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(54) **SYSTEM FOR INSPECTION OF A DISK-SHAPED OBJECT**

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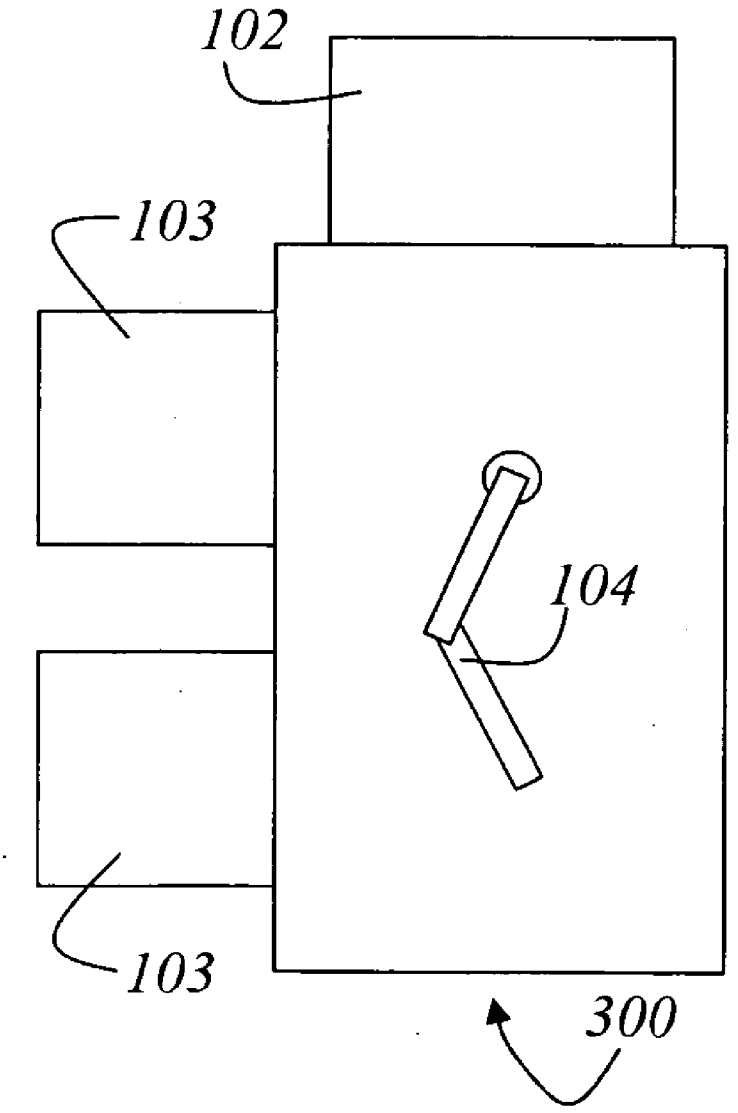
(57) **ABSTRACT**

A system (**100, 200, 300**) for inspecting a disc-shaped object is disclosed. The system (**100, 200, 300**) comprises a loading unit for disc-shaped objects **4** and a device **1** for simultaneously imaging the front side and back side of the disc-shaped object **4.**



