(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 June 2011 (03.06.2011)

PCT

(10) International Publication Number
WO 2011/064777 A1

(51) International Patent Classification:
B41J 2/00 (2006.01)

(21) International Application Number:
PCT/IL2010/000992

(22) International Filing Date:
29 November 2010 (29.11.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/264,913 30 November 2009 (30.11.2009) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: ALIGNMENT OF MATERIAL DEPOSITION SYSTEM WITH SUBSTRATE

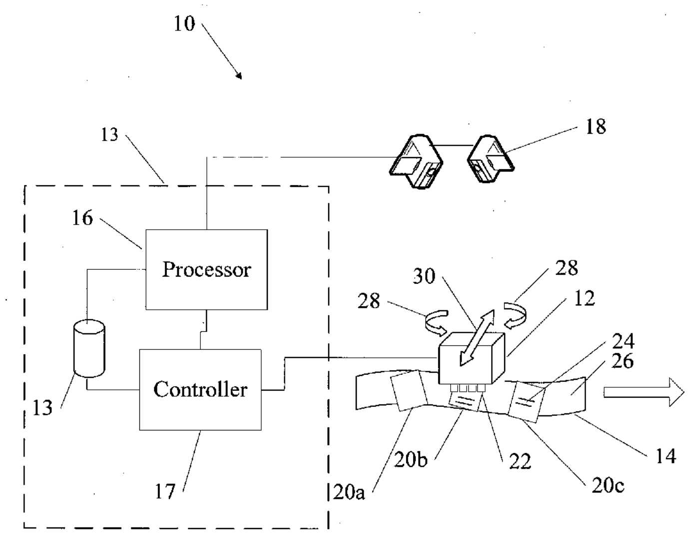


Fig. 1

(57) Abstract: A method for depositing material in a predetermined pattern on a moving substrate includes sensing an orientation and a velocity of the moving substrate. The method further includes rotating a material deposition unit in accordance with the orientation of the moving substrate and translating the material deposition unit in accordance with the orientation and location of the moving substrate. Concurrently with the rotating and translating the material deposition unit, the material deposition unit deposits the material in the predetermined pattern on the moving substrate so as to align the predetermined pattern with the substrate.

WO 2011/064777 A1

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

ALIGNMENT OF MATERIAL DEPOSITION SYSTEM WITH SUBSTRATE

BACKGROUND OF THE INVENTION

[0001] Automatic material deposition systems may be used to deposit precise patterns of material on a substrate. For example, in the manufacture of solar cells, precise arrays of fine lines of electrical conductor may be deposited on a light-collecting surface of the solar cell or on the back side of the solar cell.

[0002] For example, a pattern of deposited material may require precise alignment with the substrate. In this case, the orientation of the substrate may require precise alignment with respect to the material deposition elements. As another example, a material deposition element may be configured to deposit material on top of a layer that was previously deposited by another material deposition element. In this case, motion of the substrate may require precise alignment with the material deposition elements.

[0003] Several methods exist for adjusting the relative alignment of the substrate orientation with the deposition elements.

[0004] For example, a substrate transport device may include a guide element for physically deflecting or rotating the substrate. The guide element may thus align and rotate the substrate to a desired alignment with the material deposition elements. Such a method may not be sufficiently precise for some applications. In addition, when the substrate is fragile, physical contact between the substrate and the guide element may not be desirable.

[0005] In other systems, a substrate may be transported to a location where material is deposited, while the substrate is stationary during deposition. In such a system the orientation of the substrate may be detected prior to deposition. A material deposition device that includes the material deposition elements may then be rotated to match the orientation of the substrate. An example of such a system is a screen-printer system for depositing electrical conductors during fabrication of solar cells. In such a system, a registration subsystem detects the substrate orientation and rotates a screen-printing mask or stencil prior to deposition. Material is deposited by forcing material to be deposited through the mask while the substrate and mask are at rest.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings. Specific embodiments of the present invention will be described with reference to the following drawings, wherein:

[0007] Fig. 1 shows schematically a material deposition system, in accordance with embodiments of the present invention.

[0008] Fig. 2A illustrates deposition on a substrate when both the orientation and the motion of the substrate are aligned with a material deposition device;

[0009] Fig. 2B illustrates misalignment of an orientation of a substrate with respect to the material deposition device;

[0010] Fig. 2C illustrates misalignment of a direction of motion of a substrate with respect to the material deposition device;

[0011] Fig. 3 shows a flow chart of a method for alignment of a material deposition device with a substrate, in accordance with some embodiments of the present invention;

[0012] Fig. 4 is an illustration helpful in understanding some embodiments of the present invention; and

[0013] Fig. 5 schematically shows a production line for depositing material on a substrate, in accordance with embodiments of the present invention.

[0014] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0015] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, modules, units and/or circuits have not been described in detail so as not to obscure the invention.

[0016] Embodiments of the invention may include an article such as a computer or processor readable medium, or a computer or processor storage medium, such as for example a memory, a disk drive, or a USB flash memory, encoding, including or storing instructions, e.g., computer-executable instructions, which when executed by a processor or controller, carry out methods disclosed herein.

