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(54) **SYSTEM FOR AND METHOD OF MANUFACTURING A LARGE-AREA BACKPLANE BY USE OF A SMALL-AREA SHADOW MASK**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 10/255,972, filed on Sep. 26, 2002, now Pat. No. 6,943,066.

(51) **Int. Cl.**

C23C 16/00	(2006.01)
B05D 5/06	(2006.01)
B05D 5/12	(2006.01)

(52) **U.S. Cl.** **118/720**; 118/719; 118/729; 427/69; 438/907; 438/908

(58) **Field of Classification Search** 118/715, 118/719, 720, 729; 427/68, 69; 438/761, 438/674, 907, 908

See application file for complete search history.

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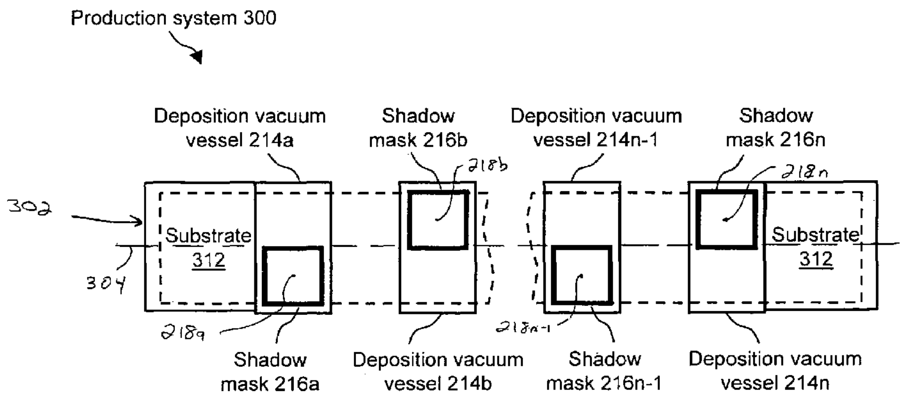
(57) **ABSTRACT**

A vapor deposition shadow mask system includes a number of series connected vacuum vessels each having a material deposition source and shadow mask positioned therein. A substrate is translated along a path that has a longitudinal axis that extends through the vacuum vessels. Centers of shadow masks in first and second vacuum vessels are offset laterally on opposite sides of the longitudinal axis. The system is operative for depositing material on a second area of the substrate via the material deposition source and shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on a first, adjacent area of the substrate via the material deposition source and shadow mask in the first vacuum vessel.

25 Claims, 6 Drawing Sheets



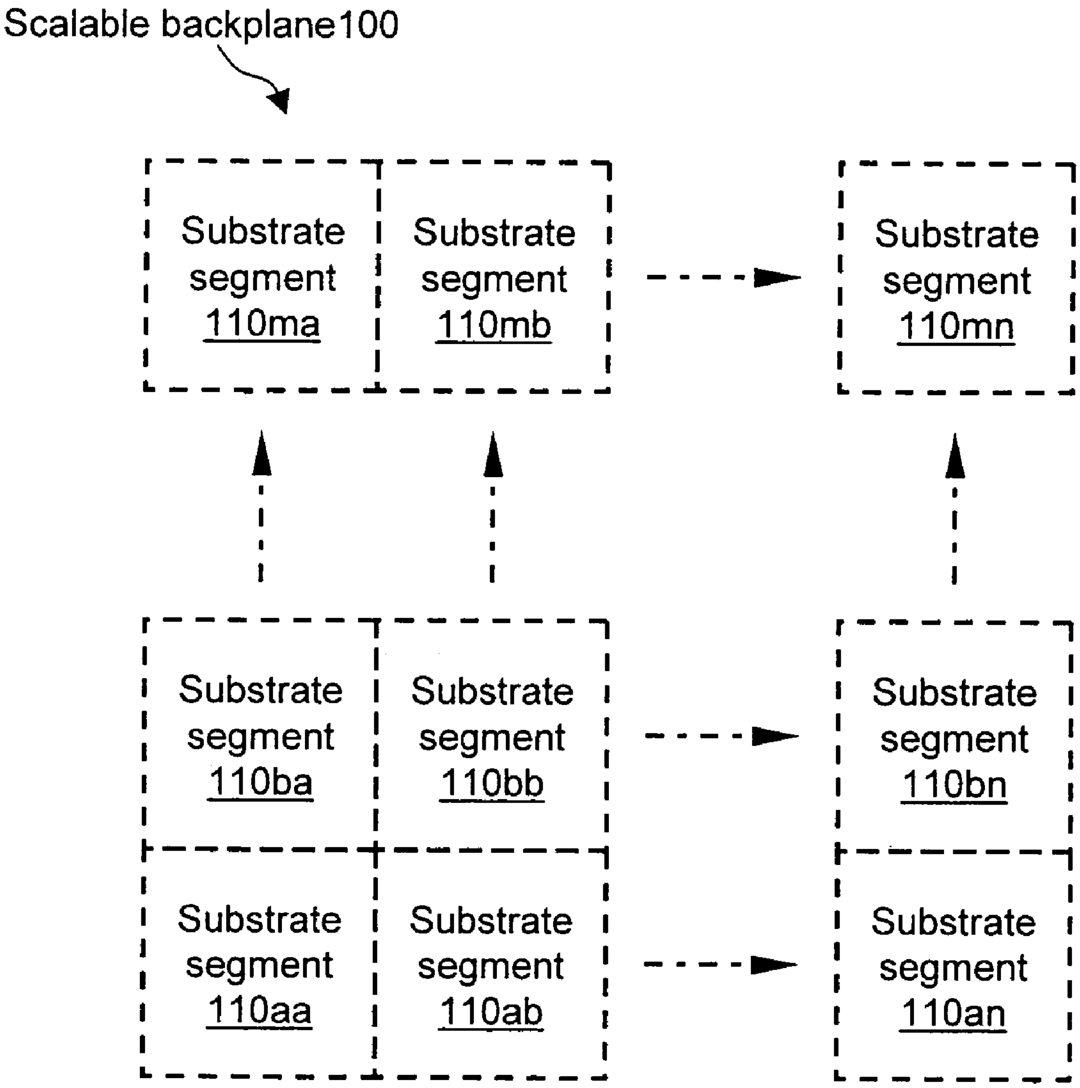

Scalable backplane100
Substrate segment 110ma
Substrate segment 110mb
Substrate segment 110mn
Substrate segment 110ba
Substrate segment 110bb
Substrate segment 110bn
Substrate segment 110aa
Substrate segment 110ab
Substrate segment 110an

