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(54) **Title**: METHOD OF MANUFACTURING A LAYER STACK FOR DISPLAY MANUFACTURING AND APPARATUS THEREFORE

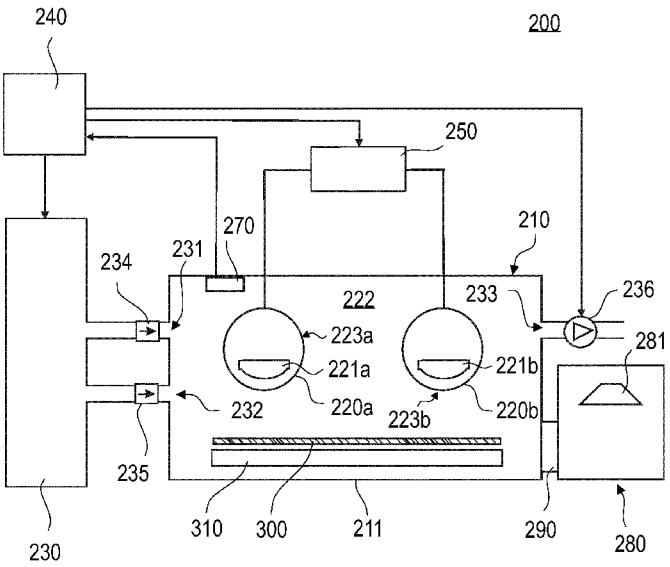


FIG. 1

(57) **Abstract**: A method of manufacturing a layer for a plurality of thin film transistors for display manufacturing and an apparatus therefore is described. The method includes depositing (101) a layer stack onto a substrate by sputtering a first layer with a first set of processing parameters from an indium oxide containing target; sputtering a second set of processing parameters different from the first set of processing parameters onto the first layer from an indium oxide containing target a second layer with, and patterning (102) the layer stack by etching. The apparatus (200) includes a vacuum chamber (210); one or more indium oxide containing targets (220a, 220b) within the vacuum chamber for sputtering a transparent conductive oxide layer; a gas distribution system (230) for providing a processing gas within the vacuum chamber; and a controller (240) connected to the gas distribution system (230) and configured to execute a program code for conducting the method.

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METHOD OF MANUFACTURING A LAYER STACK FOR DISPLAY MANUFACTURING AND APPARATUS THEREFORE

TECHNICAL FIELD

[0001] The present disclosure relates to a method and an apparatus for coating a substrate in a vacuum process chamber. In particular the present disclosure relates to an apparatus and a method for forming at least one layer of sputtered material on the substrate for display manufacturing. Particularly, the embodiments relate to an apparatus and a method of manufacturing a transistor on a substrate and layer stacks for an electronic device.

BACKGROUND

[0002] In many applications, deposition of thin layers on a substrate, e.g. on a glass substrate is desired. Conventionally, the substrates are coated in different chambers of a coating apparatus. For some applications, the substrates are coated in a vacuum using a vapor deposition technique. Several methods are known for depositing a material on a substrate. For instance, substrates may be coated by a physical vapor deposition (PVD) process, a chemical vapor deposition (CVD) process or a plasma enhanced chemical vapor deposition (PECVD) process etc. Usually, the process is performed in a process apparatus or process chamber where the substrate to be coated is located.

[0003] Electronic devices and particularly opto-electronic devices show a significant reduction in costs over the last years. Further, the pixel density in displays is continuously increased. For TFT displays, the desire is high density TFT integration. However, the yield is attempted to be increased and the manufacturing costs are attempted to be reduced in spite of the increased number of thin-film transistors (TFT) within a device.

[0004] Accordingly, there is a continuing demand on providing improved methods and apparatuses for tuning the TFT display properties during manufacturing, in particular with respect to high quality and low cost.

SUMMARY

[0005] In view of the above, a method of manufacturing a patterned layer stack for display manufacturing and an apparatus therefore according to the independent claims are provided. Further, a patterned layer stack for an electronic device and an electronic device including a patterned layer which is manufactured by the method of manufacturing a patterned layer stack according to embodiments described herein is provided. Further advantages, features, aspects and details are apparent from the dependent claims, the description and drawings.

[0006] According to one aspect of the present disclosure, a method of manufacturing a patterned layer stack for display manufacturing is provided. The method includes depositing a layer stack onto a substrate by sputtering a first layer with a first set of processing parameters from an indium oxide containing target; sputtering a second layer with a second set of processing parameters different from the first set of processing parameters onto the first layer from an indium oxide containing target, wherein the first set of processing parameters is adapted for high etchability of the layer stack, and wherein the second set of processing parameters is adapted for low resistance of the second layer stack; and patterning the layer stack by etching.

[0007] According to another aspect of the present disclosure, a patterned layer stack for an electronic device is provided which is manufactured by the method of manufacturing a patterned layer stack according to embodiments described herein.

[0008] According to a further aspect of the present disclosure, an electronic device is provided which includes a patterned layer stack manufactured by the method of manufacturing a patterned layer stack according to embodiments described herein.

[0009] According to yet another aspect of the present disclosure, an apparatus for depositing a layer stack for display manufacturing is provided. The apparatus includes a vacuum chamber; one or more indium oxide containing targets within the vacuum chamber for sputtering a transparent conductive oxide layer; a gas distribution system for providing a processing gas within the vacuum chamber; an etching device for etching the layer stack; and a controller connected to the gas distribution system and configured to execute a

program code for conducting the method of manufacturing a patterned layer stack for display manufacturing according to embodiments described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] So that the manner in which the above recited features of the disclosure described herein can be understood in detail, a more particular description, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

FIG. 1 shows a schematic view of an apparatus for depositing a layer for display manufacturing according to embodiments described herein;

FIG. 2 shows a schematic view of an apparatus for depositing a layer for display manufacturing according to other embodiments described herein;

FIG. 3 shows a block diagram illustrating a method of manufacturing a patterned layer stack for display manufacturing according to embodiments as described herein;

FIG. 4A shows a schematic view of a layer stack before patterning according to embodiments described herein;

FIG. 4B shows a schematic view of a layer stack after patterning according to embodiments described herein;

DETAILED DESCRIPTION OF EMBODIMENTS

[0011] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same components. In the following, only the differences with respect to individual embodiments are described. Each example is provided by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Further, features illustrated or described as part of one embodiment can be used on or in conjunction with other embodiments to yield yet a

further embodiment. It is intended that the description includes such modifications and variations.

[0012] In the present disclosure, the expression "processing gas atmosphere" may be understood as an atmosphere inside a processing chamber, particularly inside a vacuum processing chamber of an apparatus for depositing a layer. The "processing gas atmosphere" may have a volume which is specified by the volume inside the processing chamber.

[0013] In the present disclosure, the abbreviation "H_2" stands for hydrogen, in particular for gaseous hydrogen.

[0014] Further, in the present disclosure, the abbreviation "O_2" stands for oxygen, in particular for gaseous oxygen.

[0015] In the present disclosure, the expression "degree of amorphous structure" may be understood as the ratio of amorphous structure to non-amorphous structure in the solid state. The non-amorphous structure may be a crystalline structure. The amorphous structure may be a glass-like structure.

[0016] In the present disclosure, the expression "sheet resistance" may be understood as the resistance of a layer manufactured by the method according to embodiments described herein. In particular, "sheet resistance" may refer to a case in which the layer is considered as a two-dimensional entity. It may be understood that the expression "sheet resistance" implies that the current is along the plane of the layer (i.e. the current is not perpendicular to the layer). Further, sheet resistance may refer to a case of resistivity for a uniform layer thickness.

[0017] In FIG. 1, a schematic view of an apparatus 200 for depositing a layer stack for display manufacturing according to embodiments described herein is shown. According to embodiments as described herein, the apparatus for depositing a layer stack for display manufacturing includes a vacuum chamber 210; one or more indium oxide, particularly indium tin oxide (ITO), containing targets 220a, 220b within the vacuum chamber for sputtering a transparent conductive oxide layer (e.g. a first layer and/or a second layer); a

gas distribution system 230 for providing a processing gas within the vacuum chamber; an etching device 280 for etching the layer stack; and a controller 240 connected to the gas distribution system 230 and configured to execute a program code. Upon execution of the program code the method of manufacturing a patterned layer stack for display manufacturing as described herein may be conducted.