[0017] In accordance with embodiments of the present invention, a manufacturing device used in manufacture of a product based on a substrate may be rotated and translated so as to align with the substrate as it is moving. Such a manufacturing device may include a material deposition device or printing head for depositing material on the substrate, a tool (e.g. a laser or other radiation beam source) for marking or performing another operation on the substrate, or an inspection device (e.g. a camera) for inspecting a surface of the substrate. A substrate may include a silicon wafer, or a similar thin or fragile work piece.

[0018] A material deposition device typically includes an array of material deposition elements, e.g. nozzles or jets. A material deposition element may be configured to deposit material in a predetermined pattern on a substrate without any direct mechanical contact between the element and the substrate. For example, a metallization material may be deposited on a surface of a silicon wafer in a pattern of parallel lines or a grid. Proper function of the substrate after material deposition may require that the pattern be aligned with the substrate. Such alignment may include alignment with an edge or other feature of the substrate. Such other features may include previously deposited patterns of material, markings on the substrate, or an element attached to the substrate.

[0019] Thus, the manufacturing device may perform an operation as required as the substrate is continually transported past the manufacturing device. Both the manufacturing device and the substrate may be moved in a coordinated manner during the manufacturing process.

[0020] For example, a material deposition device may deposit material on the substrate in a predetermined pattern as the substrate is continually transported past the material deposition device. Both the material deposition device and the substrate may be moved in a coordinated manner during the material deposition process.

[0021] Although the following specifically describes embodiments of the present invention as they relate to material deposition on a moving substrate, it should be understood that embodiments of the present invention may be applicable to any manufacturing process that requires alignment of a manufacturing device with an orientation and motion of a substrate.

[0022] It should be understood that references to a moving substrate, or of a location, orientation, or velocity of a substrate, refer to a relative motion, location, orientation between a material deposition device, or a material deposition system, and the substrate, regardless of which of the two is actually in motion.

[0023] Fig. 1 shows schematically a material deposition system, a material deposition unit of which may be aligned with a substrate, in accordance with embodiments of the present invention. Material deposition system 10 may include a material deposition unit 12. Material deposition unit 12 typically includes an array of material deposition elements 22. For example, material deposition elements 22 may include an array of nozzles. Each nozzle may be configured to dispense a material from a reservoir (not shown) b in the direction of a substrate 20b. For example, material deposition unit 12 and material deposition elements 22 may be configured in a similar manner to an ink jet printing head and nozzles. The material may include a molten or vaporized metal, ink, paint, or any other material capable of being deposited on a substrate.

[0024] Material deposition elements 22 may be arranged on one or more heads, such as printing heads. When arranged on a plurality of heads, the motion each head may be independently controllable. Alternatively, the heads may be controllable as a group.

[0025] Material deposition system 10 may further include a transport unit such as substrate transporter 14. Substrate transporter 14 may be configured to transport a substrate such as substrates 20a-20c in a general direction indicated by arrow 26. For example, substrate transporter 14 may include a conveyor belt, a system of wheels or rollers, a mechanical arm, a guided mobile conveyance platform, a stream of a fluid, or any other device suitable for transporting a substrate known in the art. The substrate may be thin or fragile, such as a silicon wafer. Substrate transporter 14 may be configured to transport a substrate while applying minimal stress to, and minimizing contact with, the transported substrate. Therefore, substrate transporter 14 may not include any mechanical components such as guides or holders for ensuring a precise orientation or velocity (speed and direction of motion) of the substrate relative to material deposition unit 12. Material deposition elements 22 of material deposition unit 12, may, therefore, not be precisely aligned with a substrate being transported past material deposition unit 12.

[0026] Substrate transporter 14 may transport a substrate 20a, prior to material deposition, toward material deposition unit 12. Substrate transporter 14 may transport a substrate 20b past material deposition unit 12 as material deposition unit 12 deposits material on substrate 20b. Coordinated operation of substrate transporter 14 and material deposition unit 12 may enable deposition of material in a predetermined pattern on substrate 20b. Substrate transporter 14 may transport a substrate 20c on which material has been deposited, e.g. in the form of material pattern 24, away from material deposition unit 12.

[0027] Material deposition system 10 may further include sensor 18. Sensor 18 may include an arrangement of one or more sensors for sensing a precise location, orientation, and velocity of a substrate. As substrate transporter 14 transports a substrate 20a or 20b, sensor 18 may detect a location, orientation, or velocity of substrate 20a or 20b. Sensor 18 may detect a deviation of a substrate 20a or 20b from a desired orientation or velocity. For example, sensor 18 may include one or more cameras or video cameras. Alternatively, sensor 18 may include one or more radiation sources and detectors for detecting reflected or transmitted radiation. For example, such a detector may detect an edge of the substrate by detecting when an edge of the substrate crosses a beam of light or other radiation. Alternatively, sensor 18 may include one or more optical, acoustic, electromagnetic, or mechanical sensors for distance or edge detection known in art.

[0028] Material deposition system 10 may further include a computation unit 13 that may include processor 16, controller 17, and memory device 15. Processor 16 and controller 17 may be incorporated into a single computation unit 13. For example, a single computer may be configured with functionality of both processor 16 and controller 17. Alternatively, functionality of computation unit 13, processor 16, or controller 17 may be incorporated into several intercommunicating units or devices. Processor 16 or controller 17 may include an input/output device for enabling a human operator to interact with processor 16 or controller 17. Processor 16 or controller 17 may communicate with memory device 15. Memory device 15 may include a single memory device, or a plurality of separate internal or external memory devices. Memory device 15 may be configured to store data or programmed instructions. Processor 16 or controller 17 may operate in accordance with programmed instructions stored on memory device 15.