FIG. 1

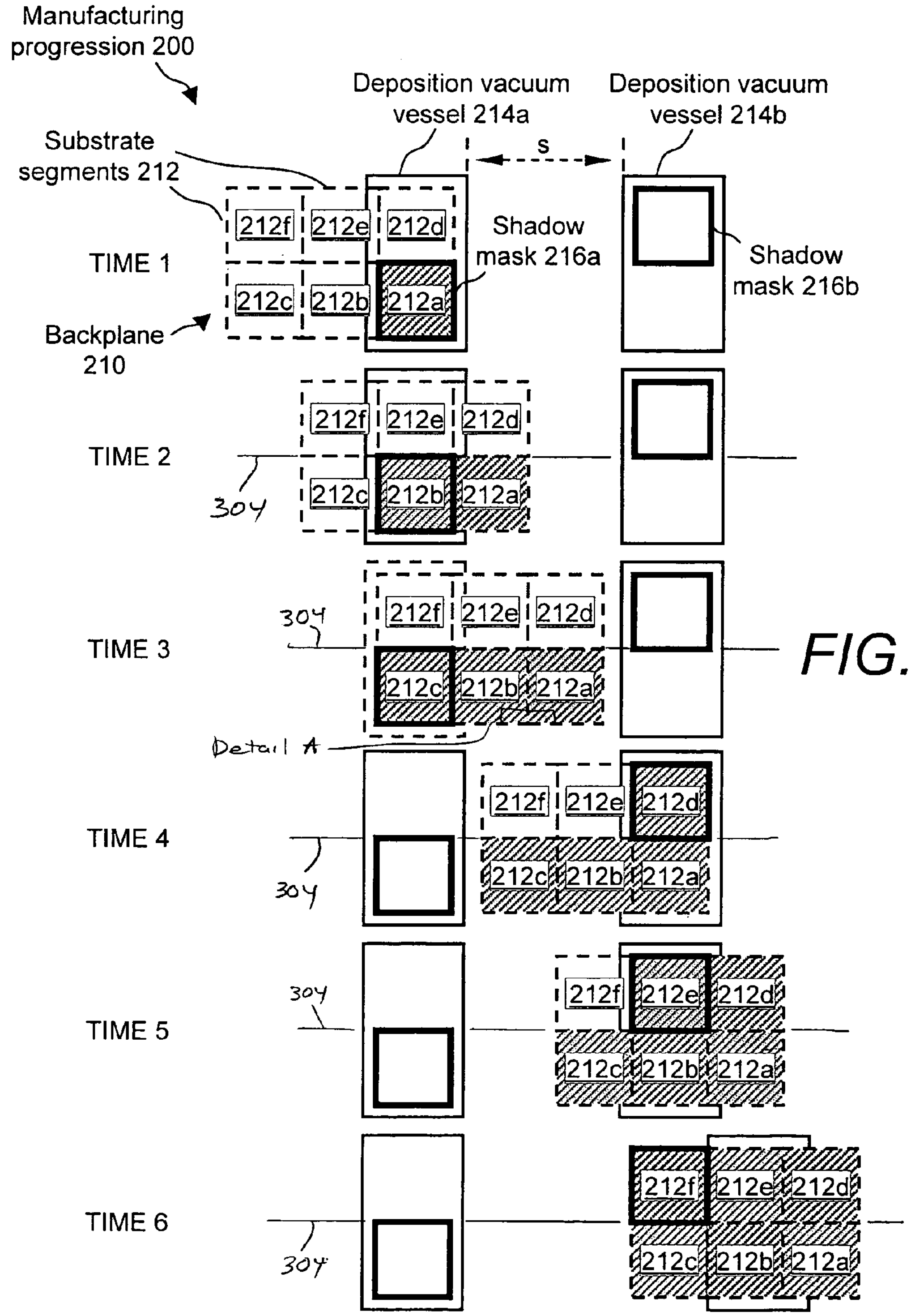

Manufacturing progression 200
Deposition vacuum vessel 214a
Deposition vacuum vessel 214b
s
Substrate segments 212
212f
212e
212d
212c
212b
212a
Shadow mask 216a
Shadow mask 216b
Backplane 210
TIME 1
TIME 2
TIME 3
TIME 4
TIME 5
TIME 6
304
Detail A

FIG. 2

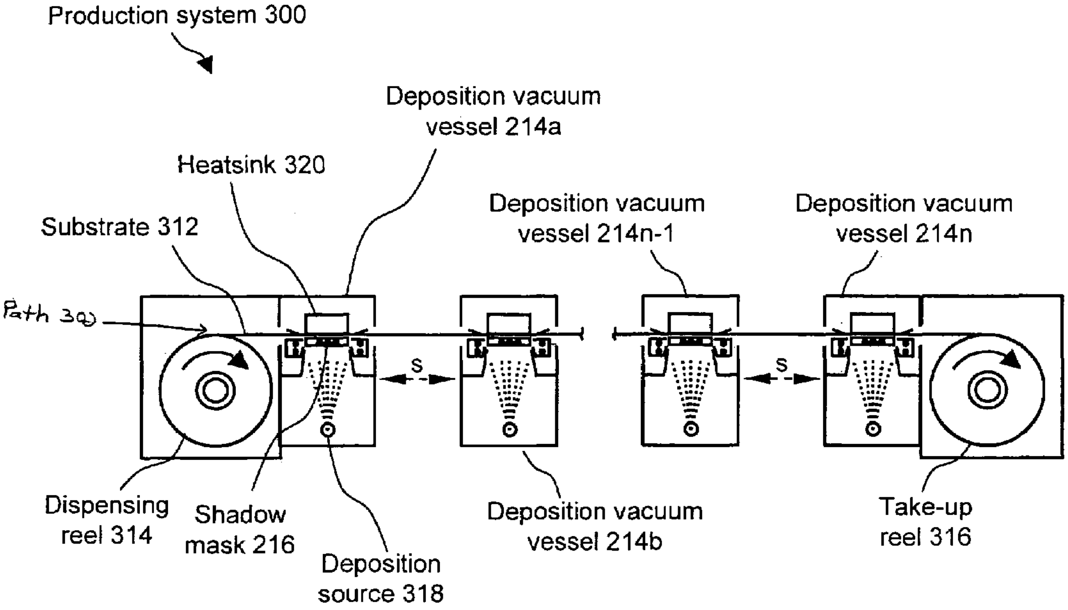

Production system 300
Deposition vacuum vessel 214a
Heatsink 320
Substrate 312
Deposition vacuum vessel 214n-1
Deposition vacuum vessel 214n
Path 302
S
S
Dispensing reel 314
Shadow mask 216
Deposition source 318
Deposition vacuum vessel 214b
Take-up reel 316

