unit **120** or the target unit **130** inside the chamber **110**. For convenience of explanation, descriptions will be given below regarding a case where the driving unit **140** linearly moves the supporting unit **120**.

The driving unit **140** may have any of various configurations. For example, the driving unit **140** may include a motor **141** and a rack gear **142**, which is connected to the motor **141** and linearly moves as the motor **141** is driven. According to another embodiment, the driving unit **140** may be a linear motion system utilizing the magnetic levitation mechanism. However, the driving unit **140** is not limited thereto, and may include any device and any structure that is arranged between either the supporting unit **120** or the target unit **130** and the chamber **110** and linearly moves either the supporting unit **120** or the target unit **130** with respect to the chamber **110**. However, for convenience of explanation, descriptions will be given below regarding a case where the driving unit **140** includes the motor **141** and the rack gear **142**.

The sputtering device **100** may include the power supply unit **150**, which applies power between the target unit **130** and the supporting unit **120**, between the target unit **130** and the chamber **110**, or between the target unit **130** and the substrate S. Here, the power supply unit **150** may be a low frequency (LF), a middle frequency (MF), or a radio frequency (RF) AC power supply or a DC power supply. However, for convenience of explanation, descriptions will be given below regarding a case where the power supply unit **150** applies a voltage between the target unit **130** and the supporting unit **120** and is a RF AC power supply.

The sputtering device **100** may include a sensor unit **160**, which measures a flow rate of oxygen or a flow rate of nitrogen inside the chamber **110**. Here, the sensor unit **160** may measure the flow rate of oxygen or the flow rate of nitrogen based on resistance changes due to contact to oxygen or nitrogen or by emitting a light from the sensor and analyzing the wavelength of the light. The sensor unit **160** may include any sensor generally used for measuring the flow rate of a gas. For convenience of explanation, descriptions will be given below regarding a case where oxygen is used inside the chamber **110** and the sensor unit **160** measures the flow rate of oxygen.

The sputtering device **100** may include a thickness measuring unit **170**, which is arranged inside the chamber **110** and measures thickness of a material deposited on the substrate S. Here, the thickness measuring unit **170** may measures thickness of a material deposited on a surface of the substrate S by emitting a light or a laser beam onto the surface of the substrate S and analyzing a reflection index. Particularly, the thickness measuring unit **170** may include an Ellipsometer.

The sputtering device **100** may include a control unit **180**, which controls the driving unit **140** and the power supply unit **150**. Here, the control unit **180** may be formed in any of various forms. For example, the control unit **180** may be a circuit board installed at the chamber **110**. Furthermore, the control unit **180** may be a circuit board arranged outside of the chamber **110**, a personal computer, or a portable terminal. However, the present disclosure is not limited thereto, and the control unit **180** may include any devices and any structures capable of receiving signals, processing the signals, and controlling other devices.

The control unit **180** may perform various operations. For example, the control unit **180** may receive and store the flow rate of oxygen measured by the sensor unit **160**. Furthermore, the control unit **180** may receive and store the thickness of a material deposited on the substrate S that is measured by the thickness measuring unit **170** during a deposition.

The control unit **180** may drive the driving unit **140** based on preset values, such that a material deposited on the substrate S is deposited to a preset first target thickness. Here, the control unit **180** may control the power supply unit **150** to apply a preset voltage to form a preset voltage.

Other than the above-stated cases, the control unit **180** may continuously receive and store the flow rate of the oxygen measured by the sensor unit **160** during a deposition. Furthermore, the control unit **180** may calculate a deposition rate at which the material is deposited on the substrate S based on a moving speed of the substrate S due to operation of the driving unit **140** and thickness of the material deposited on the substrate S that is measured by the thickness measuring unit **170**.

When a deposition rate is calculated as described above, the control unit **180** may calculate a relationship between the deposition rate and the flow rate of oxygen and store the deposition rate according to the flux of oxygen. Here, the deposition rate according to the flux of oxygen may be stored in the form of an equation regarding the flux of oxygen, and the deposition rates according to the fluxes of oxygen may be stored in the form of a table.

FIG. **4** is a block diagram showing a flow for controlling the sputtering device **100** shown in FIG. **1**. FIG. **5** is a flowchart showing a sequence for controlling the sputtering device **100** shown in FIG. **1**. FIG. **6** is a graph showing deposition rates according to the number of substrates in the sputtering device **100** shown in FIG. **1**. FIG. **7** is a graph showing deposition rates according to fluxes of oxygen of the sputtering device **100** shown in FIG. **1**.