[0029] Processor 16 may be configured to receive a signal from sensor 18 and analyze the signal. Processor may be incorporated into material deposition system 10 or may be a separate device capable of communicating with material deposition system 10. For example, processor 16 may be incorporated into sensor 18 or into controller 17. Functionality of processor 16 may be distributed among several intercommunicating processors.

[0030] Processor 16 may interpret a signal received from sensor 18. For example, processor 16 may be process a received image or video signal so as to determine a location, orientation, and velocity of a substrate 20a or 20b. Such processing may include application of a pattern recognition, edge detection, or motion detection technique.

[0031] For example, processor 16 may analyze a signal received from sensor 18 to detect a location, orientation, or velocity of a feature of a substrate 20a or 20b. Such a feature may include an edge of the substrate, a marking on the substrate, a previously deposited pattern of material on the substrate, or any other identifiable feature of the substrate.

[0032] Controller 17 may control operation of material deposition unit 12. For example, controller 17 may intercommunicate with processor 16. Controller 17 may be configured to control operation of material deposition unit 12 in accordance with a detected location, size, orientation, or velocity of a substrate, such as substrate 20a prior to deposition, or substrate 20b during the course of deposition. For example, some or all components of material deposition unit 12 may be rotated as indicated by arrows 28. The rotation of arrows 28 may enable material deposition unit 12 to align with an approaching substrate 20a prior to deposition. The rotation of arrows 28 may enable material deposition unit 12 to precisely deposit material on a substrate 20b in accordance with a detected orientation or velocity of substrate 20b. As another example, material deposition unit 12 may be translated in a direction that is not parallel to the transport direction indicated by arrow 26. The direction of translation, indicated schematically by arrow 30, may be approximately transverse to, or at an oblique angle to, the transport direction indicated by arrow 26. Such translation may enable material deposition unit 12 to precisely deposit material on a substrate 20b in accordance with a detected location, orientation, or velocity of substrate 20b.

[0033] A controller may control rotational and translational motion of the manufacturing device in accordance with the sensed orientation and motion of the substrate. Such controlled rotational and translational motion may compensate for any such deviations. Thus, the manufacturing device may be aligned with the substrate as the manufacturing device operates on the substrate. Alternatively or in addition, operation of the manufacturing device may be controlled in accordance with relative motion between the manufacturing device and the substrate. For example, control of operation may include controlling the timing of when a material deposition element dispenses material, and allocation of the deposition among various material dispensation elements.

[0034] For example, material deposition unit 12 may be mounted on a rotatable platform that is mounted in a translatable manner on a rotatable bridge. In this case, controller 17 may control an orientation of material deposition unit 12 by rotating the rotatable bridge. Controller 17 may control a translation velocity of material deposition unit 12 by rotating the rotatable bridge while concurrently controlling a speed of the rotatable platform as it moves along the rotatable bridge.

[0035] Detecting a substrate orientation or velocity, and adjusting material deposition unit 12 in accordance with the detected location, orientation, or velocity, may take place at predetermined intervals. Alternatively or in addition, detection and adjustment may occur in response to predetermined conditions (e.g. a transported substrate arriving at a station or preparing to begin a material deposition operation on the substrate). Typically, detection and adjustment continue throughout material deposition so as to enable adjustment for instantaneous changes in location, orientation, or velocity.

[0036] Fig. 2A illustrates deposition on a substrate when both the orientation and the motion of the substrate are aligned with a material deposition device. Substrate 31 (shown as square so that the orientation is visible) is oriented such that an edge 31a of substrate 31 is oriented parallel to substrate transport direction 34 material deposition elements 22. Thus when substrate 31 passes material deposition unit 12, material deposition elements 22 (shown in a single row for clarity) may deposit material onto substrate 31 in single line. For example, material deposition unit 12 may be controlled such that when leading edge 31b of substrate 31 reaches leading material deposition element 22a, leading material deposition element 22a may begin to dispense material. Each material deposition element 22 may add an additional layer of material on top of previously deposit material along the line. Thus, after material deposition by material deposition elements 22 is complete, substrate 31' may include a single line 33 of material with multiple layers.

[0037] In the absence of adjustment of the orientation and motion of material deposition unit 12, a desired pattern of material may not be deposited on the substrate.

[0038] For example, a deviation in an orientation of a substrate may result in deposition of material that is not oriented properly with respect to the substrate. Fig. 2B illustrates misalignment of an orientation of a substrate with respect to the material deposition device. Substrate 32 may be rotated such that edge 32a of substrate 32 is not oriented parallel to substrate transport direction 34. In this case, a single line 35 of material may be deposited, but single line 35 may not be oriented as desired with respect to substrate 32'.

[0039] As another example, a direction of motion of a properly oriented substrate may not be properly aligned with the material deposition device. Fig. 2C illustrates misalignment of a direction of motion of a substrate with respect to the material deposition device. Substrate 36 moves in direction 38. Direction 38 is not aligned parallel to material deposition elements 22. Thus, instead of depositing material on top of previously deposited material, each material deposition element 22 may deposit material along a different line on substrate 36. Thus, after deposition, substrate 36' may include a multiple-lined pattern 37 of deposited material.