[0018] As exemplarily shown in FIG. 1, according to embodiments which can be combined with other embodiments described herein, the vacuum chamber 210 is limited by chamber walls 211 and may be connected to the gas distribution system 230 at a first gas inlet 231 for water vapor and a second gas inlet 232 for H_2. As shown in FIG.1, the first gas inlet 231 may be connected to the gas distribution system 230 via a first conduit having a first mass flow controller 234 configured for controlling an amount of water vapor provided to the processing gas atmosphere 222, for example a first valve. The second gas inlet 232 may be connected to the gas distribution system 230 via a second conduit having a second mass flow controller 235 configured for controlling an amount of H_2 provided to the processing gas atmosphere, for example a second valve.

[0019] According to embodiments which can be combined with other embodiments described herein, the gas distribution system may include a first gas source for providing water vapor and a second gas source for providing H_2. Accordingly, the apparatus as described herein may be configured for providing water vapor and H_2 independently from each other, such that the water vapor content and/or the H_2 content of the processing gas atmosphere 222 within the vacuum chamber 210 can be controlled independently.

[0020] According to embodiments which can be combined with other embodiments described herein, the gas distribution system may include a third gas source for providing an inert gas. The third gas source for providing an inert gas may be configured for providing the inert gas to the processing gas atmosphere separately form water vapor and/or H_2, for example through a separate gas inlet which connects the vacuum chamber with the third gas source for providing an inert gas. According to embodiments which can be combined with other embodiments described herein, the gas distribution system may include an inert gas flow controller (not shown) configured for controlling an amount of inert gas provided to the processing gas atmosphere. According to some embodiments,

which can be combined with other embodiments described herein, the third gas source for providing an inert gas may be employed for providing an inert gas/water vapor mixture which can be provided to the processing gas atmosphere inside the vacuum chamber. For example, the inert gas/water vapor mixture may be provided by mixing the inert gas from the third gas source with the water vapor form the first gas source before the inert gas/water vapor mixture is provided to the processing gas atmosphere inside the vacuum chamber. Additionally or alternatively, the third gas source for providing an inert may be employed for providing an inert gas/H_2 mixture which can be provided to the processing gas atmosphere inside the vacuum chamber, for example through the second gas inlet. Accordingly, the inert gas/ H_2 mixture may be provided by mixing the inert gas from the third gas source with the H_2 from the second gas source before the an inert gas/water vapor mixture is provided to the processing gas atmosphere inside the vacuum chamber.

[0021] According to embodiments which can be combined with other embodiments described herein, the first gas source of the gas distribution system 230 for providing water vapor to the processing gas atmosphere 222 in the vacuum chamber 210 may provide an inert gas/water vapor mixture. The partial pressure of the inert gas in the inert gas/ water vapor mixture may be selected from a range between a lower limit of inert gas partial pressure and an upper limit of inert gas partial pressure as specified herein. Accordingly the partial pressure of the water vapor in the inert gas/ water vapor mixture may be selected from a range between a lower limit of water vapor partial pressure and an upper limit of water vapor partial pressure as specified herein.

[0022] According to embodiments which can be combined with other embodiments described herein, the second gas source of the gas distribution system 230 for providing H_2 to the processing gas atmosphere 222 in the vacuum chamber 210 may provide an inert gas/H_2 mixture. The partial pressure of the inert gas in the inert gas/H_2 mixture may be selected from a lower limit of inert gas partial pressure to an upper limit of inert gas partial pressure as specified herein. Accordingly, the partial pressure of the H_2 in the inert gas/H_2 mixture may be selected from a lower limit of H_2 partial pressure to an upper limit of H_2 partial pressure as specified herein.

[0023] With exemplary reference to FIG. 1, according to embodiments which can be combined with other embodiments described herein, the vacuum chamber 210 may include an outlet port 233, connected to an outlet conduit, which is in fluid connection with an outlet pump 236 for providing the vacuum in the vacuum chamber 210.

[0024] As illustrated in FIG. 1, the apparatus for depositing a layer stack for display manufacturing according to embodiments described herein may include an etching device 280 for etching a layer stack which has been deposited on a substrate 300. As exemplarily shown in FIG. 1 the etching device 280 may be located outside of the vacuum chamber 210. For Example, the etching device 280 may be connected to the vacuum chamber 210 in which the deposition of the layer stack is performed via a vacuum lock chamber 290. For example, the vacuum lock chamber 290 may be disposed at a side wall of the vacuum chamber 210, as shown in FIG. 1. The vacuum lock chamber 290 may be configured for separating the processing gas atmosphere from the atmosphere inside the etching device 280. For example, the etching device may be configured as an etching chamber having an etching source 281. The etching source 281 can be configured for dry chemical etching or wet chemical etching. According to embodiments which can be combined with other embodiments described herein, a photoresist coating for structuring the layer stack via exposure to radiation may be applied before etching.

[0025] According to embodiments which can be combined with other embodiments described herein, the apparatus for depositing a layer stack for display manufacturing may be configured for transporting a substrate from the vacuum chamber 210 in which the deposition of the layer stack is performed through the vacuum lock chamber 290 into the etching device 280.

[0026] As illustrated in FIG. 1, within the vacuum chamber 210, a first deposition source 223a and a second deposition source 223b may be provided. The deposition sources can, for example, be rotatable cathodes having targets of the material to be deposited on the substrate. In particular, the target may be an indium tin oxide (ITO) containing target, particularly an ITO 90/10 containing target. According to embodiments described herein ITO 90/10 includes an indium oxide (In_2O_3) and a tin oxide (SnO_2) at a ratio of $In_2O_3 : SnO_2 = 90:10$.

[0027] According to embodiments which can be combined with other embodiments described herein, the cathodes can be rotatable cathodes with magnet assemblies 221a, 221b therein. Accordingly, with the apparatus as described herein magnetron sputtering may be conducted for depositing a layer. As exemplarily shown in FIG. 1 the cathodes of the first deposition source 223a and the second deposition source 223b can be connected to a power supply 250. Depending on the nature of the deposition process the cathodes may be connected to an AC (alternating current) power supply or a DC (direct current) power supply. For example, sputtering from an indium oxide target, e.g. for a transparent conductive oxide film, may be conducted as DC sputtering. In particular, the first layer and/or the second layer produced in the method as described herein may be sputtered from an indium oxide target in DC mode. In case of DC sputtering, the first deposition source 223a may be connected to a first DC power supply and the second deposition source 223b may be connected to a second DC power supply. Accordingly, for DC sputtering the first deposition source 223a and the second deposition source 223b may have separate DC power supplies. According to embodiments which can be combined with other embodiments described herein, DC sputtering may include pulsed-DC sputtering, particularly bipolar-pulsed-DC sputtering. Accordingly, the power supply may be configured for providing pulsed-DC, particularly for providing bipolar-pulsed-DC. In particular, the first DC power supply for the first deposition source 223a and the second DC power supply for the second deposition source 223b may be configured for providing pulsed-DC power, particularly for providing bipolar-pulsed-DC. In FIG. 1, a horizontal arrangement of deposition sources and substrate 300 to be coated is shown. In some embodiments, which may be combined with other embodiments disclosed herein, a vertical arrangement of deposition sources and substrate 300 to be coated may be used. Accordingly, according to some embodiments which can be combined with other embodiments described herein, an etching device may be provided which is configured for etching the layer stack in a vertical setup.

[0028] With exemplary reference to FIG. 1, according to embodiments which can be combined with other embodiments described herein, a sensor 270 may be provided in the vacuum chamber 210 for measuring the composition of the processing gas atmosphere

222. In particular, the sensor 270 may be configured for measuring the content of inert gas, H_2, O_2 and residual gas within the respective content ranges as specified herein.

[0029] As shown in FIG. 1, according to embodiments which can be combined with other embodiments described herein, the sensor 270, gas distribution system 230 including the first mass flow controller 234 and the second mass flow controller 235, and outlet pump 236 may be connected to a controller 240. The controller 240 may control the gas distribution system 230 including the first mass flow controller 234 and the second mass flow controller 235, the inert gas flow controller and the outlet pump 236, so that a processing atmosphere with a composition as described herein can be created and maintained in the vacuum chamber 210. Accordingly, all constituents of a selected first processing gas atmosphere with a composition as described herein and all constituents of a selected second processing gas atmosphere with a composition as described may be controlled independently from each other. In particular, the controller may be configured for controlling the gas distribution system such that the flow of H_2, the flow of O_2, and the flow of inert gas can be controlled independently from each other for establishing a first processing gas atmosphere with a selected composition as described herein and a second processing gas atmosphere with a selected composition as described herein. Accordingly, the composition of the selected processing gas atmosphere can be adjusted very accurately.