Referring to FIGS. **4** through **7**, the sputtering device **100** may first perform an initial deposition for calculating a relationship between flux of oxygen used for a sputtering operation and a deposition rate. Here, the initial deposition may be performed based on preset values, and the control unit **180** may obtain and store various information.

In detail, when the initial deposition is performed, the substrate S is introduced inside the chamber **110** of the sputtering device **100**, and the cylindrical target **131** for providing a material for forming a deposition layer on the substrate S may be arranged to face the substrate S. Next, a voltage may be applied between the cylindrical target **131** and the supporting unit **120**, and plasma state is induced by using a gas injected into the chamber **110**, where excited particles which collide with the cylindrical target **131** and separate from the cylindrical target **131** may reach a surface of the substrate S and form a deposition layer. Here, the deposition layer may vary according to a material constituting the cylindrical target **131** and a gas injected into the chamber **110**.

Because the cylindrical target **131** rotates while deposition is being performed as described above, deposition may be performed while the entire surface of the cylindrical target **131** is being uniformly used.

While the deposition is being performed, the driving unit **140** may operate and linearly move the substrate S. Here, the substrate S may be linearly moved in a direction perpendicular to the lengthwise direction of the cylindrical target **131**. The moving speed of the substrate S based on operation of the driving unit **140** may be set in advance.

In detail, when a first target thickness is set to the control unit **180**, a moving speed of the substrate S corresponding to the first target thickness may be determined. Here, the moving speeds of the substrate S corresponding to the first target thicknesses may be stored in the form of a table. Therefore, when the first target thickness is changed, the moving speed of the substrate S may be determined in correspondence thereto.

Furthermore, other than the above-stated case, a voltage applied by the power supply unit **150** may also be preset to the control unit **180**. For example, a voltage applied by the power supply unit **150** may be preset to the control unit **180** in correspondence to the first target thickness. Here, when the first target thickness is changed, a voltage applied by the power supply unit **150** may vary in correspondence thereto. Furthermore, a voltage applied by the power supply unit **150** may be changed based on a setting of the control unit **180** or an external setting.

When deposition is performed, after the moving speed of the substrate S and the voltage applied by the power supply unit **150** are set, the flow rate of oxygen injected into the chamber **110** may vary according to the voltage applied by the power supply unit **150**.

In detail, the flow rate of oxygen may be controlled by the control unit **180** according to a voltage applied by the power supply unit **150**. Generally, to secure conditions for a high deposition rate in a sputtering operation, a voltage control technique may be used. In this case, amount of electrons emitted from the surface of the cylindrical target **131** varies according to surface condition of the cylindrical target **131** in the sputtering device **100**, and thus a voltage of the cylindrical target **131** may vary in correspondence thereto.

For example, if the cylindrical target **131** is formed of aluminum, when deposition is initiated and flow rate of oxygen is small, a metal layer may be formed on the substrate S. Next, if more oxygen is injected, an oxide layer is formed on the surface of the cylindrical target **131** and electrons are more smoothly discharged, and thus a voltage of the cylindrical target **131** drops. Next, if the voltage of the cylindrical target **131** further drops, the surface of the cylindrical target **131** is completely oxidized, and deposition rate may become very slow. Therefore, to form an aluminum oxide layer on the substrate S, a sputtering operation is performed in a domain in which a voltage of the cylindrical target **131** dops and flow rate of oxygen drops, where the deposition rate may be controlled by fixing the voltage of the cylindrical target **131** and controlling the flow rate of oxygen (operation **S110**).

During the deposition, the control unit **180** may store flow rates of oxygen measured by the sensor unit **160** (operation **S120**).

After the deposition is performed, the thickness measuring unit **170** may measure thickness of a material deposited on the substrate S (operation **S130**). The thickness measur-

ing unit **170** may transmit the measured thickness of the material deposited on the substrate S to the control unit **180**, and the control unit **180** may calculate a deposition rate of the material based on the thickness of the deposited material and moving speed of the substrate S (operation S**140**).

Here, the deposition rate of the deposited material may be calculated by multiplying the moving speed of the substrate S by the thickness of the material deposited on the substrate S, as described above. After calculating the deposition rate, the control unit **180** may correlate deposition rates to flow rates of oxygen and store them.

