APPARATUS FOR PRODUCING SPUTTERED FILMS

Original Filed July 9, 1971

FIG. 1

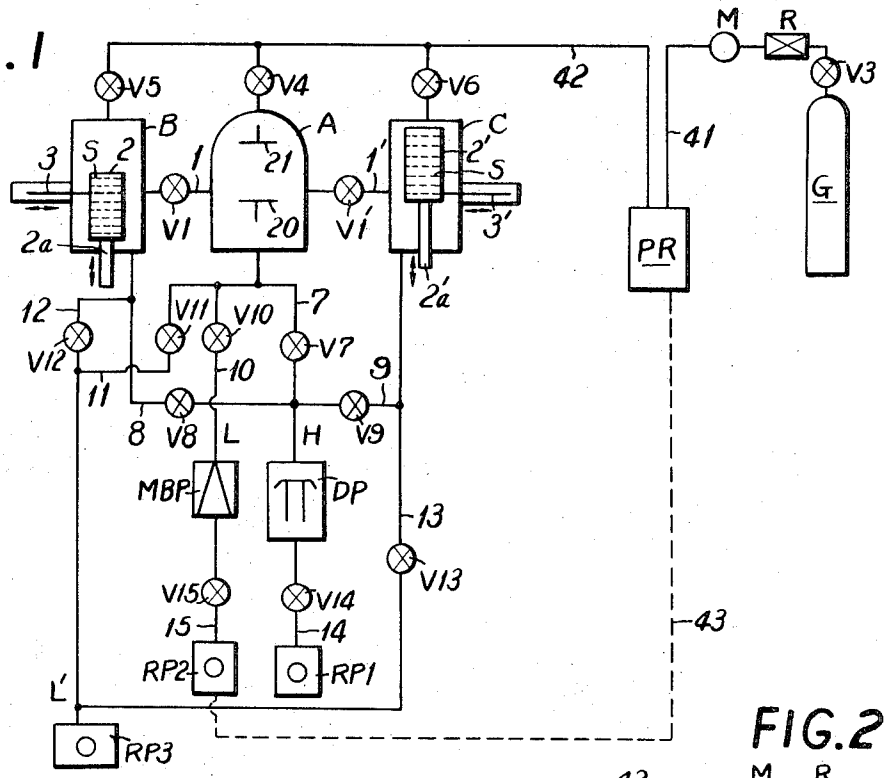


FIG. 2

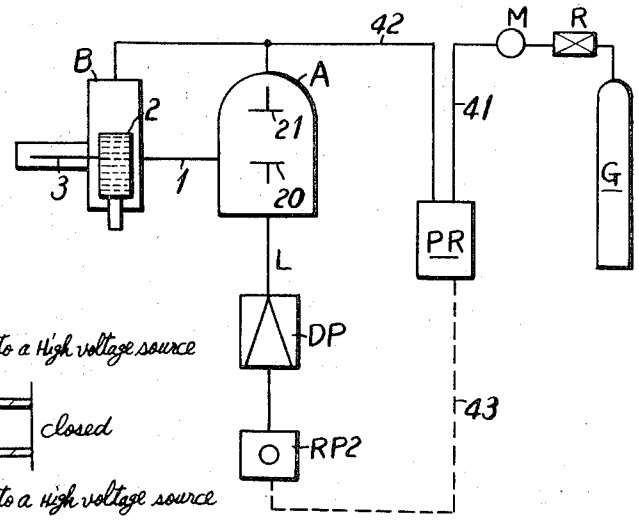
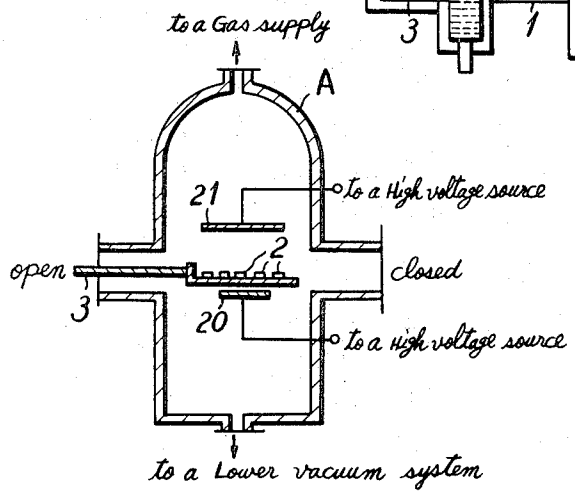