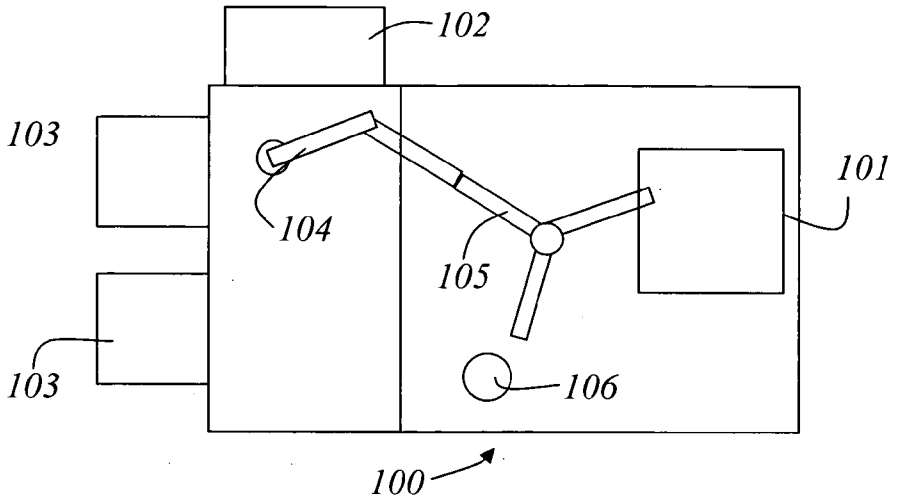


Fig. 1

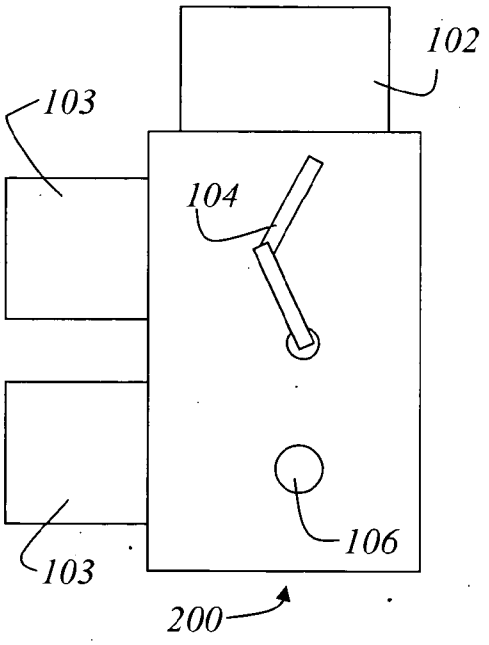


Fig. 2

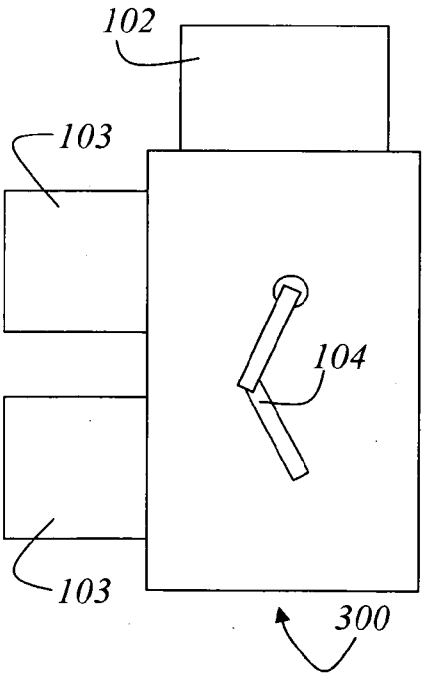


Fig. 3

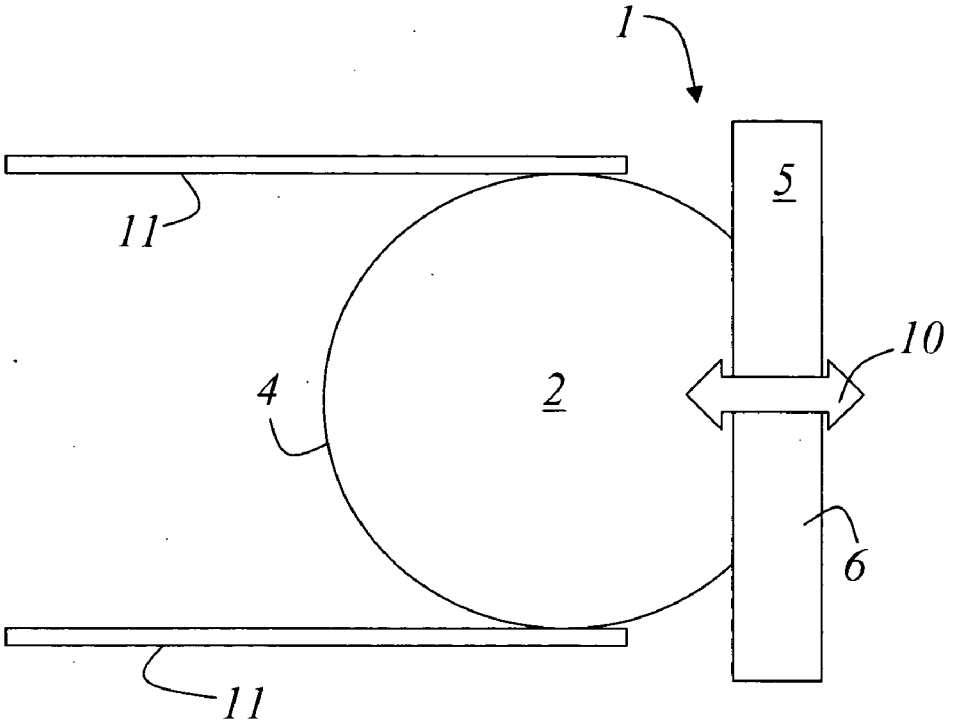


Fig. 4

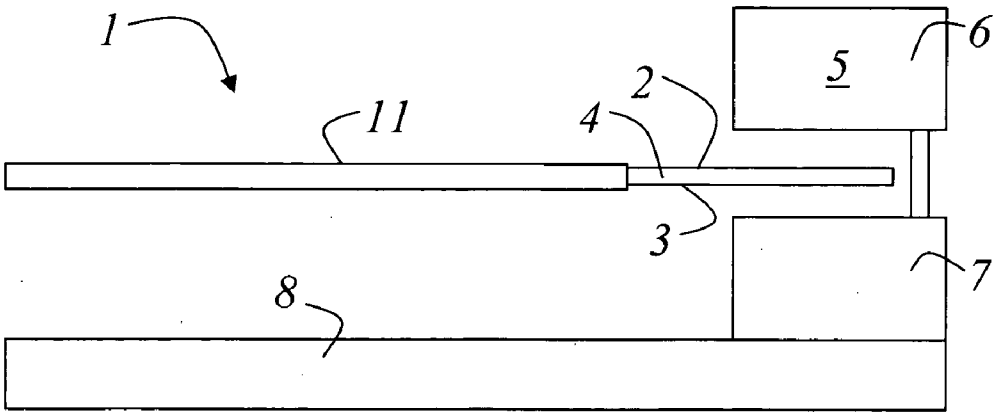