The task as described above may be performed a number of times while a deposition is performed onto one substrate S. Here, the thickness measuring unit **170** may measure thickness of the material deposited on the substrate S a number of times, and the sensor unit **160** may measure flow rates of oxygen corresponding to the measured thicknesses and transmit the flow rates of oxygen to the control unit **180**. The control unit **180** may calculate the deposition rate of the material based on the values, calculate a relationship between flow rates of oxygen and deposition rates, and store the relationship. Here, the control unit **180** may store flow rates of oxygen and deposition rates in the form of a table (operation S**150**).

Additionally, the task as described above may be performed every time deposition is performed with respect to a plurality of substrates S. For example, the control unit **180** may measure flow rates of oxygen and thicknesses of a material deposited on the substrate S while a deposition is being performed to one substrate S and calculate a deposition rate of the material. Furthermore, while a deposition is being performed to a subsequent substrate S, the control unit **180** may repeat the tasks as described above and re-calculates a deposition rate of the material. Here, the tasks as described above may be repeatedly performed with respect to each of the substrates S.

The tasks as described above may be performed for a number of times that are preset to the control unit **180**. Here, after the tasks as described above are performed for a preset number of times, data or an equation regarding deposition rates of the material according to fluxes of oxygen may be stored in the control unit **180**. Particularly, it may be set to the control unit **180** to perform the tasks as described above for at least twice.

A result thereof is shown in FIG. **6**. In FIG. **6**, it is clear that the deposition rate decreases as a number of substrates increases. Here, restorations of the deposition rate are due to pre-sputtering operations.

Furthermore, FIG. **6** shows a graph showing flow rates of oxygen measured according to a number of substrates. Here, it is clear that flow rate of oxygen also decreases according to a number of substrates. FIG. **7** shows a graph of deposition rate against flow rate of oxygen calculated based on the above-stated data.

Here, the relationship between flow rates of oxygen and deposition rates may be a linear relationship. In detail, the deposition rate of a material may be proportional to the flow rate of oxygen. The relationship as described above may be stored in the form of an equation or a table in the control unit **180**.

Particularly, as shown in FIG. **7**, regardless the number of times for performing depositions on the substrate S in the sputtering device **100**, the deposition rate versus the flow rate of oxygen is almost constant.

After the tasks as described above are completed, when the substrate S is introduced into the chamber **110**, a second target thickness for deposition on the substrate S may be stored in the control unit **180**. Here, the control unit **180** may determine whether an equation or a table regarding the deposition rate according to the flow rate of oxygen is stored in the control unit **180** (operation S**160**).

If it is determined that an equation or a table regarding the deposition rate according to the flow rate of oxygen is not stored in the control unit **180**, the control unit **180** may repeat the operations as described above and calculate the deposition rate according to the flow rate of oxygen.

Alternatively, if it is determined that an equation or a table regarding the deposition rate according to the flow rate of oxygen is stored in the control unit **180**, the control unit **180** may receive the flow rate of oxygen measured by the sensor unit **160** and calculate the deposition rate of a material to be deposited. Here, the control unit **180** may calculate the deposition rate by selecting a deposition corresponding to the corresponding flow rate of oxygen from a table or by applying the flow rate of oxygen to a calculated equation (operations S**170** and S**180**).

The control unit **180** may calculate the moving speed of the substrate S based on the calculated deposition rate. Here, the moving speed of the substrate S may be calculated by dividing the deposition rate by the second target thickness. After the moving speed of the substrate S is calculated as described above, the control unit **180** may control the driving unit **140** to move the substrate S at the calculated moving speed (operation S**190**).

Furthermore, the control unit **180** may control the power supply unit **150** and the driving unit **140** to deposit a material on the substrate S while the substrate S is being moved. Here, if the target unit **130** linearly moves, the moving speed of the target unit **130** may be set to be identical to the calculated moving speed of the substrate S (operation S**200**).

The tasks as described above may be performed even while a material is being deposited on the substrate S via the sputtering device **100**. Here, the sensor unit **160** may receive feedback of the measured flow rate of oxygen or flow rate of nitrogen and repeatedly perform the tasks as described above.

Therefore, the sputtering device **100** may calculate the deposition rate of a material from the flow rate of oxygen or flow rate of nitrogen inside the chamber **110**, thereby calculating and applying the best moving speed of the substrate S or the best moving speed of the target unit **130** for the second target thickness.

Furthermore, because the sputtering device **100** may calculate the moving speed of the substrate S or the moving speed of the target unit **130** as described above, the sputtering device **100** may deposit to a precise thickness without continuously monitoring thickness of a material deposited on the substrate S.

The sputtering device **100** may easily correct thickness of a material deposited on the substrate S in real time based on the flow rate of oxygen or flow rate of nitrogen inside the chamber **110**.