FIG. 3



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3,822,200

APPARATUS FOR PRODUCING SPUTTERED FILMS

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Int. Cl. C23c 15/00

U.S. Cl. 204—298 4 Claims

ABSTRACT OF THE DISCLOSURE

A process for producing sputtered films and an apparatus for carrying out said process in which substrates are transferred between a sputtering chamber and one of at least two preliminary chambers both of which sputtering and one preliminary chambers are maintained under the same pressure and gas atmospheric conditions, said substrates are sputtered films thereon while they are disposed in the sputtering chamber and during the transfer and sputtering of said substrates the other of said preliminary chambers is charged with a new supply of substrates to be sputtered films thereon and evacuated so that the last-mentioned preliminary chamber is ready for a subsequent sputtering cycle whereby substrates are continuously sputtered.

This is a division of application Ser. No. 161,168 filed July 9, 1971, now U.S. Pat. No. 3,776,830.

BACKGROUND OF THE INVENTION

This invention relates to a process for producing a metallic or insulative film on a substrate by sputtering or depositing metal or insulative material against and on the substrate and an apparatus for carrying out the process.

It has been known in the art that a metallic thin film can be produced by the so-called cathode sputtering process and that an insulative film can be processed by the so-called high frequency sputtering process. The sputtered metallic films find their applications in various fields such as resistor layers for electric resistors and electrodes for capacitors. The sputtered insulative films find their application in the field of dielectric films for capacitors.

According to the cathode sputtering process, after a sputtering chamber has been substantially evacuated, the chamber is supplied with inert gas such as argon gas of high purity and a substrate is disposed between an anode and a cathode positioned within the chamber. An electric glow discharge takes place across the anode and cathode over the substrate whereby the material of the cathode is sputtered against the substrate. This process has been known suitable for obtaining a film of high melting point. When a sputtering operation is carried out by this process, if the sputtering chamber is evacuated to an insufficient degree for properly performing the sputtering and the chamber is maintained at such an insufficiently low degree of vacuum, when the cathode sputtering process is employed, the obtained film will inevitably contain impurities therein. Therefore, the sputtering chamber is required initially to have a vacuum degree range on the order of 10^{-5}–10^{-6} Torr. However, even if such a vacuum degree range is selected, since there is still the tendency that the obtained film contains impurities only at an initial stage of a successive operation, it has been generally followed that a pre-sputtering is initially conducted on a substrate in the sputtering chamber to remove impurities from the environment within the chamber prior to the subsequent proper sputtering and the proper sputtering operation is then conducted on subsequent successive substrates to form films thereon.

So far as the inventor knows there have been proposed no effective apparatus for producing sputtered films on a mass production scale or if any, such apparatus is very expensive in manufacture and operation. In a prior art sputtering apparatus which is designed to experimentally produce sputtered films, an exhausting or evacuating operation and a pre-sputtering operation have to be performed as each cycle of sputtered film production is carried out. Furthermore, it takes about 30 minutes–2 hours to attain a desired or predetermined degree of vacuum depending upon the volume of the sputtering chamber and/or the capacity of the vacuum pump employed in the sputtering apparatus and the pre-sputtering operation has to be performed over a time interval of 30 minutes–1 hour whereas it takes only 5–60 minutes to carry out the proper sputtering operation. Thus, it will be appreciated that the preparation period in a cycle of sputtered film production operation accounts for a substantial portion of the production cycle. Therefore, in the prior art sputtering apparatus, the down time is substantially long during which the operation on the apparatus has to be halted for taking film-sputtered products out of the sputtering chamber and for charging a new supply of substrates to be sputtered films thereon into the sputtering chamber and as a result, the productivity of the sputtering apparatus is very low.

An improved sputtering apparatus for producing sputtered films successively has been proposed in which substrates to be deposited films thereon are successively passed through a series of chambers or passage ways the degree of vacuum in which increases stepwise to the sputtering chamber and treated or film-deposited substrates are taken out of the sputtering chamber and passed through a series of chambers or passage ways the degree of vacuum in which decreases stepwise to the atmosphere. However, this type of sputtering apparatus still has the disadvantages that evacuation means has to be provided in each of the chambers or passage ways, the entire apparatus is massive and expensive and that the apparatus fails easily.