[0030] According to embodiments which can be combined with other embodiments described herein, the controller 240 may be connected to the power supply 250. Alternatively, for example in case of DC sputtering, the controller may be connected to the first DC power supply and to the second DC power supply. Further, the controller may be configured for controlling a first power supplied to the first deposition source 223a and the second deposition source 223b within a first power range as specified herein by the respective lower and upper limits for the first power. Accordingly, the controller may be configured for controlling a second power supplied to the first deposition source 223a and the second deposition source 223b within a second power range as specified herein by the respective lower and upper limits for the second power.

[0031] When the apparatus 200 for depositing a layer stack for display manufacturing as described herein is used for conducting the method of manufacturing a patterned layer

stack according to embodiments described herein, a substrate 300 may be disposed below the deposition sources, as exemplarily shown in FIG. 1. The substrate 300 may be arranged on a substrate support 310. According to embodiments which can be combined with other embodiments described herein, a substrate support device for a substrate to be coated may be disposed in the vacuum chamber. For example, the substrate support device may include conveying rolls, magnet guiding systems and further features. The substrate support device may include a substrate drive system for driving the substrate to be coated in or out of the vacuum chamber 210. For example, the substrate drive system may be configured for transporting an uncoated substrate into the vacuum chamber and for transporting the coated substrate, e.g. with a layer stack as described herein, from the vacuum chamber 210 into the etching device 280.

[0032] With exemplary reference to FIG. 2, according to embodiments which can be combined with other embodiments described herein, the vacuum chamber 210 may be connected to the gas distribution system 230 at a third gas inlet 238 for O_2. As shown in FIG. 2, the third gas inlet 238 may be connected to the gas distribution system 230 via a third conduit having a third mass flow controller 237 configured for controlling an amount of O_2 provided to the processing gas atmosphere 222, for example a third valve.

[0033] According to embodiments which can be combined with other embodiments described herein, the gas distribution system may include a fourth gas source for providing O_2. Accordingly, the apparatus as described herein may be configured for providing water vapor, H_2, and O_2 independently from each other, such that the water vapor content and/or the H_2 content and/or the O_2 content of the processing gas atmosphere 222 within the vacuum chamber 210 can independently be controlled.

[0034] According to embodiments which can be combined with other embodiments described herein, the fourth gas source of the gas distribution system 230 for providing O_2 to the processing gas atmosphere 222 in the vacuum chamber 210 may provide an inert gas/O_2 mixture. The partial pressure of the inert gas in the inert gas/O_2 mixture may be selected from a range between a lower limit of inert gas partial pressure and an upper limit of inert gas partial pressure as specified herein. Accordingly the partial pressure of the O_2

in the inert gas/O_2 mixture may be selected from a range between a lower limit of O_2 partial pressure and an upper limit of O_2 partial pressure as specified herein.

[0035] According to some embodiments, which can be combined with other embodiments described herein, the third gas source for providing an inert gas may be employed for providing the inert gas/O_2 mixture which can be provided to the processing gas atmosphere inside the vacuum chamber. For example, the inert gas/ O_2 mixture may be provided by mixing the inert gas from the third gas source with the O_2 form the fourth gas source before the inert gas/O_2 vapor mixture is provided to the processing gas atmosphere inside the vacuum chamber.

[0036] According to embodiments which can be combined with other embodiments described herein, the gas distribution system 230 may include pumps and/or compressors for providing the desired pressure of the processing gas atmosphere inside the vacuum chamber. In particular, the gas distribution system may include pumps and/or compressors for providing the partial pressure of inert gas and/or for providing the partial pressure of H_2 and/or for providing the partial pressure of water vapor and/or for providing the partial pressure of O_2 according to the respective partial pressure ranges as specified herein by the respective upper and lower partial pressure limits of inert gas, H_2, water vapor and O_2.

[0037] As shown in FIG. 2, according to embodiments which can be combined with other embodiments described herein, the sensor 270, gas distribution system 230 including the first mass flow controller 234, the second mass flow controller 235 and the third mass flow controller 237, and outlet pump 236 may be connected to a controller 240. The controller 240 may control the gas distribution system 230 including the first mass flow controller 234, the second mass flow controller 235, the third mass flow controller 237 and the outlet pump 236, so that a processing atmosphere with a composition as described herein can be created and maintained in the vacuum chamber 210.

[0038] Accordingly, the apparatus according to embodiments as described herein is configured for manufacturing a layer stack for display manufacturing by employing the method of manufacturing a layer stack according to embodiments described herein.

[0039] FIG. 3 shows a block diagram illustrating a method of manufacturing a patterned layer stack for display manufacturing according to embodiments as described herein. The method 100 includes depositing 101 a layer stack onto a substrate by sputtering a first layer with a first set of processing parameters from an indium oxide containing target. Further, the method includes sputtering a second layer with a second set of processing parameters different from the first set of processing parameters onto the first layer from an indium oxide containing target. According to embodiments described herein, the first set of processing parameters is adapted for high etchability of the layer stack and the second set of processing parameters is adapted for low resistance of the layer stack. Further, according to embodiments described herein, the method includes patterning 102 the layer stack by etching, for example by chemical etching, particularly by wet chemical etching.

[0040] According to embodiments described herein, the expression "the first set of processing parameters is adapted for high etchability of the layer stack" may be understood in that the first set of processing parameters is adapted such that the molecular structure of the first layer sputtered under the sputter conditions specified by the first set of processing parameters is adapted for etching, e.g. chemical etching, particularly wet chemical etching. For example, the first set of processing parameters may be adapted such that the molecular structure of the first layer sputtered under the sputter conditions specified by the first set of processing parameters has a degree of amorphous structure from a lower limit to an upper limit as specified herein.

[0041] According to embodiments described herein, the expression "the first set of processing parameters is adapted for high etchability of the layer stack" may be understood in that the first set of processing parameters is adapted such that the etchability of the first layer of the layer stack is better than the etchability of the second layer of the layer stack which is sputtered under the sputter conditions specified by the second set of processing parameters. For example, the first set of processing parameters may be adapted such that the degree of amorphous structure in the first layer is higher than the degree of amorphous structure in the second layer. Accordingly the etchability of the first layer may influence the etchability of the layer stack.

[0042] According to embodiments described herein, the expression "the second set of processing parameters is adapted for low resistance of the layer stack" may be understood in that the second set of processing parameters is adapted such that the second layer of the layer stack which is sputtered under the sputter conditions specified by the second set of processing parameters has resistivity from a range between a lower limit 100 μOhm cm, particularly a lower limit of 125 μOhm cm, more particularly a lower limit of 150 μOhm cm, and an upper limit of 200 μOhm cm, particularly an upper limit 250 μOhm cm, more particularly an upper limit 300 μOhm cm. Accordingly the sheet resistance of the second layer may influence the sheet resistance of the layer stack.

[0043] According to embodiments which can be combined with other embodiments described herein, depositing 101 a layer stack onto a substrate by sputtering from an indium oxide containing target may include sputtering from an indium tin oxide (ITO) containing target, particularly an ITO 90/10 containing target. According to embodiments described herein ITO 90/10 includes an indium oxide (In_2O_3) and a tin oxide (SnO_2) at a ratio of $In_2O_3 : SnO_2 = 90:10$. According to embodiments which can be combined with other embodiments described herein, depositing 101 the layer stack onto the substrate may be carried out at room temperature.

[0044] According to embodiments which can be combined with other embodiments described herein, the first set of processing parameters includes at least one first parameter selected from the group consisting of: H2-content provided in a first processing gas atmosphere; content of water vapor provided in the first processing gas atmosphere; O_2-content provided in the first processing gas atmosphere; first total pressure of the first processing gas atmosphere; and a first power supplied to the indium oxide containing target. According to embodiments which can be combined with other embodiments described herein, depositing the first layer may be carried out at room temperature.