Fig. 5

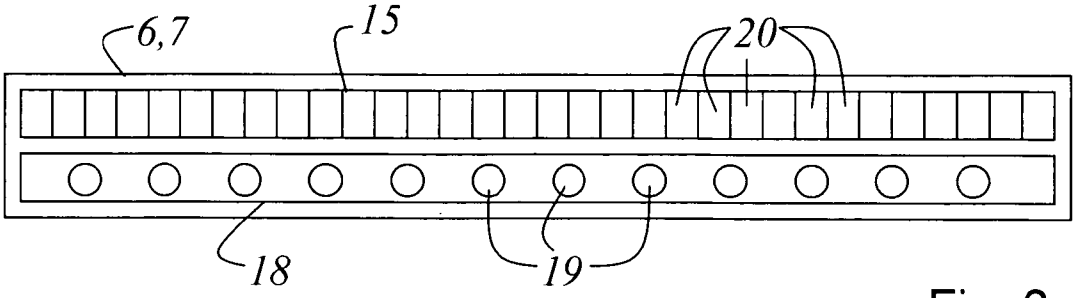


Fig. 6

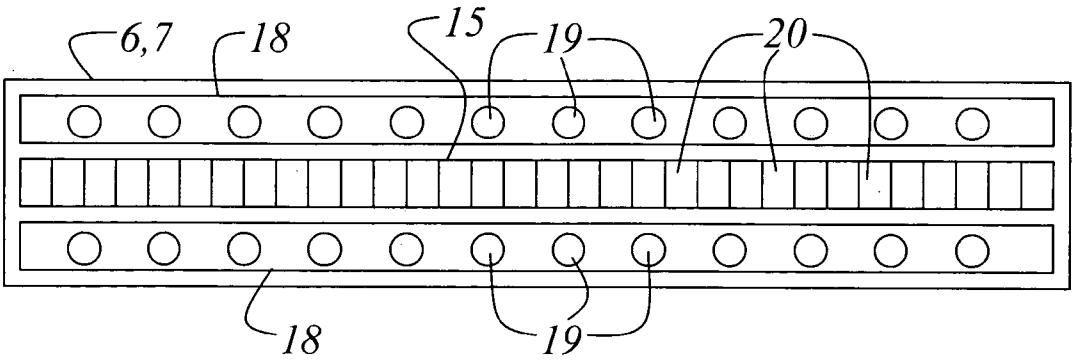


Fig. 7

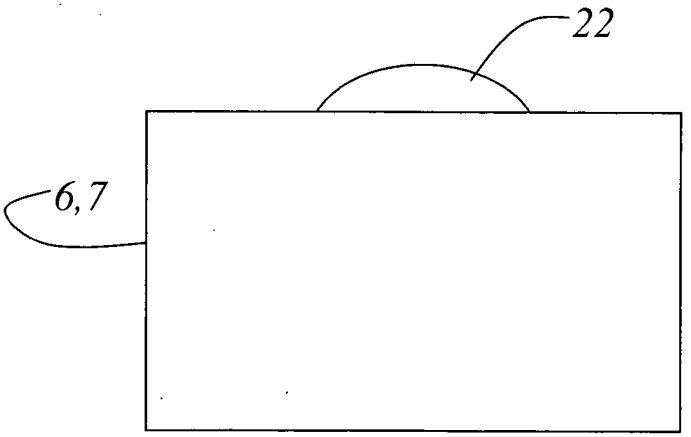


Fig. 8

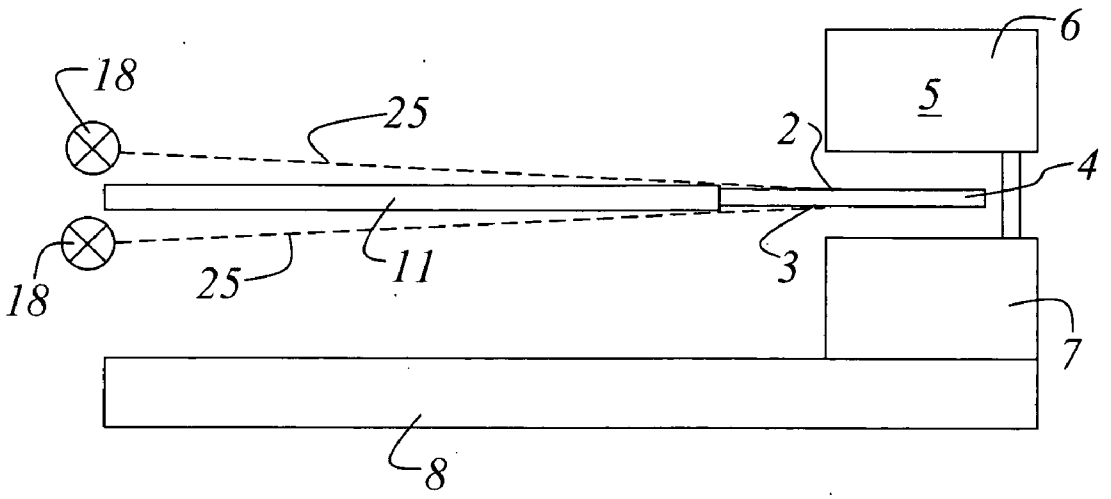


Fig. 9

SYSTEM FOR INSPECTION OF A DISK-SHAPED OBJECT

RELATED APPLICATIONS

[0001] This application claims priority to German patent application number DE 10 2004 058 128.2, filed Dec. 2, 2004, which is incorporated herein by reference in its entirety.