SUMMARY OF THE INVENTION

Therefore, one principal object of the present invention is to provide a process for producing sputtered films which can successively deposit films on substrates without the necessity for use of a plurality of chambers or passage ways the degree of vacuum in which varies stepwise.

Another object of the present invention is to provide a novel and improved apparatus for depositing material on substrates by sputtering process.

According to one aspect of the present invention, the sputtering apparatus comprises one sputtering chamber and at least two preliminary chambers in which substrates are sputtered material thereon as they are transferred between the sputtering chamber and one of the preliminary chambers both of which are maintained under the same vacuum and atmospheric conditions and simultaneously, the other preliminary chamber is opened to the atmosphere for receiving a new supply of substrates to be deposited films thereon or replacing substrates which have been deposited films thereon in the preceding sputtering operation by a new supply of substrates being followed by evacuation of the other chamber to a predetermined degree of vacuum thereby to make the other chamber ready for a next cycle of sputtering operation.

After all the substrates of the first-mentioned preliminary chamber have been deposited films thereon, the preliminary chamber is shut off the sputtering chamber and the second-mentioned preliminary chamber is then communicated with the sputtering chamber the interior of

which is maintained under vacuum conditions and substrates are passed between the sputtering chamber and second-mentioned preliminary chamber to perform a cycle of material sputtering operation on the substrates and simultaneously, the first-mentioned preliminary chamber is opened to the atmosphere for replacing the film-deposited substrates by a new supply of substrates and then evacuated to the predetermined degree of vacuum ready for a further cycle of sputtering operation.

In this way, substrates are transferred between the sputtering chamber and one of the preliminary chambers and simultaneously, substrate replacing and evacuation operations are performed with the other preliminary chamber.

According to the present invention, there is provided a process for producing sputtered films successively comprising the steps of maintaining a sputtering area and one of at least two preliminary chambers at the same gas atmosphere under the same pressure conditions, transferring selected ones of a supply of substrates from said one preliminary chamber to said sputtering chamber, sputtering material against said selected substrates at said sputtering area within the sputtering chamber to deposit said material on the substrates when the substrates are positioned in the sputtering chamber, returning said sputtered substrates to said one preliminary chamber, repeating said two preceding steps until all of said supply of substrates from the one preliminary chamber are sputtered, charging a new supply of substrates into the other of said two preliminary chambers while said three preceding steps are being conducted, after said last-mentioned step and during said first three preceding steps, highly evacuating said second-mentioned preliminary chamber before the completion of sputtering against the substrates from said first-mentioned preliminary chamber, after the completion of sputtering against all the substrates from said first-mentioned preliminary chamber, shutting the preliminary chamber off said sputtering chamber and immediately thereafter, communicating said evacuated second-mentioned preliminary chamber with said sputtering chamber for sputtering said material against the substrates from the preliminary chamber whereby the sputtering operation is continuously carried out.

According to the present invention, there is also provided an apparatus for carrying out the process which comprises a sputtering chamber having a sputtering area containing an anode and a cathode across which a glow discharge takes place, at least two preliminary chambers for receiving a supply of substrates on which films are to be deposited, respectively, passage way means for communicating between said sputtering chamber and one of said preliminary chambers, said passage way means also serving to communicate between said chambers in a gas flow relationship while maintaining the chambers under the same gas atmosphere conditions, a high vacuum system for highly evacuating each of said chambers, a low vacuum system for evacuating said sputtering chamber as the chamber operates for sputtering, a gas supply for providing each of said chambers with inert gas, first conduit means for communicating said high vacuum system with each of said chambers, second conduit means for communicating said low vacuum system with said sputtering chamber, third conduit means for communicating said gas supply with each of said chambers, a voltage source for applying a high voltage across said anode and cathode at said sputtering area and valve means provided in said passage way means and first to third conduit means in association with each of said chambers, said valve means in the passage way means being selectively operated to communicate one of said preliminary chambers with said sputtering chamber and simultaneously shutting the other preliminary chamber off the sputtering chamber, whereby substrates are in succession transferred between one of said preliminary chambers and said sputtering chamber for sputtering material thereon and at the same time a new supply of substrates are charged into the other preliminary chamber and the last-mentioned chamber is maintained at a high vacuum degree ready for a subsequent cycle of sputtering operation through the valve means in the first conduit means.