[0045] According to embodiments which can be combined with other embodiments described herein, the content of H_2 in the first processing gas atmosphere may be from a range between a lower limit of 2.2%, particularly a lower limit of 4.2%, more particularly a lower limit of 6.1%, and an upper limit of 10%, particularly an upper limit of 15.0%, more particularly an upper limit of 20.0%. With respect to the lower limits of H_2 it is to be

understood that the lower explosion limit of H_2 is 4.1% and the lower inertisation limit is 6.0 %. By sputtering the first layer of a layer stack, particularly a first conductive oxide layer of a layer stack, from an indium oxide containing target in a first processing gas atmosphere in which the content of H_2 in the first processing gas atmosphere has been selected from a lower limit to an upper limit as described herein, the etchability of the layer stack may be adjusted. In particular, the etchability of the layer stack depends on the degree of amorphous structure of the layer stack which can, for example, be controlled by the content of H_2 in the first processing gas atmosphere. Particularly, by increasing the content of H_2 in the first processing gas atmosphere, the degree of amorphous structure in the first layer of the layer stack may be increased. Accordingly, the etchability of the layer stack can be improved.

[0046] According to embodiments which can be combined with other embodiments described herein, the content of water vapor in the first processing gas atmosphere may be from a range between a lower limit of 0.0%, particularly a lower limit of 2.0%, more particularly a lower limit of 4.0%, and an upper limit of 6.0%, particularly an upper limit of 8.0%, more particularly an upper limit of 10.0%. By sputtering the first layer of a layer stack, particularly a first conductive oxide layer of a layer stack, from an indium oxide containing target in a first processing gas atmosphere in which the content of water vapor in the first processing gas atmosphere has been selected from a range between a lower limit and an upper limit as described herein, the etchability of the layer stack may be adjusted. In particular, the etchability of the layer stack depends on the degree of amorphous structure of the layer stack which can, for example, be controlled by the content of water vapor in the first processing gas atmosphere. Particularly, by increasing the content of water vapor in the first processing gas atmosphere the degree of amorphous structure in the first layer of the layer stack may be increased. Accordingly, the etchability of the layer stack can be improved.

[0047] According to embodiments which can be combined with other embodiments described herein, the ratio of water vapor to H_2 is from a range between a lower limit of 1:1, particularly a lower limit 1:1.25, more particularly a lower limit of 1:1.5, and an upper limit of 1:2 particularly an upper limit of 1:3, more particularly an upper limit of 1:4. By sputtering a transparent conductive oxide layer from an indium oxide containing target in a

processing gas atmosphere in which the ratio of water vapor to H_2 content in the processing gas atmosphere has been selected from a range between a lower limit and an upper limit as described herein, the control over the degree of amorphous structure in the oxide layer is improved. Accordingly, the degree of amorphous structure can be controlled more precisely, for example compared to a case in which the degree of amorphous structure in the oxide layer may only be controlled by water vapor.

[0048] According to some embodiments which can be combined with other embodiments described herein, the content of O_2 in the first processing gas atmosphere may be from a range between a lower limit of 0.5%, particularly a lower limit of 1.0%, more particularly a lower limit of 1.5%, and an upper limit of 3.0%, particularly an upper limit of 4.0%, more particularly an upper limit of 15.0%.

[0049] According to embodiments which can be combined with other embodiments described herein, all constituent gases of the first processing gas atmosphere may be mixed prior to filling the vacuum chamber with the first processing gas atmosphere. Accordingly, during deposition of the first layer in the first processing gas atmosphere all constituent gases of the first processing gas atmosphere may flow through the same gas showers. In particular, depending on the selected composition of the first processing gas atmosphere as described herein, H_2, water vapor, O_2 and inert gas may be supplied to the vacuum chamber through the same gas showers. For example, the gaseous constituents of a selected first processing gas atmosphere may be mixed in a mixing unit before the gaseous constituents of the selected first processing gas are provided into the vacuum chamber via the gas showers. Accordingly, according to some embodiments which can be combined with other embodiments describe herein, the apparatus for depositing a layer stack may include a mixing unit for mixing the gaseous constituents of the selected first processing gas before the gaseous constituents of the selected first processing gas are provided into the vacuum chamber via the gas showers. Accordingly, a very homogenous processing first gas atmosphere can be established in the vacuum chamber.

[0050] Accordingly, by sputtering a first layer of a layer stack from an indium containing target in a processing gas atmosphere having a content of water vapor and/or a content of H_2 as described herein, the formation of a crystalline ITO phase may be suppressed. In

view of that, in case of a subsequent patterning of the sputtered oxide layer, for example by chemical etching, a reduction in crystalline ITO residuals on the oxide layer can be achieved. Accordingly, the quality of a patterned oxide layer employed for TFT display manufacturing can be increased. Further, by providing a processing gas atmosphere having a content of water vapor and a content of H_2 as described herein, the risk of flammability and explosion of H_2 in the processing gas atmosphere can be reduced or even eliminated.

[0051] According to embodiments which can be combined with other embodiments described herein, the first total pressure of the first processing gas atmosphere may be from a range between a lower limit of 0.2 Pa, particularly a lower limit of 0.3 Pa, more particularly a lower limit of 0.4 Pa, and an upper limit of 0.6 Pa, particularly an upper limit of 0.7 Pa, more particularly an upper limit of 0.8 Pa. In particular, the total pressure of the first processing gas atmosphere may be 0.3 Pa. By sputtering the first layer of a layer stack from an indium oxide containing target in a processing gas atmosphere in which the first total pressure of the processing gas atmosphere has been selected from a lower limit to an upper limit as described herein, the etchability of the layer stack may be adjusted. In particular, the etchability of the layer stack depends on the degree of amorphous structure of the layer stack which can, for example, be controlled by the total pressure in the first processing gas atmosphere. In particular, by increasing the total pressure of the first processing gas atmosphere the degree of amorphous structure in the first layer of a layer stack may be increased. Accordingly, the etchability of the layer stack can be improved.

[0052] According to embodiments which can be combined with other embodiments described herein, the first power supplied to the indium oxide containing target may be from a range between a lower limit of 1 kW, particularly a lower limit of 2 kW, more particularly a lower limit of 4 kW, and an upper limit of 5 kW, particularly an upper limit of 10 kW, more particularly an upper limit of 15 kW. For example, in case of using a Gen 8.5 target having a target length of 2.7 m, the target may be provided with a power from a range between of 0.4 kW/m and 5.6 kW/m. Accordingly, it is to be understood that that respective lower limits and upper limits of the first power supplied to the target may be normalized with respect to the length of the target. By sputtering the first layer of a layer stack from an indium oxide containing target with a first power which has been selected from a range between a lower limit and an upper limit as described herein, the degree of

amorphous structure of the oxide layer may be adjusted. In particular, by decreasing the first power supplied to the indium oxide containing target, the degree of amorphous structure in the first layer of a layer stack may be increased.

[0053] According to embodiments which can be combined with other embodiments described herein, the second set of processing parameters includes at least one second parameter selected from the group consisting of: H_2-content provided in a second processing gas atmosphere; content of water vapor provided in the second processing gas atmosphere; O_2-content provided in a second processing gas atmosphere; a second total pressure of the second processing gas atmosphere; and a second power supplied to the indium oxide containing target. According to embodiments which can be combined with other embodiments described herein, depositing the second layer may be carried out at room temperature.

[0054] According to some embodiments which can be combined with other embodiments described herein, the content of O_2 in the second processing gas atmosphere may be from a range between a lower limit of 0.5%, particularly a lower limit of 1.0%, more particularly a lower limit of 1.5%, and an upper limit of 3.0%, particularly an upper limit of 4.0%, more particularly an upper limit of 15.0%. By sputtering the second layer of the layer stack from an indium oxide containing target in a second processing gas atmosphere in which the content of O_2 in the processing gas atmosphere has been selected from a range between a lower limit and an upper limit as described herein, the sheet resistance of the layer stack may be adjusted and optimized with respect to low resistance.. In particular, for optimizing the sheet resistance with respect to low resistance, the content of O_2 has to be selected from a range between a lower critical value and an upper critical value. For, example in case the content of O_2 is below the lower critical value or above the upper critical value, relatively high values for the sheet resistance may be obtained. Accordingly, embodiments as described herein provide for adjusting and optimizing the sheet resistance of oxide layer stacks with respect to low resistance.