[0040] Fig. 3 shows a flow chart of a method for alignment of a material deposition device with a substrate, in accordance with some embodiments of the present invention.

[0041] Fig. 4 illustrates aspects of a method for alignment of a material deposition device with a substrate, in accordance with some embodiments of the present invention. The description below of the material deposition device alignment method references items illustrated in Fig. 4. The method illustrated in Figs. 3 and 4 may be executed by a processor associated with the material deposition system (e.g. processor 16 shown in Fig. 1).

[0042] A material deposition system may be configured to deposit material on a substrate, such as substrate 40, while substrate 40 is being transported in a general direction indicated by the X-axis. A material deposition device of the material deposition system, such as material deposition unit 12, may be configured to deposit a predetermined pattern material on substrate 40. For simplicity, an example is described where material deposition unit 12 is configured to deposit material in the form of a single line that is parallel to an edge 40a of substrate 40. Alternatively, a pattern may include, for example, an array of parallel lines of material or a grid of material.

[0043] When substrate 40 approaches material deposition unit 12, a sensor may detect a location of material deposition unit 12 (operation 51). For example, the sensor system may detect one or more edges of substrate 40. The detected edges may be interpreted by an appropriately configured processor to determine a location, orientation, velocity, or size of substrate 40.

[0044] The detector or processor may determine an orientation of substrate 40 relative to a system axis, such as the X-axis (operation 52). For example, it may be determined that edge 40a substrate 40 is oriented at an angle θ to the X-axis. Thus, in order that material deposition unit 12 may deposit a single line of material parallel to edge 40a, material deposition unit 12 may be rotated by angle θ as indicated by rotated material deposition unit 12' (operation 54). The rotation of material deposition unit 12 may take place prior to the arrival of substrate 40 to material deposition unit 12.

[0045] The detector or processor may also determine that substrate 40 is moving with a velocity in a direction indicated by vector V_1 (operation 56). Vector V_1 may be understood as indicating a vector displacement of substrate 40 during the time of material deposition. For example, motion as indicated by vector V_1 during material deposition may cause substrate 40 to be displaced to the position of displaced substrate 40'. Vector V_1 may have a component transverse to the X-axis, e.g. parallel to the Y-axis. Motion as indicated by vector V_1 may not be aligned with rotated material deposition unit 12'.

[0046] The processor may then calculate how to move a rotated material deposition unit 12' so as to compensate for a misalignment of vector V_1 with rotated material deposition unit 12' (operation 58). For example, it may be determined that substrate 40 should be displaced relative to rotated material deposition unit 12' as indicated by vector V_2 during material deposition. Relative motion of substrate as indicated by vector V_2 may enable deposition of a single line of material on substrate 40 by rotated material deposition unit 12'. Since the actual measured motion of substrate 40 is as indicated by vector V_1, displacing rotated material deposition unit 12' as indicated by vector V_3 result in relative motion as indicated by vector V_2. Rotated material deposition unit 12' may be translated to starting position prior to the arrival of substrate 40 to the position of rotated material deposition unit 12' (operation 59).

[0047] Thus, rotated material deposition unit 12' may be moved during the time of material deposition as indicated by vector V_3 (step 60). Moving rotated material deposition unit 12' as indicated by vector V_3 may displace rotated material deposition unit 12' as indicated by displaced material deposition unit 12". During this time, substrate 40 may be displaced as indicated by displaced substrate 40'.

[0048] As rotated material deposition unit 12' and substrate 40 are moved, rotated material deposition unit 12' may deposit material on a deposition site of substrate 40 (step 62). For example, rotated material deposition unit 12' may begin to deposit material on substrate 40 when a sensor signal indicates that leading edge 40b of substrate 40 is at a predetermined position relative to leading material deposition element 22a of rotated material deposition unit 12'. Rotated material deposition unit 12' may have been positioned at an appropriate starting position for depositing material prior to the arrival of substrate 40. Material deposition may stop when sensor signal indicates that trailing edge 40c of displaced substrate 40' is at a predetermined position relative to trailing material deposition element 22b of displaced material deposition unit 12".

[0049] Thus, a line of material may be deposited on substrate 40 by rotated material deposition unit 12'. For example, a deposited line of material may be similar to material line 42 on displaced substrate 40'.

[0050] Motion of a substrate may not have a constant velocity. For example, the speed and direction of motion the substrate may change while rotated material deposition unit 12' deposits material on substrate 40. In this case, an alignment method in accordance with an embodiment of the invention may be executed several times as rotated material deposition unit 12' deposits material on substrate 40. Repeating execution of the alignment method may enable detection and compensation for any changes in the instantaneous location, orientation, or velocity of the substrate during the course of material deposition. For example, the method may be executed at predetermined intervals during material deposition, or at predetermined stages of a material deposition process.

[0051] Fig. 5 schematically shows a production line for depositing material on a substrate, in accordance with embodiments of the present invention.

[0052] Each material deposition unit 45 of production line 48 may include multiple material deposition element assemblies 47 arranged in a sequence. For example, one or more of material deposition element assemblies 47 may be operated concurrently to deposit a material pattern 49 on a substrate 43. Each of material deposition units 45 may be configured to sequentially deposit components of a material pattern 49. Thus, each of material deposition units 45 may be independently controllable so as to deposit an additional component of material pattern 49 (e.g. additional interspersed lines of a pattern) such that the additional component is aligned with components material pattern 49 that had been deposited by previous material deposition units 45 in the sequence. Material pattern 49 may include a plurality of parallel lines of material, or another pattern of deposited material.