The above and other objects and attendant advantages of the present invention will be more readily apparent to those skilled in the art from a reading of the following detailed description in conjunction with the accompanying drawing which shows a preferred embodiment of thin sputtered film producing apparatus in which the present invention is incorporated for illustration purpose only, but not for limiting the scope of the same in any way.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view of the gas flow system in one preferred form of sputtered thin film producing apparatus constructed in accordance with the present invention;

FIG. 2 is a fragmentary schematic view of portions of said sputtering apparatus which portions are in operation when the apparatus is operated for a particular cycle of sputtering operation; and

FIG. 3 is a vertically sectional view on an enlarged scale of the sputtering chamber of said apparatus showing one tray having a plurality of substrates carried thereon as being positioned at the sputtering area within the sputtering chamber.

PREFERRED EMBODIMENT OF THE INVENTION

The present invention will be now described referring to the accompanying drawing and more particularly, to FIG. 1 thereof in which a preferred embodiment of sputtered film producing apparatus of the invention is schematically shown. The apparatus is shown as comprising a sputtering chamber A and two preliminary chambers B and C. The opposite sides of the sputtering chamber A are in fluid communication with the two preliminary chambers B and C by means of conduits or passage ways **1** and **1'** which extend between the opposite sides of the sputtering chamber and preliminary chambers and have valves **V1** and **V1'** therein, respectively.

Disposed within the sputtering chamber A is an anode **20** which may be conveniently formed of stainless steel and a cathode **21** which may be formed of tantalum, niobium or the like which is sputtered material as desired and these electrodes are positioned one upon another in a vertically spaced relationship. The material from the cathode **21** is adapted to be sputtered against a substrate which is preferably formed of a glass plate sold under the trade name "Corning 7059," a ceramic or a porcelain such as forsterite, mullite or alumina as desired on which a sputtered film is to be produced in the manner as will be described hereinafter. The anode **20** and cathode **21** are connected to a suitable high voltage source (not shown). The voltage to be employed in AC or DC ranging from 1,000 v. to 15,000 v. When AC voltage is employed, the voltage may be preferably as asymmetrical AC voltage.

Disposed within the preliminary chamber B is a vertically movable substrate supporting framework **2** having a plurality of vertically spaced shelves inwardly extending on the opposite inner surfaces thereof to support a plurality of trays in a vertically spaced relationship independently of each other each of which trays carries a plurality of substrates formed of the above-mentioned material thereon in a side-by-side spaced relationship. Similarly, the preliminary chamber C has a similar substrate supporting framework **2'** disposed therein having the same construction as the framework **2**. A plurality of trays each carrying a plurality of similar substrates in the same manner as mentioned in connection with the preliminary chamber B are supported in the framework **2'**. The frameworks **2** and **2'** have posts or bearing rods **2***a* and **2***a'* at the lower ends respectively, which extend downwardly through the

bottom walls of the respectively associated chamber in an air-tight relationship thereto and move vertically so as to impart a vertical movement to the frameworks as the rods move vertically. Each framework is so designed that the framework is intermittently lowered in timed relationship to a particular cycle of sputtering operation to be carried out in the apparatus so as to position the succeeding lowermost trays in the plane where the conduits or passage ways **1** and **1'** lie in the manner as will be described hereinafter. The movement of the frameworks **2** and **2'** is effected by a prime mover such as an oil-pressure-operated cylinder (not shown), for example, which is provided for each of the frameworks. Each of the preliminary chambers B and C is provided on the top with an access door (not shown) which is normally closed in and air-tight by a cover (not shown) and through which the framework is placed into and taken out of the preliminary chamber for replacing the treated or film-sputtered substrates by a new supply of substrates to be sputtered.

A gas bomb G is provided for supplying an inert gas such as argon and the gas under pressure from the bomb is passed through a valve **V3**, a gas pressure regulator R and a gas flow meter M into a conduit **41** from where the gas enters a purifier PR at the inlet thereof and issues from the purifier at the outlet thereof. The gas from the purifier is then passed to a conduit **42** the other end of which is communicated through valves **V4**, **V5** and **V6** with the gas inlets of the chambers A, B and C, respectively.