[0055] According to embodiments which can be combined with other embodiments described herein, the content of H_2 in the second processing gas atmosphere may be from a range between a lower limit of 2.2%, particularly a lower limit of 5.0%, more particularly a

lower limit of 7.0%, and an upper limit of 10%, particularly an upper limit of 15.0%, more particularly an upper limit of 20.0%.

[0056] According to embodiments which can be combined with other embodiments described herein, the content of water vapor in the second processing gas atmosphere may be from a range between a lower limit of 0.0%, particularly a lower limit of 2.0%, more particularly a lower limit of 4.0%, and an upper limit of 6.0%, particularly an upper limit of 8.0%, more particularly an upper limit of 10.0%.

[0057] It is to be understood that according to embodiments described herein in which the second processing gas atmosphere includes water vapor, H_2, inert gas and O_2 the respective contents of water vapor, H_2, inert gas and O_2 may add up to 100% of the processing gas atmosphere.

[0058] According to embodiments which can be combined with other embodiments described herein, all constituent gases of the second processing gas atmosphere may be mixed prior to filling the vacuum chamber with the second processing gas atmosphere. Accordingly, during deposition of the second layer in the second processing gas atmosphere all constituent gases of the second processing gas atmosphere may flow through the same gas showers. In particular, depending on the selected composition of the second processing gas atmosphere as described herein, H_2, water vapor, O_2 and inert gas may be supplied to the vacuum chamber through the same gas showers. For example, the gaseous constituents of a selected second processing gas atmosphere may be mixed in a mixing unit before the gaseous constituents of the selected second processing gas are provided into the vacuum chamber via the gas showers. Accordingly, according to some embodiments which can be combined with other embodiments described herein, the apparatus for depositing a layer stack may include a mixing unit for mixing the gaseous constituents of the selected second processing gas before the gaseous constituents of the selected second processing gas are provided into the vacuum chamber via the gas showers. Accordingly, a very homogenous second processing gas atmosphere can be established in the vacuum chamber.

[0059] According to embodiments which can be combined with other embodiments described herein, the second total pressure of the second processing gas atmosphere may

be lower than the first total pressure of the first processing gas atmosphere. The second total pressure of the second processing gas atmosphere can be from a range between a lower limit of 0.2 Pa, particularly a lower limit of 0.3 Pa, more particularly a lower limit of 0.4 Pa, and an upper limit of 0.6 Pa, particularly an upper limit of 0.7 Pa, more particularly an upper limit of 0.8 Pa. In particular, the total pressure of the second processing gas atmosphere may be 0.3 Pa. By sputtering the second layer of a layer stack from an indium oxide containing target in a processing gas atmosphere in which the second total pressure of the second processing gas atmosphere has been selected to be lower than the first total pressure of the first processing gas atmosphere, the crystallinity of the layer stack may be adjusted. In particular, the crystallinity of the layer stack can, for example, be controlled by the second total pressure in the second processing gas atmosphere. Particularly, by decreasing the second total pressure of the second processing gas atmosphere, the degree of crystallinity in the second layer of the layer stack may be increased.

[0060] According to embodiments which can be combined with other embodiments described herein, the second power supplied to the indium oxide containing target for sputtering the second layer may be higher than the first power supplied to the indium oxide containing target for sputtering the first layer. The second power supplied to the indium oxide containing target may be from a range between a lower limit of 5 kW, particularly a lower limit of 8 kW, more particularly a lower limit of 10 kW, and an upper limit of 13 kW, particularly an upper limit of 16 kW, more particularly an upper limit of 20 kW. For example, in case of using a Gen 8.5 target having a target length of 2.7 m, the target may be provided with a power from a range between of 1.9 kW/m and 7.4 kW/m. Accordingly, it is to be understood that that respective lower limits and upper limits of the second power supplied to the target may be normalized with respect to the length of the target. By sputtering the second layer of a layer stack from an indium oxide containing target with a second power which has been selected from a lower limit to an upper limit as described herein, the crystallinity of the layer stack may be adjusted. In particular, the crystallinity of the layer stack can, for example, be controlled by the second power supplied to the indium oxide containing target. Particularly, by increasing the second power supplied to the indium oxide containing target, the degree of crystallinity in the second layer of the layer stack may be increased.

[0061] According to embodiments which can be combined with other embodiments described herein, the first processing gas atmosphere includes water vapor, H_2, O_2 and an inert gas. It is to be understood that the content of the constituents of the first processing gas atmosphere according to embodiments described herein may add up to 100%. In particular, according to some embodiments which can be combined with other embodiments described herein, the content of water vapor, H_2, $O_2$and inert gas may add up to 100% of the first processing gas atmosphere. The inert gas may be selected from the group consisting of helium, neon, argon, krypton, xenon or radon. In particular the inert gas may be argon (Ar).

[0062] According to embodiments which can be combined with other embodiments described herein, the partial pressure of water vapor in the first processing gas atmosphere may be from a range between a lower limit of 0.0 Pa, for example in a case in which the lower limit of the water vapor content of 0.0% has been selected for a first processing gas atmosphere or a second processing gas atmosphere, and an upper limit of 0.08 Pa, for example in a case in which the upper limit of the water vapor content of 10.0% has been selected for a first processing gas atmosphere with the upper limit of the total pressure of 0.8 Pa.

[0063] Accordingly, it will be understood that the partial pressure of water vapor in the processing gas atmosphere can be calculated by the product of the selected water vapor content in per cent [%] of the processing gas atmosphere and the selected total pressure of the processing gas atmosphere in Pascal [Pa]. Accordingly, depending on the selected values of the upper and lower limits of water vapor content in the processing gas atmosphere and the selected values of the upper and lower limits of the total pressure of the processing gas atmosphere corresponding values for the lower and the upper limit of the partial pressure of water vapor in the processing gas atmosphere can be calculated and selected.

[0064] According to embodiments which can be combined with other embodiments described herein, the partial pressure of H_2 in the first processing gas atmosphere may be from a range between a lower limit of 0.0044 Pa, for example in a case in which the lower limit of the H_2 content of 2.2% has been selected for a first processing gas atmosphere with

the lower limit of the total pressure of 0.2 Pa, and an upper limit of 0.16 Pa, for example in a case in which the upper limit of the H_2 content of 20.0% has been selected for a first processing gas atmosphere with the upper limit of the total pressure of 0.8 Pa.

[0065] Accordingly, it will be understood that the partial pressure of H_2 in the processing gas atmosphere can be calculated by the product of the selected H_2 content in per cent [%] of the processing gas atmosphere and the selected total pressure of the processing gas atmosphere in Pascal [Pa]. Accordingly, depending on the selected values of the upper and lower limits of H_2 content in the processing gas atmosphere and the selected values of the upper and lower limits of the total pressure of the processing gas atmosphere, corresponding values for the lower and upper limit of the partial pressure of H_2 in the processing gas atmosphere can be calculated and selected.

[0066] According to embodiments which can be combined with other embodiments described herein, the second processing gas atmosphere includes water vapor, H_2, O_2 and an inert gas. It is to be understood that the content of the constituents of the second processing gas atmosphere according to embodiments described herein may add up to 100%. In particular, according to some embodiments which can be combined with other embodiments described herein, the content of water vapor, H_2, O_2 and inert gas may add up to 100% of the second processing gas atmosphere. The inert gas may be selected from the group consisting of helium, neon, argon, krypton, xenon or radon. In particular the inert gas may be argon (Ar). The contents and partial pressures of water vapor and H_2 in the second processing gas atmosphere may be selected within the ranges as specified herein by the respective upper and lower limits for the first processing gas atmosphere.

[0067] According to embodiments which can be combined with other embodiments described herein, the partial pressure of O_2 in the processing gas atmosphere may be from a range between a lower limit of 0.001 Pa, for example in a case in which the lower limit of the O_2 content of 0.5% has been selected for a processing gas atmosphere with the lower limit of the total pressure of 0.2 Pa, and an upper limit of 0.12 Pa, for example in a case in which the upper limit of the O_2 content of 15.0% has been selected for a processing gas atmosphere with the upper limit of the total pressure of 0.8 Pa.

[0068] Accordingly, it will be understood that the partial pressure of O_2 in the processing gas atmosphere can be calculated by the product of the selected O_2 content in per cent [%] of the processing gas atmosphere and the selected total pressure of the processing gas atmosphere in Pascal [Pa]. Accordingly, depending on the selected values of the upper and lower limits of O_2 content in the processing gas atmosphere and the selected values of the upper and lower limits of the total pressure of the processing gas atmosphere corresponding values for the lower and upper limit of the partial pressure of O_2 in the processing gas atmosphere can be calculated and selected.