FIG. 3A

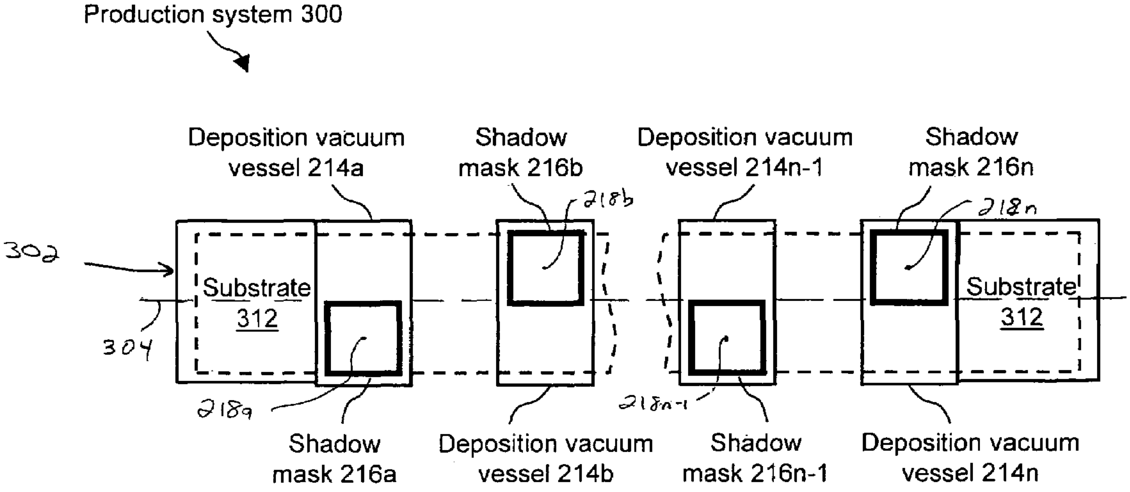

Production system 300
Deposition vacuum vessel 214a
Shadow mask 216b
218b
Deposition vacuum vessel 214n-1
Shadow mask 216n
218n
302
Substrate 312
304
Substrate 312
218a
Shadow mask 216a
Deposition vacuum vessel 214b
218n-1
Shadow mask 216n-1
Deposition vacuum vessel 214n

FIG. 3B

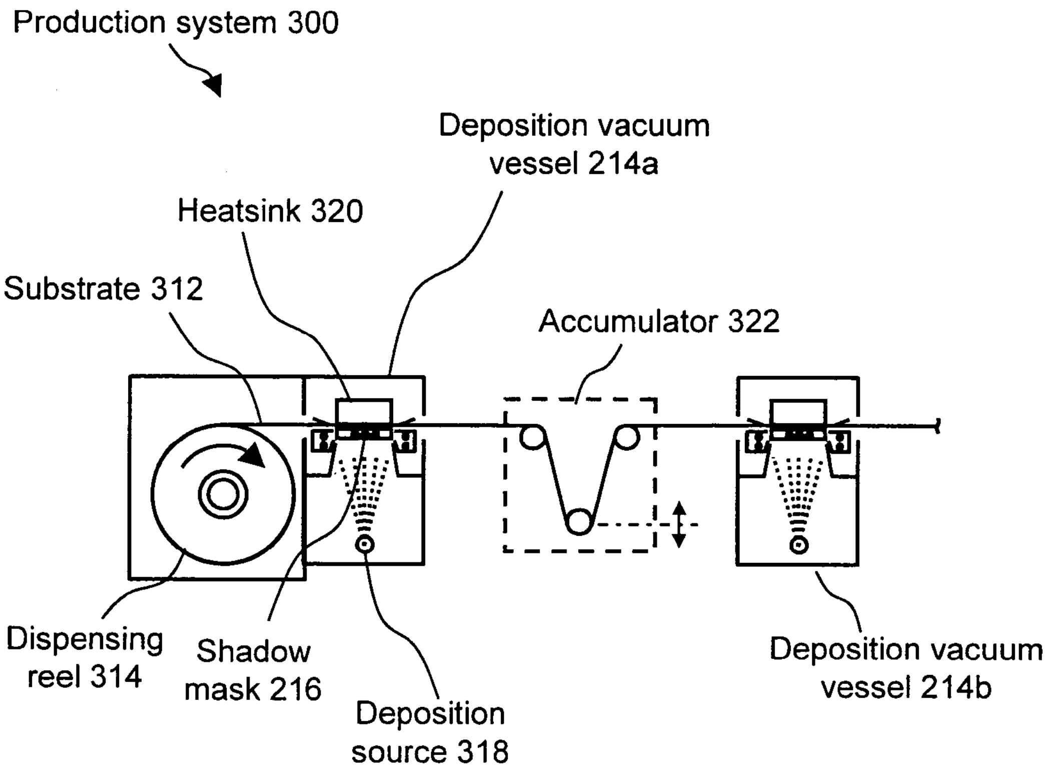

Production system 300
Deposition vacuum vessel 214a
Heatsink 320
Substrate 312
Accumulator 322
Dispensing reel 314
Shadow mask 216
Deposition source 318
Deposition vacuum vessel 214b

FIG. 3C

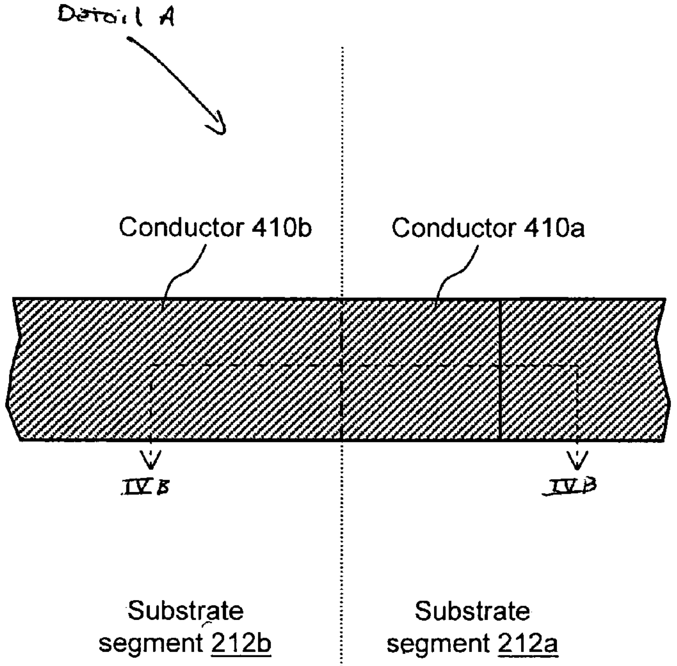

Detail A
Conductor 410b
Conductor 410a
IVB
IVB
Substrate segment 212b
Substrate segment 212a