[0053] For example, as substrate 43 is transported along production line 48, its instantaneous velocity, as indicated by corresponding arrow 44, and its orientation may vary. In this case, material deposition device alignment method 50 may be executed several times as substrate 43 is transported along production line 48. For example, the material deposition device alignment method (Fig. 3) may be executed when a substrate reaches a predetermined location along production line 48, at predetermined time intervals, or at predetermined stages of a material deposition production line process.

[0054] As a result of executing the material deposition device alignment method at various points along production line 48, each of material deposition units 45 may be rotated as needed. In addition, each of material deposition units 45 may be moved with an instantaneous velocity as indicated by arrows 46.

[0055] A plurality of substrates 43 may be concurrently transported along production line 48. As each substrate 43 approaches a material deposition unit 45, that material deposition unit 45 may be controlled (independently of other material deposition units 45) so as to deposit a pattern of material that is aligned with that substrate 43.

[0056] Although the particular embodiments shown and described above will prove to be useful for the many distribution systems to which the present invention pertains, further modifications of the present invention will occur to persons skilled in the art. All such modifications are deemed to be within the scope and spirit of the present invention as defined by the appended claims.

CLAIMS

1.A method for depositing material in a predetermined pattern on a moving substrate, the method comprising:

sensing a orientation and a location of the moving substrate;

rotating a material deposition unit in accordance with the orientation of the moving substrate;

translating the material deposition unit in accordance with the orientation and location of the moving substrate; and

concurrently with rotating and translating the material deposition unit, depositing the material on the moving substrate so as to align the predetermined pattern with the substrate.

2.The method of claim 1, comprising sensing a velocity of the moving substrate, wherein translating the material deposition unit includes translating the material deposition unit further in accordance with the velocity of the moving substrate.

3.The method of claim 2, wherein translating the material deposition unit comprises translating the material deposition unit with a velocity substantially equal to a vector difference between the velocity of the moving substrate and a required relative velocity between the material deposition unit and the moving substrate.

4.The method of claim 2, wherein sensing the orientation and sensing the velocity of the moving substrate comprise sensing an instantaneous orientation and velocity of the moving substrate.

5.The method of claim 1, wherein rotating the material deposition unit comprises rotating the material deposition unit such that an orientation of the material deposition unit substantially matches the orientation of the moving substrate.

6.The method of claim 1, wherein sensing the orientation of the moving substrate comprise acquiring an image of the moving substrate and analyzing the acquired image.

7.The method of claim 1, wherein depositing the material comprises controlling the material deposition unit to deposit a plurality of layers of material along a substantially straight line.

8.The method of claim 1, wherein depositing the material comprises separately controlling deposition by an individual material deposition element of the material deposition unit.

9.The method of claim 1, further comprising rotating the material deposition unit prior to depositing the material on the moving substrate.

10.The method of claim 1, further comprising moving the material deposition unit to a starting position prior to arrival of the substrate to the material deposition unit.

11. The method of claim 1, wherein depositing the material comprises metallizing a silicon wafer.

12.A material deposition apparatus for depositing material in a predetermined pattern on a moving substrate, the apparatus comprising:

a sensor for sensing at least an orientation and a location of the moving substrate;

a rotatable and translatable material deposition unit for depositing the material on the moving substrate;

a controller for controlling rotation and translation of the material deposition unit on the basis of the orientation and location of, and a velocity of, the moving substrate while concurrently controlling deposition of the material by the material deposition unit so as to align the predetermined pattern with the substrate.

13. The apparatus of claim 12, wherein the sensor is configured to sense a velocity of the moving substrate.

14. The apparatus of claim 13, wherein the orientation comprises an instantaneous orientation of the moving substrate and the velocity comprises an instantaneous velocity of the moving substrate.