[0069] According to embodiments which can be combined with other embodiments described herein, the content of inert gas is in the first processing gas atmosphere and/or the second processing gas atmosphere may be from a range between a lower limit of 55%, particularly a lower limit of 73%, more particularly a lower limit of 81%, and an upper limit of 87.5%, particularly an upper limit of 92.0%, more particularly an upper limit of 97.3%. By sputtering a transparent conductive oxide layer from an indium oxide containing target in a processing gas atmosphere in which the content of inert gas in the processing gas atmosphere has been selected from a range between a lower limit and an upper limit as described herein, the quality of the transparent conductive oxide layer can be ensured. In particular, by providing a processing gas atmosphere with inert gas as described herein, the risk of flammability and explosion of H_2 in the processing gas atmosphere can be reduced or even eliminated.

[0070] According to embodiments which can be combined with other embodiments described herein, the partial pressure of inert gas in the first processing gas atmosphere and/or the second processing gas atmosphere may be from a range between a lower limit of 0.11 Pa, for example in a case in which the lower limit of the inert gas content of 55%, the upper limit of the water vapor content of 10%, the upper limit of the H_2 content of 20%, and the upper limit of the O_2 content of 15.0% has been selected for a processing gas atmosphere with the lower limit of the total pressure of 0.2 Pa, and an upper limit of 0.7784 Pa, for example in a case in which the upper limit of the inert gas content of 97.3%, the lower limit of the water vapor content of 0.0%, the lower limit of the H_2 content of 2.2%, and the lower limit of the O_2 content of 0.5% have been selected for a processing gas atmosphere with the upper limit of the total pressure of 0.8 Pa.

[0071] Accordingly, it will be understood that the partial pressure of inert gas in the processing gas atmosphere can be calculated by the product of the selected inert gas content in per cent [%] of the processing gas atmosphere and the selected total pressure of the processing gas atmosphere in Pascal [Pa]. Accordingly, depending on the selected values of the upper and lower limits of inert gas content in the processing gas atmosphere and the selected values of the upper and lower limits of the total pressure of the processing gas atmosphere corresponding values for the lower and the upper limit of the partial pressure of inert gas in the processing gas atmosphere can be calculated and selected.

[0072] According to embodiments which can be combined with other embodiments described herein, the first processing atmosphere may be selected and controlled for controlling the etchability of the layer stack, for example by controlling the degree of amorphous structure of the first layer, e.g. by controlling the content of water vapor and/or the content of H_2 in the first processing gas atmosphere. In particular, by increasing the content of water vapor and/ or content of H_2 in the first processing gas atmosphere, the degree of amorphous structure in the first layer may be increased. In particular, by increasing the content of H_2 in the first processing gas atmosphere the number of crystalline grains, particularly at the interface between the substrate and the first layer may be decreased. According to embodiments which can be combined with other embodiments described herein, the etchability of the layer stack may be improved by only controlling the content of H_2 in the first processing gas atmosphere. This may be beneficial for the adjustment of the resistivity of the layer stack properties, in particular since water vapor may also influence resistivity additionally to etchability of the layer stack.

[0073] According to embodiments which can be combined with other embodiments described herein, the second processing atmosphere may be selected and controlled for controlling the sheet resistance 104 of the layer stack, for example by controlling the content of O_2 in the second processing gas atmosphere during deposition of the second layer. In particular, for optimizing the sheet resistance of the layer stack with respect to low resistance after an annealing, the content of O_2 in the second processing gas atmosphere during layer deposition has to be selected from a range between a lower limit and an upper limit as described herein. According to embodiments, after layer deposition

an annealing procedure may be performed, for example in a temperature range from 200°C to 250°C.

[0074] According to embodiments which can be combined with other embodiments described herein, the resistivity after annealing of the layer stack may be from a range between a lower limit 100 μOhm cm, particularly a lower limit of 120 μOhm cm, more particularly a lower limit of 150 μOhm cm, and an upper limit of 250 μOhm cm, particularly an upper limit 275 μOhm cm, more particularly an upper limit 300 μOhm cm. In particular, the resistivity after annealing of the layer stack may be approximately 230 μOhm cm. According to embodiments which can be combined with other embodiments described herein, the resistivity of the layer stack may be determined by the second layer.

[0075] According to embodiments which can be combined with other embodiments described herein, the first processing gas atmosphere may consist of water vapor, H_2, an inert gas, and a residual gas. The content of water vapor, H_2, inert gas and residual gas in the first processing gas atmosphere consisting of water vapor, H_2, inert gas, and residual gas may be selected from a respective lower limit to a respective upper limit as described herein.

[0076] According to embodiments which can be combined with other embodiments described herein, the second processing gas atmosphere may consist of water vapor, H_2, an inert gas, O_2, and a residual gas. The content of water vapor, H_2, inert gas and O_2 in the second processing gas atmosphere consisting of water vapor, H_2, inert gas, and O_2 and a residual gas may be selected from a respective lower limit to a respective upper limit as described herein.

[0077] According to embodiments which can be combined with other embodiments described herein, the residual gas may be any impurity or any contaminant in the first processing gas atmosphere or second processing gas atmosphere. According to embodiments which can be combined with other embodiments described herein, the content of residual gas may be from 0.0% to 1.0% of the respective processing gas atmosphere. In particular, the content of residual gas may be 0.0% of the respective processing gas atmosphere. It is to be understood that the content of the constituents of the

processing gas atmosphere according to embodiments described herein may add up to 100%.

[0078] By employing the method of manufacturing a patterned layer stack according to embodiments described herein, for example by means of an apparatus according to embodiments described herein, a patterned layer stack 334 as exemplarily shown in FIG. 4B can be manufactured. In FIG. 4A a layer stack 333 before patterning, particularly before patterning by etching, is shown. According to embodiments of the patterned layer stack 334 which is manufactured by the method according to embodiments described herein, the layer stack may include a first layer 311 and a second layer 312. The first layer 311 may be deposited directly on the substrate 300. The second layer 312 may be deposited directly on the first layer 312, as exemplarily shown in FIG: 4A.

[0079] According to embodiments which can be combined with other embodiments described herein, the first layer may have a first thickness T1 from a range between a lower limit of 10 nm, particularly a lower limit of 15 nm, more particularly a lower limit of 20 nm, and an upper limit of 30 nm, particularly an upper limit of 40 nm, more particularly an upper limit of 50nm.

[0080] According to embodiments which can be combined with other embodiments described herein, the second layer may have a second thickness T2 from a range between a lower limit of 30 nm, particularly a lower limit of 40 nm, more particularly a lower limit of 50 nm, and an upper limit of 70 nm, particularly an upper limit of 85 nm, more particularly an upper limit of 150nm.

[0081] As exemplarily shown in FIG. 4B, the patterned layer stack 334 according to embodiments described herein may include regularly spaced cavities 330. The cavities can be created by using chemical etching, particularly wet chemical etching. According to embodiments which can be combined with other embodiments described herein, a photoresist coating for structuring the layer stack via exposure to radiation may be applied before etching. Further, the cavities may have a depth which corresponds to the sum of the first thickness T1 of the first layer and the second thickness T2 of the second layer.

[0082] According to embodiments described herein, the layer stack manufactured by the method of manufacturing a layer stack according to embodiments described herein may be employed in an electronic device, particularly in an opto-electronic device. Accordingly, by providing an electronic device with a layer stack according to embodiments described herein, the quality of the electronic device can be improved. In particular, it will be understood by the skilled person that the method of manufacturing a layer stack for display manufacturing and the apparatus therefore according to embodiments described herein provide for high quality and low cost TFT display manufacturing.

CLAIMS

1. A method (100) of manufacturing a patterned layer stack for display manufacturing, comprising:

depositing (101) a layer stack onto a substrate by sputtering a first layer with a first set of processing parameters from an indium oxide containing target;

sputtering a second layer with a second set of processing parameters different from the first set of processing parameters onto the first layer from an indium oxide containing target, wherein the first set of processing parameters is adapted for high etchability of the layer stack, and wherein the second set of processing parameters is adapted for low resistance of the layer stack; and

patterning (102) the layer stack by etching.