FIG. 4A

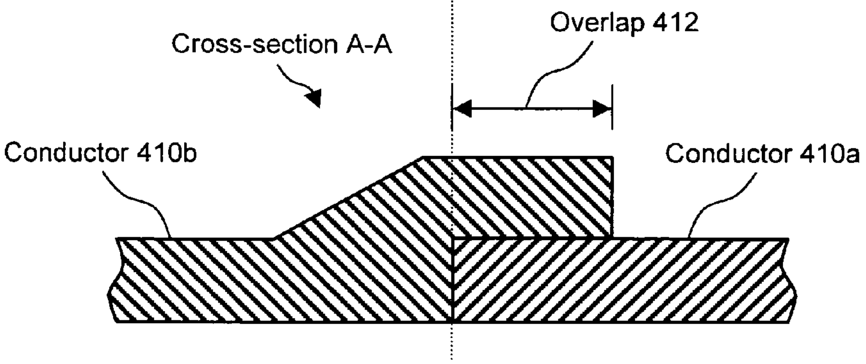

Cross-section A-A
Overlap 412
Conductor 410b
Conductor 410a

FIG. 4B

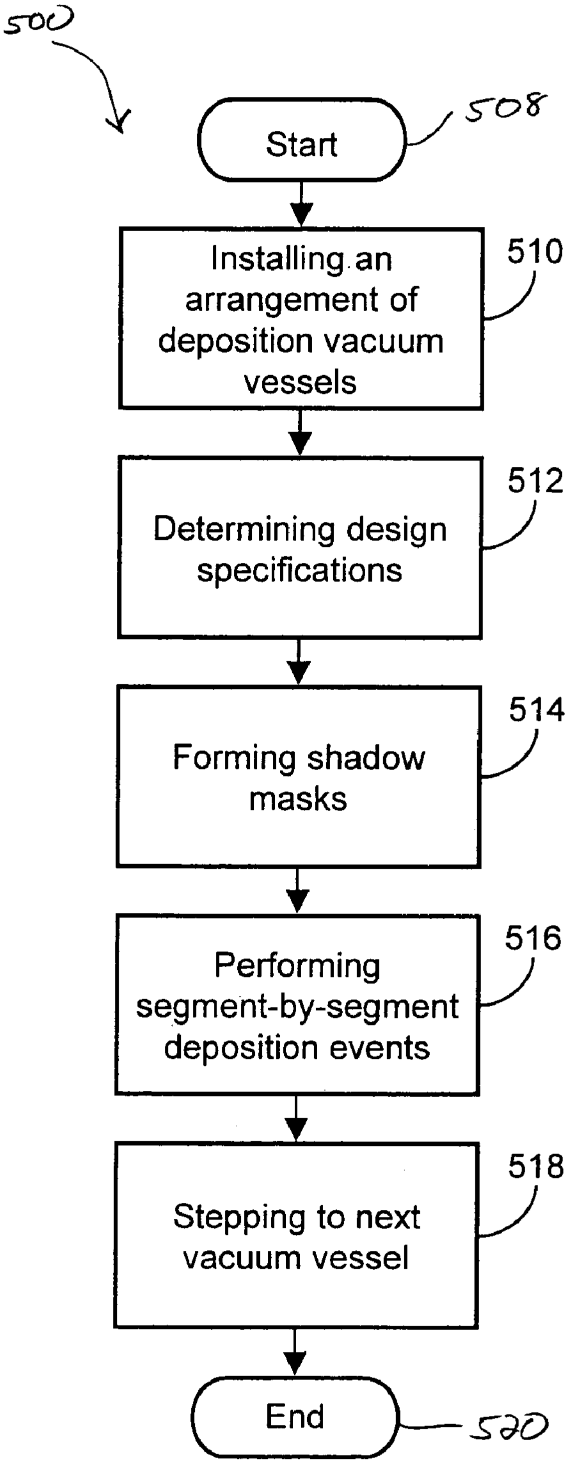

500
Start
508
Installing an arrangement of deposition vacuum vessels
510
Determining design specifications
512
Forming shadow masks
514
Performing segment-by-segment deposition events
516
Stepping to next vacuum vessel
518
End
520

FIG. 5

SYSTEM FOR AND METHOD OF MANUFACTURING A LARGE-AREA BACKPLANE BY USE OF A SMALL-AREA SHADOW MASK

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. patent application Ser. No. 10/255,972, filed Sep. 26, 2002, now U.S. Pat. No. 6,943,066 entitled "Active Matrix Backplane For Controlling Controlled Elements And Method Of Manufacture Thereof", which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to manufacturing backplanes for large-scale flat panel displays and, more particularly, to a system and method of forming a large-area backplane by use of one or more small-area shadow masks.

2. Description of Related Art

Active matrix backplanes are widely used in flat panel displays for routing signals to pixels of the display in order to produce viewable pictures. Presently, such active matrix backplanes are formed via a photolithographic manufacturing process, which has been driven in the market by the demand for higher and higher resolution displays which are not otherwise possible with other manufacturing processes. Photolithography is a pattern definition technique which uses radiation, such as ultraviolet (UV) radiation, to expose a layer of resist that is deposited on the surface of a substrate. Exemplary photolithography processing steps to produce an active matrix backplane include coat photoresist, pre-bake, soak, bake, align/expose, develop, rinse, bake, deposit layer, lift off photoresist, scrub/rinse and dry. As can be seen, the photolithographic manufacturing process for producing an active matrix backplane includes numerous deposition and etching steps in order to define appropriate patterns of the backplane.

Because of the number of steps required to form an active matrix backplane with the photolithographic manufacturing process, foundries of adequate capacity for volume production of backplanes are very expensive. An exemplary partial list of equipment needed for manufacturing active matrix backplanes utilizing the photolithographic manufacturing process includes glass-handling equipment, wet/dry strip equipment, glass cleaning equipment, wet clean equipment, plasma chemical vapor deposition (CVD) equipment, laser equipment, crystallization equipment, sputtering equipment, ion implant equipment, resist coater equipment, resist stripping equipment, developer equipment, particle inspection equipment, exposure systems, array filet/repair equipment, dry etch systems, anti-electrostatic discharge equipment, wet etch systems and a clean oven. Furthermore, because of the nature of the photolithographic manufacturing process, the foregoing equipment must be utilized in a class one or class ten clean room. In addition, because of the amount of equipment needed and the size of each piece of equipment, the clean room must have a relatively large area, which can be relatively expensive.