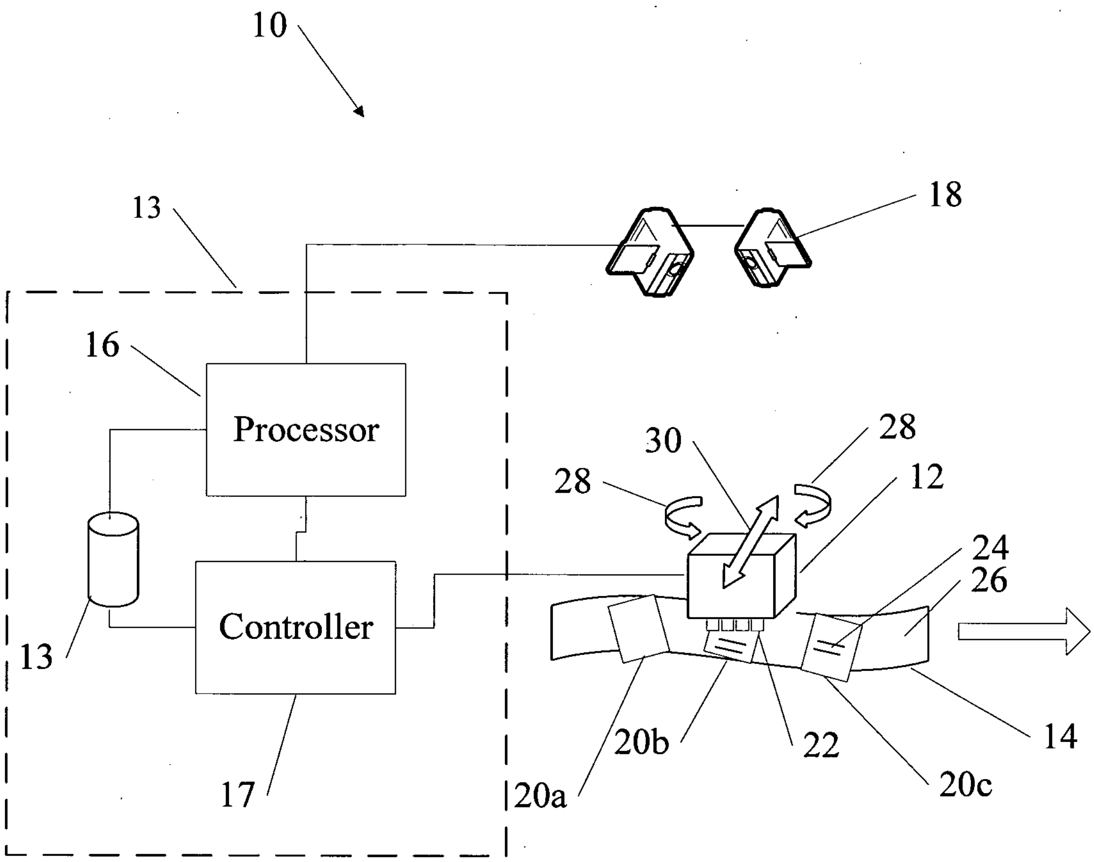
15. The apparatus of claim 12, wherein the material deposition unit comprises an array of material deposition elements.

16. The apparatus of claim 12, wherein the sensor comprises a camera.

17. The apparatus of claim 12, comprising a plurality of material deposition units arranged in a sequence, such that the moving substrate may be transported to each of said plurality of material deposition units in accordance with the sequence, each of said plurality of material deposition units being independently controllable in accordance with the orientation and location of, and a velocity of, the moving substrate so as to deposit an associated pattern component of the predetermined pattern such that the associated pattern component is aligned with the moving substrate.

18. The apparatus of claim 17, wherein said plurality of material deposition units are configured to operate concurrently on a plurality of moving substrates such that each material deposition unit of said plurality of material deposition units, concurrently with another material deposition unit of said plurality of material deposition units, is controllable in accordance with the orientation and location

of, and a velocity of, a moving substrate of said plurality of moving substrates so as to deposit its associated pattern component on that moving substrate such that the associated pattern component is aligned with that moving substrate.


10
13
18
16
Processor
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28
28
12
13
Controller
24
26
17
20a
20b
22
20c
14