FIELD OF INVENTION

[0002] The invention relates to a device for inspecting the front side and the back side of a semiconductor substrate.

BACKGROUND OF THE INVENTION

[0003] In semiconductor manufacture, wafers are processed sequentially in a multiplicity of processing steps during the production process. The quality requirements for structures applied to the wafers increase with increasing integration density. As a result, the need to test for defects, not only on the front side of the wafer, but to find defects on the back side of the wafer as well, increases. The front side of the wafer is the side to which the various structures are applied.

[0004] German patent DE 100 53 232 C2 discloses a substrate feed module for feeding substrates to a workstation. The substrate feed module is surrounded by side walls and has connector elements that interact with the corresponding connector elements in the workstation.

[0005] German published application DE 101 03 253 A1 discloses a method and an arrangement for transporting and inspecting semiconductor substrates. The arrangement for transporting and inspecting semiconductor substrates comprises at least three workstations in a housing. One workstation is a transfer position of a transfer unit for semiconductor substrates; another workstation is a macroinspection device, and a further workstation is a microinspection device.

[0006] German published application DE 101 21 115 A1 discloses a holding apparatus for a wafer. The holding apparatus possesses two grippers that in their closed state surround the edge of the wafer. The front side and back side of the wafer are therefore not covered. The holding apparatus can be swiveled, which enables visual inspection of the back side of the wafer.

[0007] German published application DE 103 07 373 A1 discloses a method and an apparatus for inspecting semiconductor wafers, taking die-saw designs into consideration. An image of the entire wafer can be constructed from a multiplicity of individual images. In the process. the size of the image field of the camera is selected such that the current die/saw design is taken into account.

[0008] U.S. Pat. No. 6,559,938 B1 discloses a device for simultaneously inspecting for defects on the front side and the back side of a wafer. The wafer lies on a table that exhibits an open channel that in its length corresponds to the diameter of the wafer. A detector moves in the channel, and simultaneously takes an image of a part of the wafer. In order to image the entire surface of the wafer, the wafer can be rotated on the table. The friction between the table and the wafer is minimized by corresponding air bearings. Simultaneous imaging or inspection of the entire surface of the front side and the back side of the wafer is not possible with this apparatus.

[0009] U.S. Pat. No. 6,747,464 B1 discloses a wafer holder with which the back side of the wafer can be observed, and measurements can be taken on the front side of the wafer. The wafer holder may be used in machines for automatically inspecting a wafer. The wafer holder is implemented such that the front side and the back side of the wafer are almost completely accessible from both sides. Simultaneous imaging of the front side and the back side of the wafer is not possible with the wafer holder.

[0010] US patent application 2004/0087146 discloses a ring-shaped wafer holder. The wafer holder possesses a bracket for the wafer and is open at the top such that the wafer can be completely inspected from one side. The wafer rests with its other side on a crib that is implemented with an inspection window through which a fraction of the side of the wafer that lies on the crib can be inspected. Simultaneous and complete inspection of the front side and the back side of the wafer is not possible with this wafer holder.

SUMMARY OF THE INVENTION

[0011] The object underlying the invention is to create a system that makes possible effective imaging of the front side and the back side of a disc-shaped object, whereby the footprint of the system is also reduced.

[0012] This object is solved by a system comprising a loading unit for disc-shaped objects and a device to simultaneously image the front side and the back side of the disc-shaped object.

[0013] It is particularly advantageous for the system for inspecting a disc-shaped object to comprise a loading unit for disc-shaped objects and a device for simultaneous imaging of the front side and back side of the disc-shaped object.

[0014] Furthermore, the system may comprise a device for microinspection of the disc-shaped objects in addition to the loading unit and the device for simultaneous imaging of the front side and back side of the disc-shaped object.