A vapor deposition shadow mask process has been used for years in microelectronics manufacturing. The vapor deposition shadow mask process is significantly less costly and less complex than the photolithography process. However, heretofore, the vapor deposition shadow mask process has not been favored by those of ordinary skill in the art for fabricating large-area backplanes. Publications disclosing vapor deposition shadow mask processes as well as related processes are disclosed in U.S. Patent Application Publication No. 2003/0193285; U.S. Patent Application Publication No. 2002/0011785; U.S. Pat. Ser. No. 6,592,933; U.S. Pat. No. 6,384,529 and U.S. Pat. No. 4,919,749.

What is, therefore, needed, and not disclosed in the prior art, is a method and apparatus for fabricating large-area backplanes via the vapor deposition shadow mask process, rather than utilizing the more costly photolithographic process. Other needs that the present invention fulfills will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description.

SUMMARY OF THE INVENTION

The invention is a vapor deposition shadow mask system that includes a plurality of series connected vacuum vessels each having a material deposition source and a shadow mask position therein and means for translating a substrate along a path that has a longitudinal axis that extends through the vacuum vessels. A center of the shadow mask in a first vacuum vessel is offset laterally to one side of the longitudinal axis of the path and a center of the shadow mask in a second vacuum vessel is offset laterally to the other side of the longitudinal axis of the path.

The system is operative for depositing material on a second area of the substrate via the material deposition source and shadow mask in the second vacuum vessel in a manner that overlaps a portion of material deposited on a first, adjacent area of the substrate via the material deposition source and shadow mask in the first vacuum vessel.

The first and second areas of the substrate are positioned adjacent each other in a direction transverse to the longitudinal axis of the path. The overlap occurs adjacent a boundary between the first and second areas in a direction parallel to the longitudinal axis of the path. Desirably, the first and second areas of the substrate do not overlap.

A center of a shadow mask in a third vacuum vessel can be offset laterally to the same side of the longitudinal axis of the path as the center of the shadow mask in the first vacuum vessel. The system is operative for depositing material on the first area of the substrate via the material deposition source and shadow mask in the third vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate and overlaps a portion of the material deposited on the second area of the substrate.

Also or alternatively, the system is operative for depositing material on a third area of the substrate via the material deposition source and a shadow mask in the first vacuum vessel in a manner that overlaps a portion of the material deposited on the first, adjacent area of the substrate by the material deposition source and shadow mask in the first vacuum vessel.

The first and third areas of the substrate are adjacent each other in a direction parallel to the longitudinal axis of the path. The material deposited on the third area of the substrate overlaps the material deposited on the first area of the substrate in a direction transverse to the longitudinal axis of the path. Desirably, the first, second and third areas of the substrate do not overlap.

The invention is also a vapor deposition shadow mask system that includes a plurality of series connected vacuum vessels each having a material deposition source and a shadow mask position therein and means for translating a substrate along a path that has a longitudinal axis that extends through the vacuum vessels. Centers of shadow masks in first and second vacuum vessels are offset laterally to one side of the longitudinal axis of the path.

The system is operative for depositing material on a second area of the substrate via the material deposition source and shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on a first, adjacent area of the substrate via the material deposition source and shadow mask in the first vacuum vessel.

The first and second areas of the substrate are adjacent each other in a direction parallel to the longitudinal axis of the path. The overlap occurs adjacent a boundary between the first and second areas in a direction transverse to the longitudinal axis of the path. Desirably, the first and second areas of the substrate do not overlap.

The invention is also a shadow mask vapor deposition method. The method includes (a) positioning a first area of a substrate in operative relation to a material deposition source and shadow mask in a first vacuum vessel; (b) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel; (c) advancing the first area of the substrate into a second vacuum vessel along a path that has a longitudinal axis that extends through the vacuum vessels; (d) positioning a second, adjacent area of the substrate in operative relation to a material deposition source and shadow mask in the second vacuum vessel; and (e) depositing material on the second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on the first area of the substrate, wherein centers of the shadow masks in the first and second vacuum vessels are offset laterally on opposite sides of the longitudinal axis of the path.

The overlap occurs adjacent a boundary between the first and second areas in a direction parallel to the longitudinal axis of the path. Desirably, the first and second areas of the substrate do not overlap.

The method can also include (f) advancing the first area of the substrate into a third vacuum vessel along the path; (g) positioning the first area of the substrate in operative relation to a material deposition source and shadow mask in the third vacuum vessel; and (h) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the third vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel and overlaps a portion of the material deposited on the second area of the substrate, wherein centers of the shadow masks in the first and third vacuum vessels are offset laterally to the same side of the longitudinal axis of the path.

The method can also include advancing the first area of the substrate into the second vacuum vessel along the path and positioning a third area of the substrate in operative relation to the material deposition source and shadow mask in the first vacuum vessel, wherein the third area of the substrate is adjacent the first area of the substrate. Material is deposited on the third area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate.

Desirably, the first, second and third areas of the substrate do not overlap. The material deposited on the third area overlaps the material deposited on the first area adjacent a boundary between the first and third areas in a direction transverse to the longitudinal axis of the path.

Lastly, the invention is a shadow mask vapor deposition method. The method includes (a) positioning a first area of a substrate in operative relation to a material deposition source and shadow mask in a first vacuum vessel; (b) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel; (c) advancing the first area of the substrate into a second vacuum vessel along a path that has a longitudinal axis that extends through the vacuum vessels; (d) positioning a second, adjacent area of the substrate in operative relation to a material deposition source and shadow mask in the second vacuum vessel; and (e) depositing material on the second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on the first area of the substrate, wherein centers of the shadow masks in the first and second vacuum vessels are offset laterally to one side of the longitudinal axis of the path.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a scalable backplane in accordance with the invention, which is formed of an m×n array of substrate segments upon a common substrate;

FIG. **2** illustrates a timed view of an exemplary manufacturing progression in accordance with the invention;

FIGS. **3**A and **3**B illustrate side and top views, respectively, of an exemplary production system for forming large-area backplanes in accordance with the invention;

FIG. **3**C illustrates the production system of the present invention with an optional accumulator device installed;

FIG. **4**A illustrates an enlarged view of Detail A in FIG. **2**;

FIG. **4**B is a cross-sectional view taken along lines IVB—IVB in FIG. **4**A; and

FIG. **5** is a flow diagram of a method whereby each layer of a backplane is formed by multiple deposition events of multiple successive segments, respectively.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIG. **1**, a scalable backplane **100** formed of an m×n array of substrate segments **110** upon a common substrate is sized according to, for example, a desired size of a large-area display. For example, scalable backplane **100** can be an array formed from substrate segment **110***aa*–**110***mn*. Each substrate segment **110** is formed via its own deposition event upon the common substrate, as described in further detail hereinafter.