There is provided a high vacuum system H for evacuating the chambers and the system includes an oil diffusion pump DP and an oil rotary pump **PR1**. The system H is communicated through a conduit **7** having a valve **V7** with the chamber A and through conduits **8** and **9** having valves **V8** and **V9**, respectively, with the chambers B and C, respectively. The suction port in the oil diffusion pump DP is communicated with the conduits **7**, **8** and **9** whereas the exhaust port in the diffusion pump is communicated through a conduit **14** having a valve **V14** with the oil rotary pump **PR1**.

Before a high range of vacuum is provided in the chambers, it is necessary to rapidly evacuate the chambers. For the purpose, a rapid evacuation system L' provided with an oil rotary pump **PR3** of higher exhaust capacity is provided. The pump **PR3** is communicated through conduits **11**, **12** and **13** which have valves **V11**, **V12** and **V13**, respectively, with the chambers A, B and C, respectively.

The rapid evacuation system L' serves to evacuate the chamber from the atmospheric pressure to the order of 10^{-2}–10^{-3} Torr. whereas the high vacuum system H serves to evacuate the chamber from the order of 10^{-2}–10^{-3} Torr. to the order of 10^{-5}–10^{-6} Torr.

In order to maintain the exhaust pressure of the inert gas on the order of 10^{-2}–10^{-3} Torr. within the sputtering chamber during a successive sputtering operation thereon, a lower vacuum system L including a mechanical booster pump MBP and an oil rotary pump **PR2** is provided. The booster pump MBP is communicated through a conduit **10** having a valve **V10** with the sputtering chamber A.

Prior to initiation of the sputtering operation, the cover which closes the open top of the preliminary chamber B is first removed and thereafter, the sputtering framework **2**, which supports a plurality of trays each of which in turn supports a plurality of substrates in the manner mentioned above, is placed into the chamber B. After the framework **2** has been placed in the chamber B, the top cover is replaced on the top of the chamber to seal the latter. Thereafter, the valves **V1**, **V11** and **V12** are opened to operate the rapid evacuation system L' whereby the preliminary chambers B and C are rapidly evacuated. Then, the valves **V11** and **V12** are closed whereas the valves **V7** and **V8** are opened to operate the higher vacuum system H whereby the chambers A and B are further rapidly evacuated to the order of 10^{-5}–10^{-6} Torr. When the pressure reaches the predetermined value, the valves **V7** and **V8** are closed to stop the operation of the higher vacuum system H whereas the valves **V3**, **V4** and **V5** are opened whereby inert gas such as argon gas is allowed to flow at a predetermined rate through the regulator R, flow meter M, conduit **41**, gas purifier PR, conduit **42**, valves **V4** and **V5** which are now open to the chambers A and B. Simultaneously, the valve **V10** is opened to operate the booster pump MBP and oil rotary pump **RP2** of the lower evacuation system L whereby the degree of vacuum within the chamber A is maintained on the order of 10^{-2}–10^{-3} Torr. At this time, since the chamber B is in communication with the chamber A by means of the conduit **1**, the chamber B is maintained at the same degree of vacuum as the chamber A.