[0015] In addition, a transport robot is also provided in the loading unit of this system, which transports the disc-shaped object from and to at least one FOUP, from and to the device for simultaneously imaging the front side and back side of the disc-shaped object, and from and to the device for microinspection of the disc-shaped object.

[0016] A further advantageous development of the system is that the device for microinspection of the disc-shaped object comprises a transfer position for the disc-shaped objects from the transport robot to a three-paddle handler, and that the three-paddle handler then transports the disc-shaped objects to a pre-aligner and a microinspection element.

[0017] A transport robot is provided in the loading unit, which transports the disc-shaped object from and to the FOUPs and from and to the device for simultaneously imaging the front side and back side of the disc-shaped object. The device for imaging the front side and back side of the disc-shaped object comprises an optical alignment.

[0018] An device that comprises a detection unit for inspection of the front side and back side of a disc-shaped

object is provided in the system. The detection unit comprises a first detector element facing the front side of the disc-shaped object and a second detector element facing the back side of the disc-shaped object. A means is provided for generating a relative movement between the detection unit and the disc-shaped object such that an image is made of the front side and the back side of the disc-shaped object.

[0019] The disc-shaped object may be a wafer on a semiconductor substrate or on a glass substrate, or a mask for lithography, or a flat-panel display.

[0020] An edge grip system is provided that fixes the disc-shaped object in place. The first and the second detector element is a linear detector with integrated optic and an integrated light source.

[0021] The means for generating relative movement between the detection unit and the disc-shaped object is a movement device, whereby the first and a second detector element are attached to the movement device, which moves the first and the second detector element along the top and bottom of the disc-shaped object when the disc-shaped object is fixed in place.

[0022] The first and the second detector element is a linear detector with an integrated optic, whereby an external light source is provided for the two-dimensional object. The light source is fixed in place and the light glances off the wafer.

[0023] The first and the second detector element have at least the same width as the two-dimensional object.

[0024] The above and other features of the invention including various novel details of construction and combinations of parts, and other advantages, will now be more particularly described with reference to the accompanying drawings and pointed out in the claims. It will be understood that the particular method and device embodying the invention are shown by way of illustration and not as a limitation of the invention. The principles and features of this invention may be employed in various and numerous embodiments without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In the accompanying drawings, reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale; emphasis has instead been placed upon illustrating the principles of the invention.

[0026] In the diagram, the subject of the invention is schematically represented and described below based on the figures. They show:

[0027] **FIG. 1 a** schematic view of a first embodiment of the system, comprising a micro-inspection and a macroinspection device;

[0028] **FIG. 2 a** schematic view of a second embodiment of the system, comprising a macroinspection device with a pre-aligner;

[0029] **FIG. 3 a** schematic view of a third embodiment of the system, comprising a macroinspection device with an optical alignment;

[0030] **FIG. 4 a** schematic top view of an element of the system for simultaneously inspecting the front side and the back side of a disc-shaped object;

[0031] **FIG. 5 a** schematic lateral view of the system for simultaneously inspecting the front side and the back side of a disc-shaped object;

[0032] **FIG. 6 a** top view of a first embodiment of a detector element for the detector unit;

[0033] **FIG. 7 a** top view of a second embodiment of a detector element for the detector unit;

[0034] **FIG. 8 a** lateral view of a linear detector; and

[0035] **FIG. 9 a** lateral view of a further embodiment of the construction of an element of the system for simultaneously inspecting the front side and the back side of a disc-shaped object, whereby the light source is implemented externally.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] **FIG. 1** shows a schematic view of a first embodiment of the system **100**, comprising a microinspection device **101** and a macroinspection device **102**. The macroinspection device **102** is implemented as a module and can therefore be quickly and easily connected to the system. The front side and the back side **2**, **3** of a disc-shaped object **4** (see **FIG. 4**) are imaged in the macroinspection device **102**. In addition, the system is provided with at least one FOUP **103** via which the disc-shaped object **4** is fed into and transported away from the system. The system is provided with a handler **104** that takes the disc-shaped objects **4** out of the FOUPs **103** and places them in the FOUPs **103**, or transfers them to the macroinspection device **102** or to the three-paddle handler **105**. The system represented in **FIG. 1** comprises a first transfer position, a second transfer position, and a third transfer position. At the first transfer position, the three-paddle handler **105** receives the disc-shaped object **4** from the handler **104**. At the second transfer position, a pre-aligner **106** receives the disc-shaped object **4** from the three-paddle handler **105**. At the third transfer position, the microinspection device **101** receives the disc-shaped object **4** from the three-paddle handler **105**.