Furthermore, the sputtering device **100** may easily control thickness of a material to be deposited, and thus thickness of a desired material may be conveniently managed.

FIG. **8** is a sectional view showing an organic light emitting display apparatus **10** manufactured by using the sputtering device **100** shown in FIG. **1**. FIG. **9** is a sectional view showing the portion F of FIG. **8** in closer detail.

Referring to FIGS. **8** and **9**, an organic light emitting display apparatus **10** is formed on a substrate **30**. The substrate **30** may be formed of a glass material, a plastic material, or a metal.

A buffer layer **31**, which provides a flat surface on the substrate **30** and contains an insulating material for preventing permeation of moisture and impurities toward the substrate **30**, is formed on the substrate **30**.

A thin-film transistor (TFT) **40**, a capacitor **50**, and an organic light emitting device **60** are formed on the buffer layer. The TFT **40** includes an active layer **41**, a gate electrode **42**, and source electrode and drain electrode **43**. The organic light emitting device **60** includes a first electrode **61**, a second electrode **62**, and an intermediate layer **63**. The capacitor **50** includes a first capacitor electrode **51** and a second capacitor electrode **52**.

In detail, the active layer **41** formed to have a designated pattern is arranged on top surface of the buffer layer **31**. The active layer **41** may contain an inorganic semiconductor material, such as silicon, an organic semiconductor material, or an oxide semiconductor material and may selectively be doped with a p-type dopant or an n-type dopant.

A gate insulation layer **32** is formed on the active layer **41**. The gate electrode **42** is formed on the gate insulation layer **32** in a position overlapping the active layer **41**. The first capacitor electrode **51** may be formed on the gate insulation layer **32**, where the first capacitor electrode **51** may be formed of a same material as the gate electrode **42**.

An interlayer insulation layer **33** is formed to cover the gate electrode **42**, and the source electrode and drain electrode **43** are formed on the interlayer insulation layer **33**, where the source electrode and drain electrode **43** are formed to contact a designated portion of the active layer **41**. The second capacitor electrode **52** may be formed on the interlayer insulation layer **33**, where the second capacitor electrode **52** may be formed of a same material as the source electrode and drain electrode **43**.

A passivation layer **34** is formed so as to cover the source electrode and drain electrode **43**, and an additional insulation layer may be further formed on the passivation layer **34** for planarization of the TFT **40**.

The first electrode **61** is formed on the passivation layer **34**. The first electrode **61** is formed to be electrically connected to one from between the source electrode and drain electrode **43**. Next, a pixel defining layer **35** is formed to cover the first electrode **61**. After a designated opening **64** is formed in the pixel defining layer **35**, the intermediate layer **63** including an emission layer is formed in a region defined by the opening **64**. The second electrode **62** is formed on the intermediate layer **63**.

An encapsulation layer **70** is formed on the second electrode **62**. The encapsulation layer **70** may contain an organic material or an inorganic material and may have a structure in which organic materials and inorganic materials are alternately stacked.

In detail, the encapsulation layer **70** may be formed by using the sputtering device **100**. In other words, after the substrate **30** on which the second electrode **62** is formed is introduced into the chamber **110**, a desired layer may be formed by using the sputtering device **100**.

Particularly, the encapsulation layer **70** includes an inorganic layer **71** and an organic layer **72**, where the inorganic layer **71** includes a plurality of layers **71***a*, **71***b*, and **71***c*, and the organic layer **72** includes a plurality of layers **72***a*, **72***b*, and **72***c*. Here, the plurality of layers **71***a*, **71***b*, and **71***c* of the inorganic layer **71** may be formed by using the sputtering device **100**.

However, the present disclosure is not limited thereto. In other words, the gate electrode **42**, the source electrode and drain electrode **43**, the first electrode **61**, and the second electrode **62** of the organic light emitting display apparatus **10** may be formed by using the sputtering device **100**.

Furthermore, the buffer layer, the gate insulation layer **32**, the interlayer insulation layer **33**, the passivation layer **34**, the pixel defining layer **35**, and other insulation layers may also be formed by using the sputtering device **100**.

As described above, by using the sputtering device **100** according to the present embodiments, characteristics of a deposition layer formed at the organic light emitting display apparatus **10** may be improved, thereby improving electric characteristics and image quality of the organic light emitting display apparatus **10** may be improved.

As described above, according to the one or more of the above embodiments of the present disclosure, a sputtering device and a sputtering method may easily control deposition thickness.

It should be understood that the example embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should usefully be considered as available for other similar features or aspects in other embodiments.