With reference to FIG. **2**, an exemplary manufacturing process **200** for progressively forming a backplane **210**, that includes a 3×2 array of substrate segments **212***a*, **212***b*, **212***c*, **212***d*, **212***e* and **212***f*, via a shadow mask deposition process within a serial arrangement of deposition vacuum vessels **214***a* and **214***b* is shown. Deposition vacuum vessels **214***a* and **214***b* include shadow masks **216***a* and **216***b*, respectively. Backplane **210** and substrate segments **212** correspond to backplane **100** and substrate segments **110** in FIG. **1**.

One layer of backplane **210** is formed by a number of deposition events on multiple successive substrate segments **212**. More specifically, at a TIME **1**, a deposition event occurs upon substrate segment **212***a* within deposition vacuum vessel **214***a* by use of shadow mask **216***a*. The substrate is then advanced and, at a TIME **2**, a subsequent deposition event occurs upon substrate segment **212***b* within deposition vacuum vessel **214***a* by use of shadow mask **216***a*. The substrate is then advanced and, at a TIME **3**, a subsequent deposition event occurs upon substrate segment **212***c* within deposition vacuum vessel **214***a* by use of shadow mask **216***a*.

Upon completion of the deposition events along the line of substrate segments **212***a*, **212***b* and **212***c*, the substrate is advanced into deposition vacuum vessel **214***b*, wherein shadow mask **216***b* is positionally offset relative to shadow mask **216***a* in order to form the next line of substrate segments **212**. At a TIME **4**, a deposition event occurs upon substrate segment **212***d* within deposition vacuum vessel **214***b* by use of shadow mask **216***b*. The substrate is then advanced and, at a TIME **5**, a subsequent deposition event occurs upon substrate segment **212***e* within deposition vacuum vessel **214***b* by use of shadow mask **216***b*. The substrate is then advanced and, at a TIME **6**, a subsequent deposition event occurs upon substrate segment **212***f* within deposition vacuum vessel **214***b* by use of shadow mask **216***b*. In this way, one layer of backplane **210** that is the combination of a 3×2 array of substrate segments **212** is formed by sequential deposition events at TIME **1**, **2**, **3**, **4**, **5** and **6** by use of shadow masks **216***a* and **216***b*. The aperture layout and design of shadow masks **216***a* and **216***b* is such that they achieve electrical connections between adjacent substrate segments **212** at their boundaries, where required.

A spacing "s" between deposition vacuum vessels **214***a* and **214***b* can be any suitable or desirable distance that enables backplane **210** to pass from deposition vacuum vessel **214***a* to deposition vacuum vessel **214***b* while enabling deposition vacuum vessels **214***a* and **214***b* to operate without interference. To this end, spacing "s" can be zero. However, this is not to be construed as limiting the invention. For practical purposes, spacing "s" is suitably large to allow backplane **210** to have a wide range of dimensions while using a common configuration of deposition vacuum vessels **214**.

Using a combination of multiple deposition vacuum vessels and shadow masks, scalable backplane **100** may be formed of any m×n array of substrate segments **110** in a manner similar to that of backplane **210** and substrate segments **212**.

With reference to FIGS. **3**A and **3**B, an exemplary production system **300** representative of a system for producing an electronic device, such as an active matrix backplane that has OLEDs deposited thereon, is shown. In the illustrated example, production system **300** is configured to form a scalable backplane **100** formed of an n×2 array of substrate segments **110**. However, this is not to be construed as limiting the invention since production system **300** can be configured for forming a scalable backplane **100** formed of any m×n array of substrate segments **110**. An example of a suitable production system **300** is disclosed in U.S. Patent Application Publication No. 2003/0228715, entitled "Active Matrix Backplane For Controlling Controlled Elements and Method Of Manufacture Thereof", which is incorporated herein by reference.

Production system **300** includes a plurality of serially connected deposition vacuum vessels **214***a*–**214***n*. Production system **300** includes means for translating a substrate **312** along a path **302** that has a longitudinal axis **304** that extends through vacuum vessels **214***a*–**214***n*. Each deposition vacuum vessel **214** includes at least one deposition source **318**, a heatsink **320** and a shadow mask **216**. More specifically, deposition vacuum vessels **214***a*–**214***n* house shadow masks **216***a*–**216***n*, respectively. In the illustrated embodiment of production system **300**, a center **218***a* of shadow mask **216***a* in deposition vacuum vessel **214***a* is offset laterally to one side of longitudinal axis **304** while a center **218***b* of shadow mask **216***b* in deposition vacuum vessel **214***b* is offset laterally to the other side of longitudinal axis **304**. Depending upon the number of deposition events production system **300** is required to perform, production system **300** can also have a center **218***n*−1 of shadow mask **216***n*−1 of deposition vacuum vessel **214***n*−1 offset laterally to the same side of longitudinal axis **304** as the center **218***a* of shadow mask **216***a*.

In the illustrated embodiment of production system **300**, centers **218***a*–**218***n* of shadow masks **216***a*–**216***n*, respectively, are illustrated as being alternatingly offset on different sides of longitudinal axis **304**. For example, center **218***a* of shadow mask **216***a* is offset to a first side of longitudinal axis **304**, center **218***b* of shadow mask **216***b* is offset to a second side of longitudinal axis **304**, center **218***n*−1 of shadow mask **216***n*−1 is offset to the first side of longitudinal axis **304**, and so forth. However, this is not to be construed as limiting the invention since any pair of adjacent deposition vacuum vessels **214** can have their respective shadow masks **216** positioned on the same side of longitudinal axis **304**. Hence, the alternating position of the centers **218** of shadow masks **216** on opposite sides of longitudinal axis **304** in FIG. **3**B is not to be construed as limiting the invention.

Each shadow mask **216** is formed of, for example, nickel, chromium, steel, copper, Kovar®, or Invar®, having a thickness of, for example, 150–200 microns. In the United States, Kovar® is a registered trademark, Registration No. 337,962, currently owned by CRS Holdings, Inc. of Wilmington, Del., and Invar® is a registered Trademark, Registration No. 63,970, currently owned by Imphy S.A. Corporation of France.