[0037] **FIG. 2** shows a schematic view of a second embodiment of the system **200**, comprising a macroinspection device **102** with a pre-aligner **106**. As previously shown in **FIG. 1**, the system comprises a pre-aligner **106** in which mechanical alignment is carried out. The macroinspection device **102** has a device for simultaneously imaging the front side and back side of the disc-shaped object. In the pre-aligner **106**, the disc-shaped object can be oriented such that imaging by the device occurs at a right angle to the structural edges of the disc-shaped object. The disc-shaped objects can be placed in various orientations in the minimum of one FOUP **103** that can be connected to the system **200**.

[0038] **FIG. 3** shows a schematic view of a third embodiment of the system **300**, comprising a macroinspection device **102** with an optical alignment. Optical alignment occurs by means of graphic analysis of the captured image. The image of the front side and the back side of the disc-shaped object is taken with the device as described in **FIG. 4**. Higher throughput can be achieved by this method, and the costs for the entire system reduced.

[0039] **FIG. 4** shows a schematic top view of the construction of a device **14** (see **FIG. 5**) of a disc-shaped object

for simultaneously inspecting the front side and the backside **2**, **3**. **FIG. 5** represents a lateral view of the construction of the apparatus for simultaneously inspecting the front side and the back side **2**, **3** of the disc-shaped object **4**. It is obvious that the same reference numbers in the different figures relate to the same characteristics of the invention. The device **1** comprises a detection unit **5**. The detection unit **5** comprises a detector element **6** facing the front side **2** and a detector element **7** facing the back side **3** of the disc-shaped object **4**. Furthermore, a means **8** is provided for generating a relative movement between the detection unit **5** and the disc-shaped object **4**. As a result, the detection unit **5** (first detector element **6** and second detector element **7**) creates an image of the front side and the back side **2**, **3** of the disc-shaped object **4**. The direction of the relative movement is indicated in **FIG. 1** with a double arrow **10**. The disc-shaped object **4** can be a wafer on a semiconductor substrate, or a wafer on a glass substrate, or a mask for lithography, or a flat-panel display. A crib is provided that fixes in place the disc-shaped object **4**. The edge grip system **11** makes the front side and the back side of the disc-shaped object **4** accessible for optical inspection. The first detector element **6** and the second detector element **7** are at least as wide as the disc-shaped object **4**. The means **8** for generating the relative movement between the detection unit **5** and the disc-shaped object **4** is a movement device that can, for example, be implemented as a carriage. The first detector element **6** and the second detector element **7** are attached to the movement device. As a result of the movement device, the first detector element **6** and a second detector element **7** may be moved simultaneously along the top and bottom of disc-shaped object **4** when the disc-shaped object **4** is fixed in place.

[**0040**] **FIG. 6** is a top view of a first embodiment of a detector element **6**, **7** for the detection unit **5**. The detector element **6**, **7** has a largely linear form. In the embodiment represented here, the detector element **6**, **7** comprises at least one linear arrangement **15** of individual detectors **20**. The detector element **6**, **7** is also provided with a light source that is arranged parallel to the linear arrangement. The light source **18** may consist of an array of several diodes **19**. A suitably dimensioned surface emitter is also conceivable as the light source **18**.

[**0041**] **FIG. 7** is a top view of a second embodiment of a detector element **6**, **7** for the detection unit **5**. The detector element **6**, **7** has a largely linear form. In the embodiment represented here, the detector element **6**, **7** comprises at least one linear arrangement **15** of individual detectors **20**. The detector element **6**, **7** is also provided with a light source that is arranged parallel to the linear arrangement. The light source **18** may consist of an array of several diodes **19**. A suitably dimensioned surface emitter is also conceivable as the light source **18**.