Referring to FIG. 2 of the accompanying drawing, in this Figure the chambers A and B are shown as being maintained at 10^{-2}–10^{-3} Torr. of inert gas at which the proper sputtering operation is conducted. It is preferable to conduct a pre-sputtering operation prior to the initiation of the proper sputtering operation. The pre-sputtering operation is achieved by transferring one tray on which no substrate is supported from the chamber B through the passage way **1** onto the anode **20** in the sputtering chamber A and then applying a high voltage across the anode and cathode **20** and **21**. The pre-sputtering operation is carried out only before the proper sputtering operation which is to be carried out continuously is initiated and for the purpose of disclosure herein, the empty tray which is to be employed in the above-mentioned pre-sputtering operation is the lowermost tray of the trays supported on the framework **2**. As shown in FIG. 3, the transfer of the empty tray from the chamber B to the chamber A is effected by means of a fork-shaped feed bar **3** which engages and holds the empty tray and then places the tray on the anode **20**. As the feed bar **3** transfers the empty tray, the bar is first advanced by a suitable drive means (not shown) until the bar engages and holds the tray and then the feed bar is further advanced through the passage **1** to the chamber A until the tray reaches a position just above the anode **20** whereupon the feed bar **3** releases the tray to allow the latter to seat on the anode. After the tray has been placed on the anode, the feed bar is retracted from the chamber A carrying the tray thereon. The pre-sputtering operation is carried out over a time interval ranging from 30 minutes to 1 hour whereupon the bar is advanced from the chamber B to the chamber A and then retracted from the chamber A through the passage **1** into the chamber B until the tray is again received in the framework **2**. Thereafter, the feed bar releases the tray to allow the tray to remain in the framework. Thereafter, the post **2*a*** and accordingly, the framework **2** supported thereby is lowered by a distance corresponding to the vertical space between adjacent two trays and the feed bar **3** is again advanced until the bar engages and holds the second lowermost tray or the tray having a plurality of substrates thereon positioned just above the lowermost tray. The feed bar **3** which holds the next tray is further advanced through the passage **1** to the sputtering chamber A until the tray is held on the anode **20** in the sputtering chamber A whereupon the feed bar is retracted from the chamber A to the original position. Thereafter, a cycle of proper sputtering operation is conducted over a predetermined time interval by the high voltage applied across the anode and cathode which sputters metal from the cathode against the substrates on the tray to produce films thereon. After the films have been produced on the substrates on the second lowermost tray, the feed bar **3** is again advanced through the conduit **1** into the sputtering chamber A until the bar engages and holds the tray and then retracted to the original position in the chamber B. The same procedure is repeated until all the substrates on the trays which are now supported in the framework **2** are sputtering-treated.

While the substrates on the trays are being transferred between the sputtering and preliminary chambers A and B

and sputtered in the sputtering chamber A in the manner mentioned above, the other preliminary chamber C is charged with the framework 2' in which a plurality of trays each carrying a plurality of substrates to be sputtered through the top of the chamber which has been now uncovered and the chamber is evacuated to the order of 10^{-5}–10^{-6} Torr. This is carried out by opening the valve V13 to operate the lower vacuum system L' until the vacuum degree in the chamber C reaches the order of 10^{-2}–10^{-3} Torr. whereupon the lower vacuum system ceases to operate and the valve V13 is closed whereas the valve V9 is opened to operate the higher vacuum system H to evacuate the chamber C to the order of 10^{-5}–10^{-6} Torr. and the chamber is then maintained at the vacuum degree until the substrates on all the trays in the preliminary chamber B are formed thereon with films from metal of the cathode 21. In this way, the substrates on all the trays in the chamber C are ready for sputtering treatment while a cycle of sputtering operation is being conducted on the substrates of the chamber B and upon the termination of the cycle on the substrates of the chamber B has been completed, a successive sputtering operation is conducted on the substrates of the chamber C.

After all the substrates of the chamber B have been formed thereon with films in the manner mentioned above, the valves V1 and V3 are closed to shut the preliminary chamber B off the sputtering chamber A and the valves V1' and V6 are opened whereas the valve V9 is closed whereupon the next cycle of metal sputtering operation is conducted on the substrates of the preliminary chamber C. Since inert gas at 10^{-2}–10^{-3} Torr. continues to flow through the sputtering chamber A when the sputtering operation is shifted from the chamber B to the chamber C, the sputtering operation can be immediately initiated on the substrates of the chamber C without any time delay.

While the cycle of sputtering operation is being conducted on the substrates of the chamber C, the top of the chamber B is uncovered to expose the interior of the chamber to the atmosphere and the framework 2 supporting the trays the substrates on which have been deposited with metal is taken out of the chamber B through the now uncovered top thereof for replacing the treated substrates for a new supply of substrates. After the new supply of substrates have been positioned on the respective trays supported in the framework in the manner mentioned above, the framework is again charged into the chamber B and the chamber is then evacuated to the order of 10^{-5}–10^{-6} Torr. and maintained at the vacuum degree ready for a next cycle of sputtering operation for the new supply of substrates.

The exhaust port of the rotary pump PR2 which is adapted to continuously operate during a cycle of sputtering operation may be communicated through a conduit 43 (shown with the dotted line in FIG. 1) with a second inlet of the gas purifier PR and this arrangement is economical because the inert gas which was used in the preceding cycle can be reused for a succeeding cycle.