Each deposition source **318** is charged with a desired material to be deposited onto a flexible substrate **312** through a corresponding shadow mask **216**. Each heatsink **320** is a top plate that has a large mass that provides a flat reference surface that is in contact with the non-deposition side of substrate **312** and which serves as a heat removal means for substrate **312** as it translates through production system **300**. Production system **300** may include additional stages (not shown), such as an anneal stage, a test stage, one or more cleaning stages, a cut and mount stage, and the like, as is well known. The number, purpose and arrangement of deposition vacuum vessels **214** can be modified, as needed, for the deposition of one or more materials required for a particular application by one of ordinary skill in the art.

Each shadow mask **216** includes a pattern of apertures (not shown), e.g., slots and holes. The pattern of apertures formed in each shadow mask **216** corresponds to a desired pattern of material to be deposited on substrate **312** from the deposition source **318** in the corresponding deposition vacuum vessel **214** as substrate **312** advances therethrough. Each shadow mask **216** is desirably configured such that a material deposited therewith overlaps a material deposited by another, e.g., preceding, deposition event thereby providing a "stitching" effect that allows the formation of a large-area backplane.

Deposition vacuum vessels **214** are utilized for depositing materials on substrate **312** in order to form one or more electronic elements on substrate **312**. Each electronic element may be, for example, a thin film transistor (TFT), a diode, a memory element or a capacitor. A multi-layer circuit can be formed solely by the successive deposition of materials on substrate **312**, i.e., without having to perform an etch pattern, via the successive operation of each deposition vacuum vessel **214**.

Each deposition vacuum vessel **214** is connected to a source of vacuum (not shown) used for establishing a suitable vacuum therein. More specifically, the source of the vacuum establishes a suitable vacuum in one or more deposition vacuum vessels **214**, in order to enable a charge of the desired material that is positioned in deposition sources **318** to be deposited on substrate **312** in a manner known in the art, e.g., sputtering or vapor phase deposition, through apertures within the sheets of shadow masks **216**.

In the following description, substrate **312** will be described as being a continuous flexible sheet, which is initially disposed on a dispensing reel **314** that dispenses substrate **312** into the first deposition vacuum vessel **214**. However, production system **300** can be configured to continuously process a plurality of individual substrates **312**. Dispensing reel **314** is positioned in a preload vacuum vessel, which is connected to a source of vacuum (not shown) used for establishing a suitable vacuum therein. Each deposition vacuum vessel **214** includes supports or guides that avoid the sagging of substrate **312** as it advances through deposition vacuum vessels **214**.

In operation of production system **300**, the material of each deposition source **318** is deposited on substrate **312** via the corresponding shadow mask **216** in the presence of a suitable vacuum as substrate **312** is step advanced through the corresponding deposition vacuum vessel **214** whereupon plural progressive patterns are formed on substrate **312**. More specifically, substrate **312** has plural portions, each of which is positioned for a predetermined interval in each deposition vacuum vessel **214** where a deposition event is to occur. During this predetermined interval, material is deposited from the deposition sources **318** onto the portion of substrate **312** that is positioned in the corresponding deposition vacuum vessel **214**. After this predetermined interval, substrate **312** is step advanced, whereupon the plural portions of substrate **312** are advanced to the next deposition vacuum vessel **214** in series for additional processing, as applicable. This step advancement continues until each portion of substrate **312** has passed through all deposition vacuum vessels **214**. Thereafter, each portion of substrate **312** exiting the final deposition vacuum vessel **214** in the series is received on a take-up reel **316** which is positioned in a storage vacuum vessel. Alternatively, each portion of substrate **312** exiting deposition vacuum vessel **214** is separated from the remainder of substrate **312** by a cutter (not shown).

With reference to FIG. 3C, production system **300** can include an optional accumulator **322** installed in series between one or more pairs of adjacent deposition vacuum vessels **214**. Accumulator **322** desirably includes a series of non-adjustable and/or adjustable rollers for transporting substrate **312**. The spacing "s" between deposition vacuum vessels **214** is therefore not dependent upon the backplane pattern dimensions and, thus, a common configuration of deposition vacuum vessels **214** within production system **300** is suitable for the production of any backplane design.

With reference to FIG. **4**A, an enlarged view of Detail A in FIG. **2** shows exemplary conductors **410***a* and **410***b* at the boundary of two adjacent substrate segments, e.g., substrate segments **212***a* and **212***b*, respectively. FIG. **4**B illustrates a cross-sectional view of conductors **410***a* and **410***b* taken along line IVB—IVB in FIG. **4**A. FIG. **4**B illustrates the overlap or "stitching" of conductor **410***a* of substrate segment **212***a* to conductor **410***b* of substrate segment **212***b* which enables electrical conductivity between the conductors **410***a* and **410***b*. In one example, an overlap **412** of conductor **410***a* of substrate segment **212***a* to conductor **410***b* of substrate segment **212***b* is in the range of 10 to 15 μm. Conductors **410***a* and **410***b* can be deposited via the same shadow mask as shown in the example of FIG. **2**. Alternatively, conductor **410***a* can be deposited via one shadow mask while conductor **410***b* can be deposited via another shadow mask positioned on the same side of longitudinal axis **304** in FIG. 3B.

In addition to "stitching" of material deposited on substrate segments that are adjacent each other in a direction parallel to longitudinal axis **304**, production system **300** can "stitch" material deposited on substrate segments that are adjacent each other in a direction transverse, desirably perpendicular, to longitudinal axis **304**. Hence, the overlap or "stitching" of material can occur either parallel or transverse, desirably perpendicular, to the direction of longitudinal axis **304**.

With reference to FIG. **5**, and with continuing reference to FIGS. **1**–**4**B, a flow diagram **500** of a method, wherein each layer of a backplane is formed by multiple deposition events of multiple successive segments, each segment is a repetitive pattern, and stitching of the conductors takes place at the boundaries of the segments to form continuous conductive paths is shown.

Initially, the method advances from a start step **508** to a step **510** wherein a plurality of deposition vacuum vessels **214** is installed in series to form a production system, such as production system **300**.

The method advances to step **512** wherein the design specifications of the specific structure to be formed via production system **300**, for example, a circuit layout, are determined.

In step **514**, a shadow mask, such as shadow mask **216**, for each layer of the structure defined in step **512** is formed. The plurality of apertures within each shadow mask is arranged according to the predetermined pattern for each layer of the structure, as defined in step **510**.

In step **516**, a deposition event is performed on a segment, like segment **212** of substrate **312** positioned in a deposition vacuum vessel **214**.

In step **518**, substrate **312** advances into the next successive deposition vacuum vessel **214** for processing. The method then advances to end step **520** where the method terminates.