While one or more embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present disclosure, including the following claims.

What is claimed is:

1. A sputtering device comprising:
a chamber;
a supporting unit, which is arranged inside the chamber and supports a substrate;
a target unit, which is arranged inside the chamber to face the supporting unit;
a driving unit, which is connected to either the supporting unit or the target unit and linearly moves either the supporting unit or the target unit to which it is connected;
a power supply unit, which applies a voltage between the target unit and the supporting unit, between the target unit and the chamber, or between the target unit and the substrate;
a sensor unit, which measures at least one of a flow rate of oxygen and a flow rate of nitrogen inside the chamber;
a thickness measuring unit, which measures a thickness of a material deposited on the substrate; and
a control unit, which controls the driving unit to be driven according to preset values to deposit the material on the substrate to a preset first target thickness, controls the power supply unit to form a preset voltage to deposit the material on the substrate, calculates a deposition rate of the deposited material from either a moving speed of the substrate or a moving speed of the target unit and a deposition thickness of the deposited material measured by the thickness measuring unit, and calculates and stores a relationship between the at least one of the flow rate of oxygen and the flow rate of nitrogen measured by the sensor unit during a deposition of the deposited material and the deposition rate.

2. The sputtering device of claim **1**, wherein the deposition rate of the deposited material is calculated by multiplying either the moving speed of the substrate or the moving speed of the target unit by the thickness of the deposited material.

3. The sputtering device of claim 2, wherein the control unit stores the deposition rate of the deposited material according to either the flow rate of oxygen or the flow rate of nitrogen.

4. The sputtering device of claim 3, wherein the relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material is a linear relationship.

5. The sputtering device of claim 1, wherein the control unit calculates the deposition rate corresponding to either the flow rate of oxygen or the flow rate of nitrogen inside the chamber that is measured by the sensor unit after deposition is completed with respect to at least one substrate.

6. The sputtering device of claim 5, wherein the control unit calculates the moving speed of the substrate or the moving speed of the target unit according to a preset second target thickness from the calculated deposition rate.

7. The sputtering device of claim 6, wherein the control unit deposits the material on the substrate while controlling the driving unit to move the substrate or the target unit at the calculated moving speed.

8. A sputtering method comprising:
- introducing a substrate into a chamber, the substrate supported by a supporting unit and facing a target unit;
- supplying oxygen or nitrogen into the chamber;
- applying a voltage to one from among between the supporting unit and the target unit, between the chamber and the target unit, and the substrate and the target unit; performing a deposition to a preset first target thickness;
- measuring and storing either a flow rate of the oxygen or a flow rate of the nitrogen while the deposition is being performed;
- storing either a moving speed of the supporting unit or a moving speed of the target unit;
- calculating a deposition rate of the material based on either the moving speed of the supporting unit or the moving speed of the target unit and a thickness of the material deposited on the substrate.

9. The sputtering method of claim 8, wherein the deposition rate of the deposited material is calculated by multiplying either the moving speed of the substrate or the moving speed of the target unit by the thickness of the deposited material.

10. The sputtering method of claim 9, further comprising calculating and storing a relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material.

11. The sputtering method of claim 10, wherein the relationship between either the flow rate of oxygen or the flow rate of nitrogen and the deposition rate of the deposited material is a linear relationship.

12. The sputtering method of claim 10, wherein either the flow rate of oxygen or the flow rate of nitrogen and the deposition of the material corresponding thereto are stored in the form of a table.

13. The sputtering method of claim 10, further comprising, when the above-stated operations are completed and a substrate is introduced into the chamber, measuring flow rate of oxygen or flow rate of nitrogen inside the chamber.

14. The sputtering method of claim 13, further comprising determining the deposition rate corresponding to the measured flow rate of oxygen or flow rate of nitrogen.

15. The sputtering method of claim 14, further comprising calculating either the moving speed of the substrate or the moving speed of the target unit based on a preset second target thickness and the deposition rate; and
- depositing the material on the substrate while moving the substrate or the target unit.

16. The sputtering method of claim 8, further comprising repeating the introducing, supplying, applying, measuring and storing, storing, and calculating processes for a plurality of substrates.

17. The sputtering method of claim 8, further comprising determining whether there is data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen.

18. The sputtering method of claim 17, further comprising, if there is no data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen, securing data related to the deposition rate corresponding to the flow rate of oxygen or the flow rate of nitrogen by repeating the introducing, supplying, applying, measuring and storing, storing, and calculating processes.

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