In a practical sputtering operation on the sputtering apparatus of the present invention, glass plates sold under the trade name "Corning 7059" were deposited with tantalum. The cathode comprised tantalum which was the material to be deposited and the anode comprised stainless steel. Each of the glass plates was 50 mm. by 50 mm. with 0.8 mm. thickness. One tray carried 60 substrates thereon and 16 trays were stacked in one framework. Each chamber was initially rapidly evacuated to the order of 1×10^{-3} Torr. over a time interval of about 15 minutes and then shifted to the higher vacuum system to be evacuated to the order of 1.6×10^{-5} Torr. over a time interval of about 60 minutes. A presputtering operation was conducted by allowing argon gas to flow through the sputtering chamber A while maintaining the chamber at 3×10^{-2} Torr. as the lower vacuum system operates and thereafter, the proper sputtering was conducted. The time interval for the proper sputtering varied within the range of 5–60 minutes depending upon desired sheet resistance values and temperature coefficients. Thus, it took at least 100 minutes to deposit metal on all the substrates of one preliminary chamber and when one preliminary chamber is charged with a new supply of substrates while a cycle of proper sputtering operation is being conducted between the sputtering chamber and the other preliminary chamber, a sufficient time was obtained for rapidly evacuating.

In the foregoing, although one embodiment of the invention which is considered best at present time has been illustrated and described, it will be apparent to those skilled in the art that the same is illustrative in nature and may be embodied in various other different modes other than the illustrated one within the scope and without departing from the spirit of the invention. For example, when all the substrates of one preliminary chamber is deposited with metal by sputtering over a relatively short time interval, three or more preliminary chambers may be provided to be successively operated for sputtering. In this way, it will be appreciated that the sputtering apparatus of the invention is less expensive as compared with the prior art sputtering apparatus in which a plurality of preliminary chambers of different degrees of vacuum are provided on the inlet and outlet sides of the sputtering chamber. Furthermore, inert gas such as argon may be added thereto one or more reactive gases selected from the group comprising N_2, O_2 and CH_4 to provide nitride, oxide and/or carbonate films. The present invention intends to broadly include such and all other modifications which may fall within the scope of the appended claims.

What is claimed is:

1. An apparatus for producing sputtered films comprising a sputtering chamber having a sputtering area containing an anode and a cathode across which a glow discharge takes place, at least two preliminary chambers for receiving a supply of substrates on which films are to be deposited, respectively, passage way means for communicating between said sputtering chamber and each of said preliminary chambers, said passage way means also serving to communicate between said chambers in a gas flow relationship while maintaining the chambers under the same gas atmospheric conditions, a high vacuum system for highly evacuating each of said chambers, a low vacuum system for evacuating said sputtering chamber as the chamber operates for sputtering, a gas supply for providing each of said chambers with inert gas, first conduit means for communicating said high vacuum system with each of said chambers, second conduit means for communicating said low vacuum system with said sputtering chamber, third conduit means for communicating said gas supply with each of said chambers, a voltage source for applying a high voltage across said anode and cathode at said sputtering area and valve means provided in said passage way means and first to third conduit means in association with each of said chambers, said valve means in the passage way means being selectively operated to communicate one of said preliminary chambers with said sputtering chamber and simultaneously shutting the other preliminary chamber off the sputtering chamber, whereby substrates are in succession transferred between one of said preliminary chambers and said sputtering chamber for sputtering said substrates and at the same time a new supply of substrates are charged into the other preliminary chamber or chambers and the last-mentioned chamber is maintained at a high vacuum degree ready for a subsequent cycle of sputtering operation by means of said valve means in the first conduit means.

2. The apparatus as set forth in Claim 1, in which each of said preliminary chambers removably receives a framework in which a plurality of trays are supported in a vertically spaced relationship each of which trays in turn supports a plurality of substrates to be sputtered.

3. The apparatus as set forth in Claim 1, in which said framework is supported on a vertically movable bearing rod and said bearing rod is connected to drive means, said drive means driving said bearing rod so that the bearing rod is intermittently moved by a distance corresponding to the vertical distance between two adjacent trays so as to present each tray to a position opposite to a port of said passage way means.

4. The apparatus as set forth in Claim 1, in which each of said preliminary chambers includes a feed bar adapted to engage and hold one tray at one time and then transfer the tray through said passage way means to said sputtering chamber and said feed bar is connected to drive means

adapted to move the feed bar reciprocally while said bearing rod is at rest whereby said reciprocal movement of the bearing rod is effected for placing one tray onto said anode and taking said tray out of the anode.

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