The method may be repeated for any number of continuous or discrete substrates **312** formed of any number of substrate segments whose conductors are "stitched" at the boundaries of adjacent substrate segments to form a seamless backplane structure.

Production system **300** can be configured to enable one substrate segment to experience a deposition event in one deposition vacuum vessel **214** while, concurrently, another substrate segment experiences a deposition event in another deposition vacuum vessel **214**. Stitching at the boundaries of each adjacent substrate segment **110** enables the formation of a seamless backplane that is scalable to any dimension.

As can be seen, production system **300** and flow diagram **500** provide a system and method for forming a large-area display backplane utilizing the same manufacturing process and small-area shadow mask(s) that are also utilized for small- or medium-sized displays by performing m×n deposition events in order to form the backplane.

Production system **300** and the method of flow diagram **500** are not limited to forming a large-area matrix flat panel display backplane, but are also applicable to any scalable circuit layout that may be segmented into a repetitive pattern to be used for any purpose.

The present invention has been described with reference to the preferred embodiments. Obvious modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

The invention claimed is:

1. A vapor deposition shadow mask system comprising:

a plurality of series connected vacuum vessels each having a material deposition source and a shadow mask housed completely therein; and

means for translating a substrate along a path that has a longitudinal axis that extends through the vacuum vessels, wherein a center of the shadow mask in a first vacuum vessel is offset laterally to one side of the longitudinal axis of the path and a center of the shadow mask in a second vacuum vessel is offset laterally to the other side of the longitudinal axis of the path.

2. The system of claim **1**, wherein the system is operative for depositing material on a second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of material deposited on a first, adjacent area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel.

3. The system of claim **2**, wherein the first and second areas of the substrate are adjacent each other in a direction transverse to the longitudinal axis of the path.

4. The system of claim **2**, wherein the overlap occurs adjacent a boundary between the first and second areas in a direction parallel to the longitudinal axis of the path.

5. The system of claim **2**, wherein the first and second areas of the substrate do not overlap.

6. The system of claim **2**, wherein:

a center of a shadow mask in a third vacuum vessel is offset laterally to the same side of the longitudinal axis of the path as the center of the shadow mask in the first vacuum vessel; and

the system is operative for depositing material on the first area of the substrate via the material deposition source and the shadow mask in the third vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate and overlaps a portion of the material deposited on the second area of the substrate.

7. The system of claim **2**, wherein the system is operative for depositing material on a third area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel in a manner that overlaps a portion of material deposited on the first, adjacent area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel.

8. The system of claim **7**, wherein the first and third areas of the substrate are adjacent each other in a direction parallel to the longitudinal axis of the path.

9. The system of claim **7**, wherein the material deposited on the third area of the substrate overlaps the material deposited on the first area of the substrate in a direction transverse to the longitudinal axis of the path.

10. The system of claim **7**, wherein the first, second and third areas of the substrate do not overlap.

11. A vapor deposition shadow mask system comprising:

a plurality of series connected vacuum vessels each having a material deposition source and a shadow mask housed completely therein; and

means for translating a substrate along a path that has a longitudinal axis that extends through the vacuum vessels, wherein centers of shadow masks in first and second vacuum vessels are offset laterally to one side of the longitudinal axis of the path.

12. The system of claim **11**, wherein the system is operative for depositing material on a second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of material deposited on a first, adjacent area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel.

13. The system of claim **12**, wherein the first and second areas of the substrate are adjacent each other in a direction parallel to the longitudinal axis of the path.

14. The system of claim **12**, wherein the overlap occurs adjacent a boundary between the first and second areas in a direction transverse to the longitudinal axis of the path.

15. The system of claim **12**, wherein the first and second areas of the substrate do not overlap.

16. A shadow mask vapor deposition method comprising:

(a) positioning a first area of a substrate in operative relation to a material deposition source and shadow mask housed completely in a first vacuum vessel;

(b) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel;

(c) advancing the first area of the substrate into a second vacuum vessel along a path that has a longitudinal axis that extends through the vacuum vessels;

(d) positioning a second, adjacent area of the substrate in operative relation to a material deposition source and shadow mask housed completely in the second vacuum vessel; and

(e) depositing material on the second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on the first area of the substrate, wherein centers of the shadow masks in the first and second vacuum vessels are offset transverse on opposite sides of the longitudinal axis of the path.

17. The method of claim **16**, wherein the overlap occurs adjacent a boundary between the first and second areas in a direction parallel to the longitudinal axis of the path.

18. The method of claim **16**, wherein the first and second areas of the substrate do not overlap.

19. The method of claim **16**, further including:

(f) advancing the first area of the substrate into a third vacuum vessel along the path;

(g) positioning the first area of the substrate in operative relation to a material deposition source and shadow mask housed completely in the third vacuum vessel; and

(h) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the third vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel and overlaps a portion of the material deposited on the second area of the substrate, wherein centers of the shadow masks in the first and third vacuum vessels are offset laterally to the same side of the longitudinal axis of the path.

20. The method of claim **16**, further including:

positioning a third area of the substrate in operative relation to the material deposition source and the shadow mask in the first vacuum vessel, wherein the third area of the substrate is adjacent the first area of the substrate; and

depositing material on the third area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel in a manner that overlaps at least a portion of the material deposited on the first area of the substrate.

21. The method of claim **20**, wherein the first, second and third areas of the substrate do not overlap.

22. The method of claim **20**, wherein the material deposited on the third area overlaps the material deposited on the first area adjacent a boundary between the first and third areas in a direction transverse to the longitudinal axis of the path.

23. A shadow mask vapor deposition method comprising:

(a) positioning a first area of a substrate in operative relation to a material deposition source and shadow mask housed completely in a first vacuum vessel;

(b) depositing material on the first area of the substrate via the material deposition source and the shadow mask in the first vacuum vessel;

(c) advancing the first area of the substrate into a second vacuum vessel along a path that has a longitudinal axis that extends through the vacuum vessels;

(d) positioning a second, adjacent area of the substrate in operative relation to a material deposition source and shadow mask housed completely in the second vacuum vessel; and

(e) depositing material on the second area of the substrate via the material deposition source and the shadow mask in the second vacuum vessel in a manner that overlaps a portion of the material deposited on the first area of the substrate, wherein centers of the shadow masks in the first and second vacuum vessels are offset laterally to one side of the longitudinal axis of the path.

24. The method of claim **23**, wherein the overlap occurs adjacent a boundary between the first and second areas in a direction transverse to the longitudinal axis of the path.

25. The method of claim **23**, wherein the first and second areas of the substrate do not overlap.

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