2. The method (100) according to claim 1,

wherein the first set of processing parameters comprises at least one first parameter selected from the group consisting of:

- H_2-content provided in a first processing gas atmosphere;
- content of water vapor provided in the first processing gas atmosphere;
- O_2-content provided in the first processing gas atmosphere;
- first total pressure of the first processing gas atmosphere; and
- a first power supplied to the indium oxide containing target.

3. The method (100) according to claim 2,

wherein the H_2-content provided in the first processing gas atmosphere is from 2.2% to 20.0%.

4. The method (100) according to claim 2 or 3,

wherein the content of water vapor provided in the first processing gas atmosphere is from 0.0% to 10%.

5. The method (100) according to any of claims 2 to 4,

wherein the first total pressure of the first processing gas atmosphere is from 0.2 Pa to 0.8 Pa.

6. The method (100) according to any of claims 2 to 5,

wherein the first power supplied to the indium oxide containing target is from 0.4 kW/m to 5.6 kW/m.

7. The method (100) according to any of claims 1 to 6,

wherein the second set of processing parameters comprises at least one second parameter selected from the group consisting of:

- H_2-content provided in a second processing gas atmosphere;
- content of water vapor provided in the second processing gas atmosphere;
- O_2-content provided in the second processing gas atmosphere;
- second total pressure of the second processing gas atmosphere;
- and a second power supplied to the indium oxide containing target.

8. The method (100) according to claim 7;

wherein the O_2-content provided in the second processing gas atmosphere is from 0.5% to 15.0%.

9. The method (100) according to claim 7 or 8;

wherein the second total pressure of the second processing gas atmosphere is from 0.2 Pa to 0.8 Pa.

10. The method (100) according to any of claims 7 to 9;

wherein the second power supplied to the indium oxide containing target is from 1.9 kW/m to 7.4 kW/m.

11. The method (100) according to any of claims 1 to 10;

wherein the first layer has a thickness from 10 nm to 50 nm and the second layer has a thickness from 30 nm to 150nm.

12. The method (100) according to claim 1,

wherein the target is an indium tin oxide (ITO) containing target, particularly ITO 90/10,

wherein the first set of processing parameters comprises at least one first parameter selected from the group consisting of:

- H_2-content provided in a first processing gas atmosphere, wherein the H_2-content provided in the first processing gas atmosphere is from 2.2% to 20.0%;
- content of water vapor provided in the first processing gas atmosphere wherein the content of water vapor is from 0.0% to 10%,
- O_2-content provided in a second processing gas atmosphere, wherein the O_2-content provided in the first processing gas atmosphere is from 0.5% to 15.0%;
- first total pressure of the first processing gas atmosphere, wherein the first total pressure of the first processing gas atmosphere is from 0.2 Pa to 0.8 Pa; and
- a first power supplied to the indium oxide containing target, wherein the first power supplied to the indium oxide containing target is from 0.4 kW/m to 5.6 kW/m,

wherein the second set of processing parameters comprises at least one parameter selected from the group consisting of:

- H_2-content provided in a second processing gas atmosphere, wherein the H_2-content provided in the first processing gas atmosphere is from 2.2% to 20.0%;
- content of water vapor provided in the second processing gas atmosphere wherein the content of water vapor is from 0.0% to 10%,
- O_2-content provided in a second processing gas atmosphere, wherein the O_2-content provided in the first processing gas atmosphere is from 0.5% to 15.0%;
- second total pressure of the second processing gas atmosphere, wherein the total pressure of the second processing gas atmosphere is from 0.2 Pa to 0.8 Pa; and
- and a second power supplied to the indium oxide containing target wherein the second power supplied to the indium oxide containing target is from 1.9 kW/m to 7.4 kW/m,

wherein the first layer has a thickness from 20 nm to 50 nm, and wherein the second layer has a thickness from 30 nm to 150 nm.

13. A patterned layer stack (334) for an electronic device which is manufactured by the method (100) according to any of claims 1 to 12.

14. An electronic device comprising a patterned layer stack (334) according to claim 13.

15. An apparatus (200) for depositing a layer stack for display manufacturing, comprising:

a vacuum chamber (210);

one or more indium oxide containing targets (220a, 220b) within the vacuum chamber (210) for sputtering a transparent conductive oxide layer;

a gas distribution system (230) for providing a processing gas within the vacuum chamber (210);

particularly an etching device (280) for etching the layer stack, and

a controller (240) connected to the gas distribution system (230) and configured to execute a program code, wherein upon execution of the program code a method (100) according to any of claims 1 to 13 is conducted.