Fig. 1

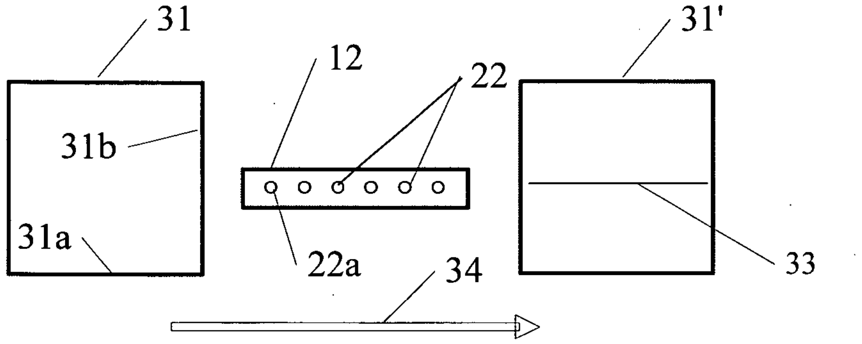

Fig. 2A

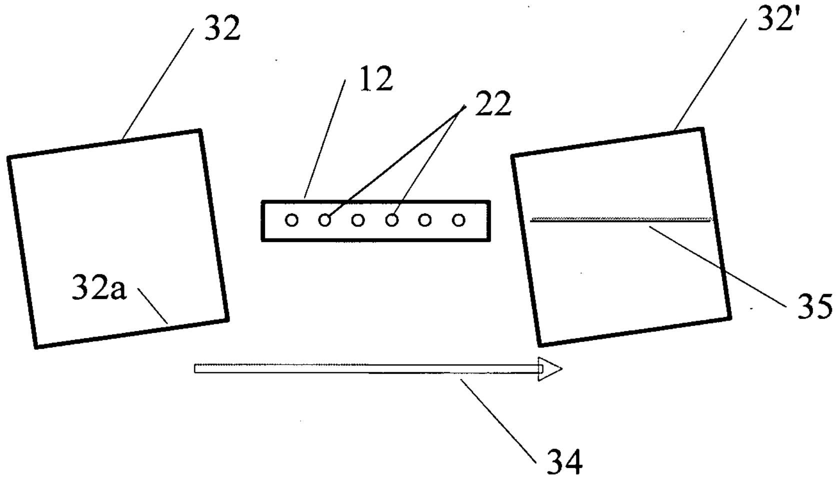

Fig. 2B

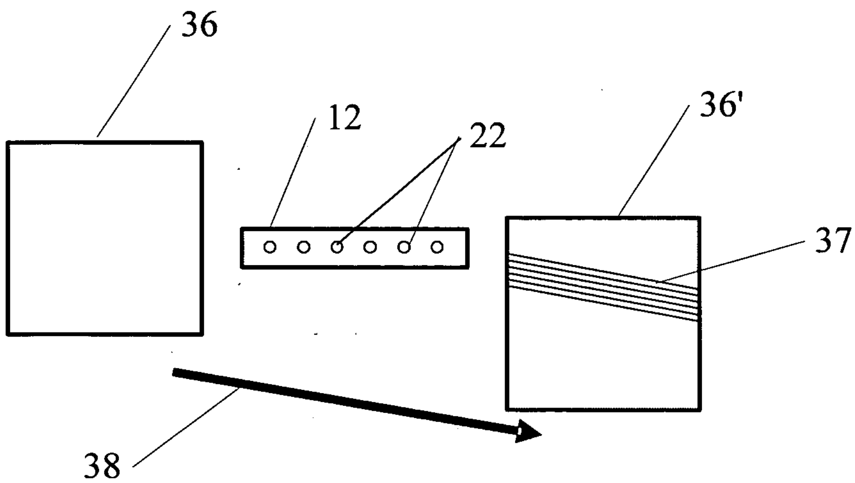

Fig. 2C

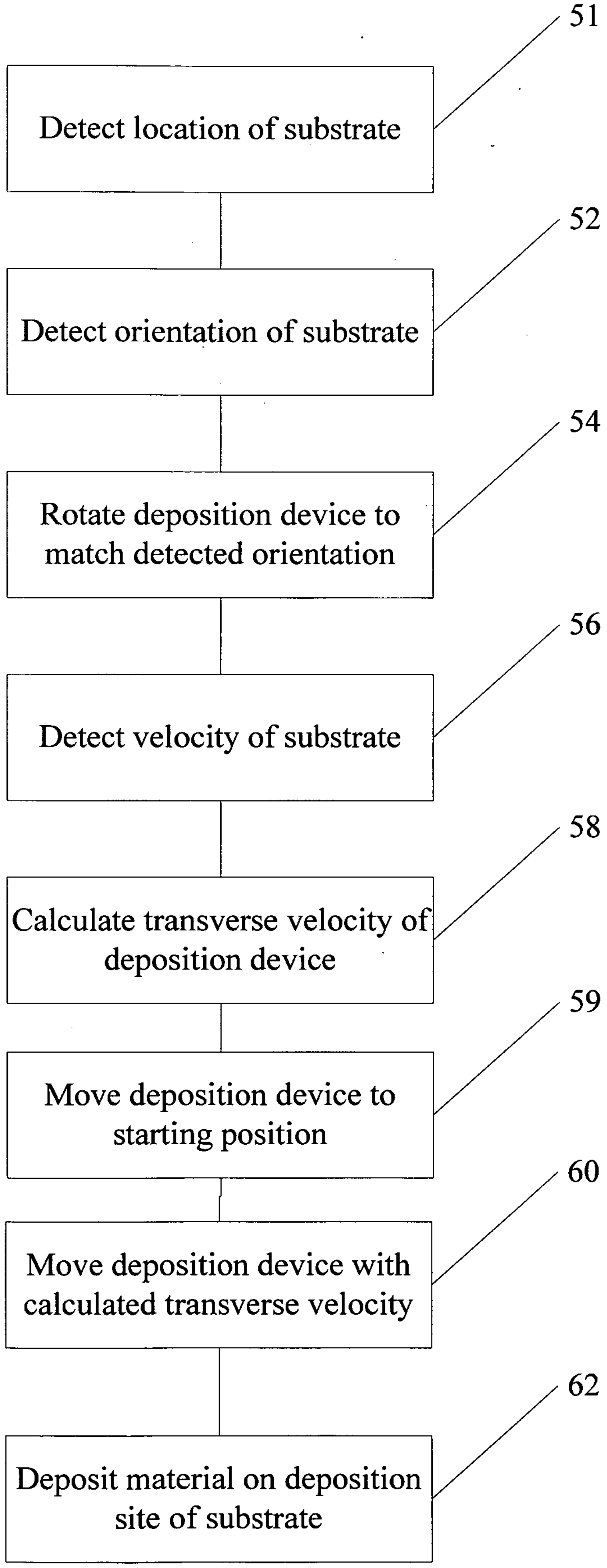
51
Detect location of substrate
52
Detect orientation of substrate
54
Rotate deposition device to match detected orientation
56
Detect velocity of substrate
58
Calculate transverse velocity of deposition device
59
Move deposition device to starting position
60
Move deposition device with calculated transverse velocity
62
Deposit material on deposition site of substrate