[**0042**] **FIG. 8** shows a lateral view of the detector element **6**, **7**. Here the first and the second detector element **6**, **7** comprise a linear arrangement **15** of detectors **20** having at least one integrated optic **22** for imaging the front side and the back side **2**, **3** of a disc-shaped object **4**. Furthermore, as already described in **FIGS. 3 and 4**, the first and the second detector element **6**, **7** may be implemented with an integrated light source **18**.

[**0043**] **FIG. 9** shows a lateral view of a further embodiment of the construction of the apparatus for simultaneous inspection of the front side and back side **2**, **3** of a disc-shaped object **4**, whereby the light source **18** is provided externally. The light source **18** is fixed in place and emits a two-dimensional light beam **25** that glances off the front side and the back side **2**, **3** of the disc-shaped object **4**.

[**0044**] While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

What is claimed is:

1. A system for inspecting a disc-shaped object. comprising a loading unit for disc-shaped objects and a device for simultaneously imaging the front side and the back side of the disc-shaped object.

2. System according to claim 1, wherein a device for microinspection of the disc-shaped object is provided in addition to the loading unit and the device for simultaneously imaging the front side and the back side of the disc-shaped object.

3. System according to claim 2, wherein a transport robot is provided in the loading unit, which transports the disc-shaped objects from and to at least one FOUP, from and to the device for simultaneously imaging the front side and back side of the disc-shaped object, and from and to the device for microinspection of the disc-shaped object.

4. System according to claim 1, wherein the device for microinspection of the disc-shaped object comprises a transfer position for the disc-shaped objects from the transport robot to the three-paddle handler, and wherein the three-paddle handler further transports the disc-shaped objects to a pre-aligner and a microinspection element.

5. System according to claim 1, wherein a transport robot is provided in the loading unit, which transports the disc-shaped objects from and to the FOUPs, from and to the device for simultaneously imaging the front side and back side of the disc-shaped object, and a pre-aligner.

6. System according to claim 1, wherein a transport robot is provided in the loading unit, which transports the disc-shaped objects from and to the FOUPs and from and to the device for simultaneously imaging the front side and back side of the disc-shaped object, and wherein the device for simultaneously imaging the front side and the back side of the disc-shaped object comprises an optical alignment.

7. System according to claim 1, wherein the device for simultaneously imaging the front side and back side of the disc-shaped object comprises a detection unit that exhibits a first detector element facing the front side and a second detector element facing the back side of the disc-shaped object, and wherein a relative movement is generated between the detection unit and the disc-shaped object such that in image is made of the front side and the back side of the disc-shaped object.

8. System according to claim 7, wherein the disc-shaped object is a wafer on a semiconductor substrate, or a wafer on a glass substrate, or a mask for lithography, or a flat-panel display.

9. System according to claim 1. where in an edge grip system is provided that fixes the disc-shaped object in-place.

10. System according to claim 7, wherein the first and the second detector element is a linear detector with integrated optic and an integrated light source.

11. System according to claim 10, wherein the first and the second detector element are attached to a movement device that moves the first and the second detector element along the top and bottom of the wafer when the wafer is fixed in place.

12. System according to claim 7, wherein the first and the second detector element comprises a linear detector with integrated optic, and wherein an external light source is provided for the two-dimensional object.

13. System according to claim 10, wherein the first and second detector element are attached to a movement device that moves the first and the second detector element along the top and bottom of the wafer when the wafer is fixed in place.

14. System according to claim 7, wherein the first and the second detector element exhibit a width at least that of the two-dimensional object.

15. System according to claim 1, wherein the device for simultaneously imaging the front side and back side of the disc-shaped object is constructed as a module that can be integrated into the system.

16. System according to claim 15, wherein the module is designed for macroinspection.

* * * * *