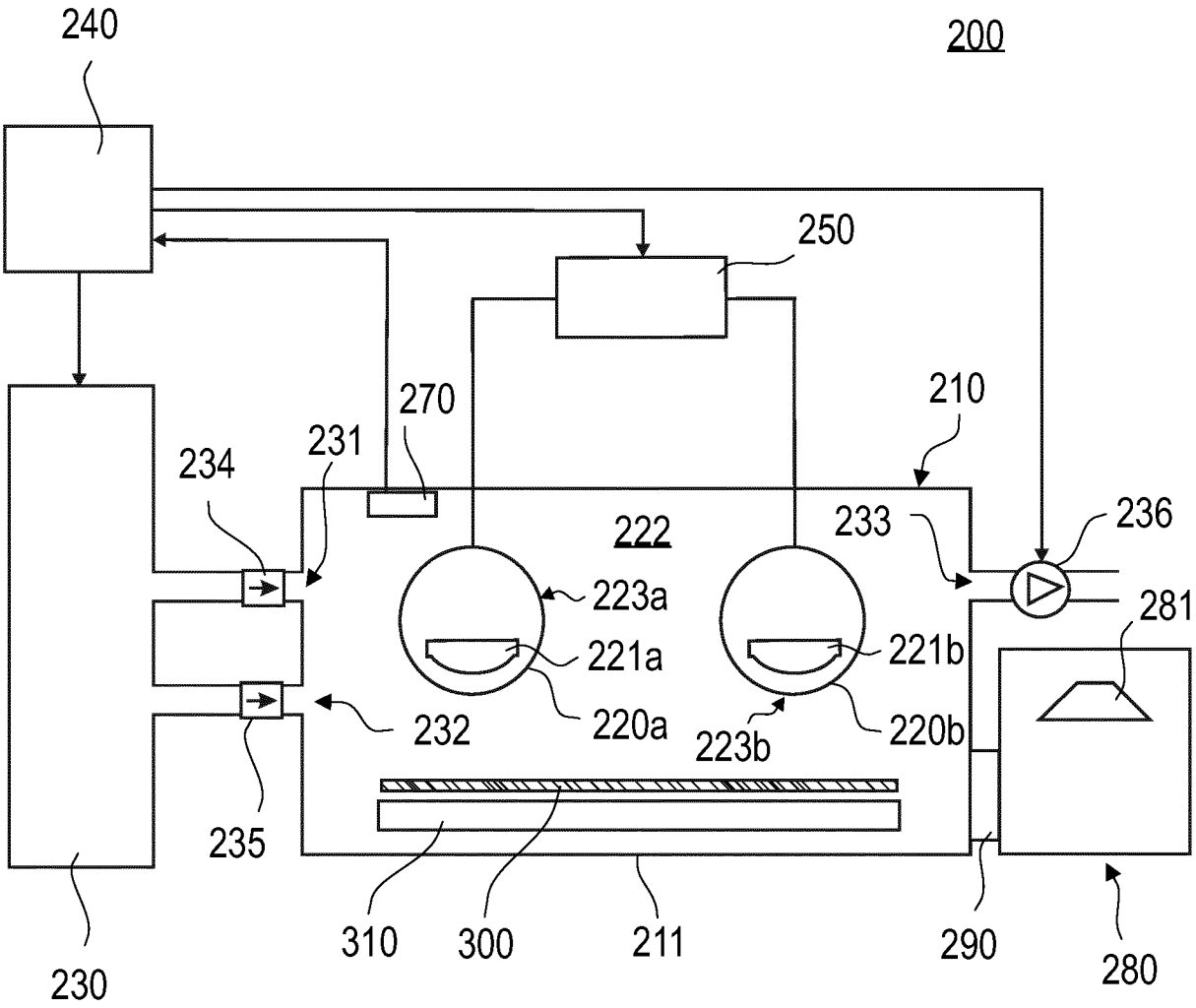

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FIG. 1

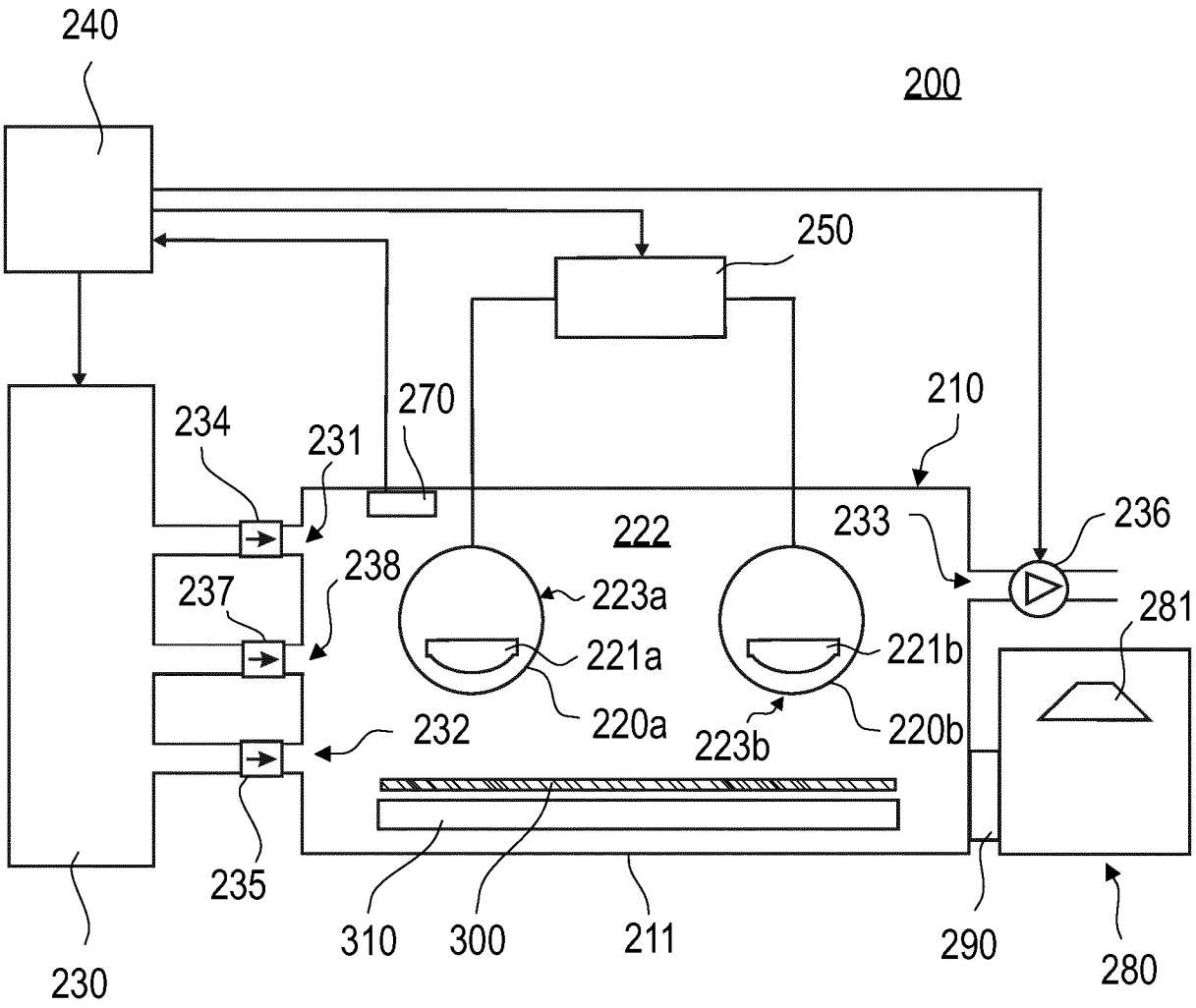

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FIG. 2

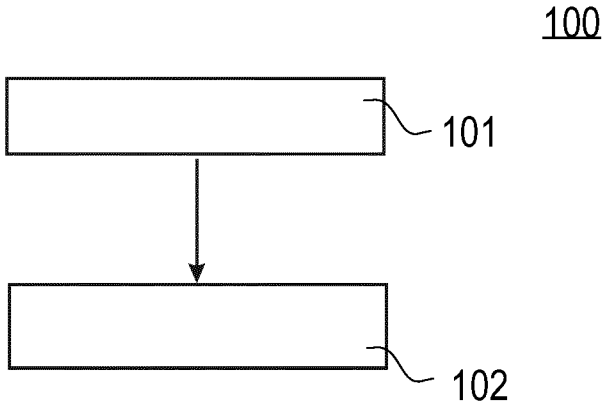

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FIG. 3

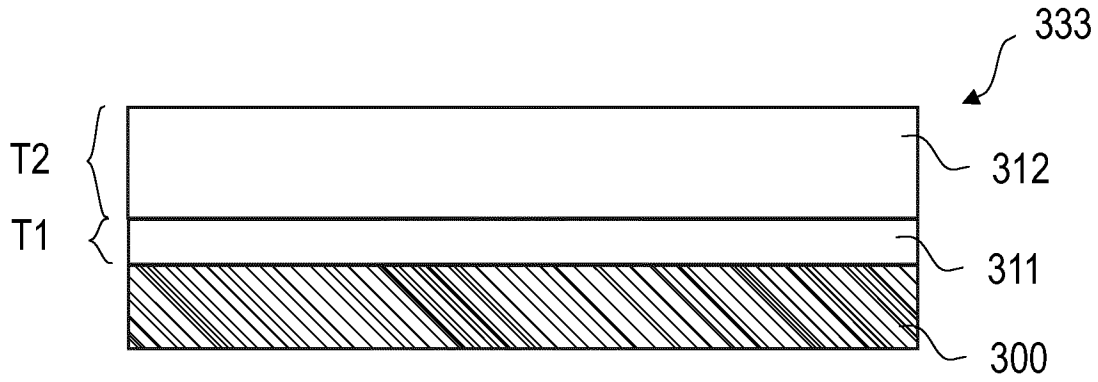


FIG. 4A

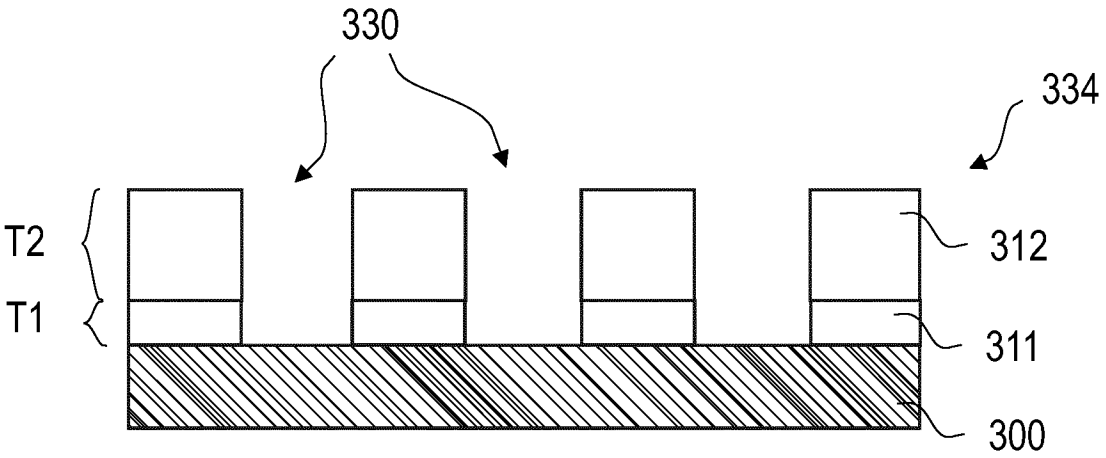


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/060233

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C14/08 C23C14/34 C23C14/54 C23C14/58
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C23C

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H02 213090 A (SHARP KK) 24 August 1990 (1990-08-24) Abstract; figure 3 -----	1,2,4-15
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X	JP 2012 172219 A (TOPPAN PRINTING CO LTD) 10 September 2012 (2012-09-10) paragraphs [0032] - [0033]; claim 1; example 1 ----- -/--	1-7,9-15

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 October 2015	22/10/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Peijzel, Paul

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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