Fig. 3

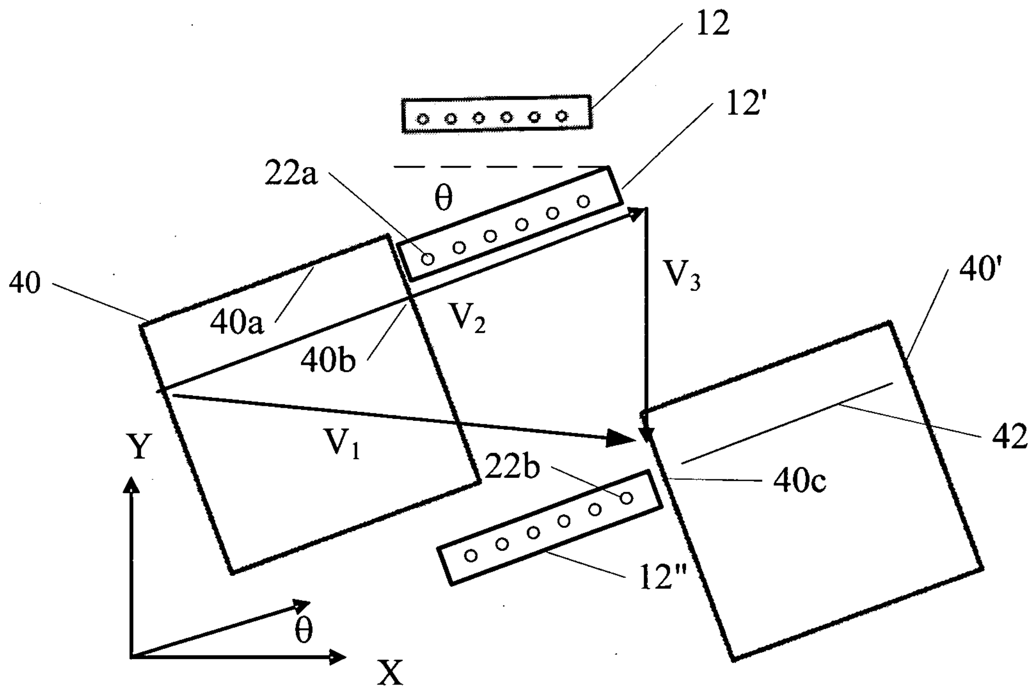

Fig. 4

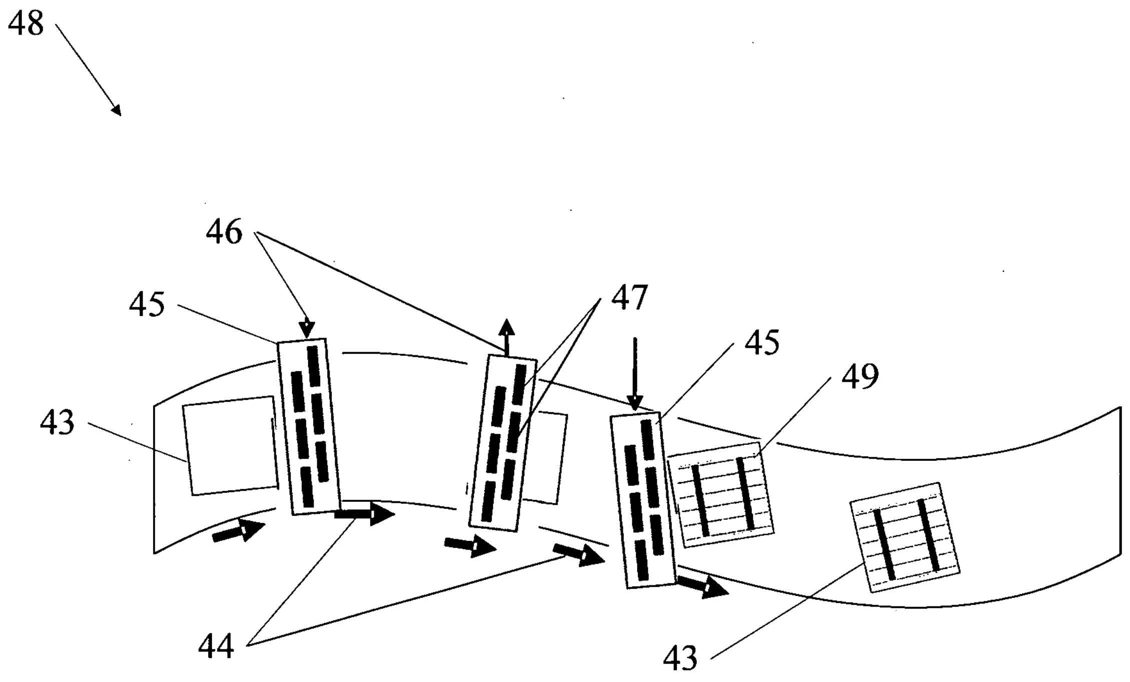

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 10/00992

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B41J 2/00 (2011.01)
USPC - 347/110
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)
IPC(8): B41J 2/00 (2011.01)
USPC: 347/110

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents, Non-Patent Literature (search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Google Scholar, Google Patents, PubWEST (PGPB,USPT,EPAB,JPAB)
search terms: material, deposit, substrate, guide, deflect, rotate, align, orient, nozzle, pattern, processor, controller, velocity, speed, camera, silicon, wafer, chip

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0066775 A1 (Silverbrook) 12 March 2009 (12.03.2009) Figures 1, 2, paragraphs [0014], [0104], [0148]-[0151], [0162]-[0164], [0170], [0181], [0220], [0243], [0253]	1-18
Y	US 2008/0158327 A1 (Siegel) 03 July 2008 (03.07.2008) Figures 1, 3, paragraphs [0018], [0025]-[0028]	1-18

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 Mar 2011 (11.03.2011)	30 MAR 2011

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774