

TITLE: WAFER OPTICAL RECOGNITION SYSTEM

BACKGROUND OF THE INVENTION

a Technical Field of the Invention

The present invention is generally related to semiconductors and optical
5 recognition, and more particular to a wafer optical recognition system for
recognizing marking on a wafer.

b Description of the Prior Art

Semiconductor wafers are generally engraved with serial numbers on their
surface to indicate their identity, facilitating subsequent manufacturing processes
10 and inspections. For example, Patent No. M632730 of the Republic of China,
Taiwan, titled "Marking Identification Device for Wafers," describes a device
including an optical recognition component. On one side of this component,
there is a wafer-carrying mechanism, which is further equipped with an upper
reflective element and a lower reflective element. With this setup, the wafer can
15 be placed on the carrying mechanism, where the upper reflective element reflects
the image of the wafer's top surface to the optical recognition component, while
the lower reflective element reflects the image of the wafer's bottom surface to
the same component. This enables the optical recognition component to identify
the serial numbers engraved on both the top and bottom surfaces simultaneously,
20 improving usability and convenience.

However, the aforementioned marking identification device for wafers has
certain shortcomings that require improvement.

While it can recognize serial numbers, the identification device lacks the ability to adjust the angle of illumination. As a result, when different semiconductor wafers with varying sizes or differently positioned serial numbers are processed using this device, it may fail to recognize the markings accurately, increasing the risk of misjudgment. Additionally, ambient light sources may cause glare, further hindering accurate identification.

SUMMARY OF THE INVENTION

The main objective of this invention is to control the light emission mode of multiple light-emitting elements using a light refraction device and a circuit board. This allows the light-emitting elements to adjust their emission pattern as
5 needed. By incorporating the light refraction device, the emitted light can be distributed over a wider area, ensuring that the graphical and textual information on the semiconductor wafer is more clearly visible. As a result, the image data captured by the imaging device is sharper and clearer, preventing issues such as insufficient lighting or glare caused by incorrect light angles.

10 To achieve the aforementioned objective, a wafer optical recognition system is disclosed and the system includes an imaging device for capturing the graphical and textual information on a semiconductor wafer, a light-emitting device equipped with multiple light-emitting elements, a circuit board capable of recognizing graphical and textual information and controlling the operation of
15 the light-emitting elements, and a light refraction device that refracts the light emitted by the light-emitting elements. When the image data captured by the imaging device is unclear due to lighting issues, the circuit board can issue control commands to adjust the light-emitting elements of the light-emitting device. After passing through the light refraction device, the emitted light is
20 enhanced or optimized to improve illumination on the graphical and textual information. Additionally, the circuit board can modify the operation mode of the light-emitting elements, ensuring that the correct light-emitting elements are

activated in the appropriate positions. This prevents issues such as insufficient illumination or glare, ultimately resulting in clearer image data.

Through the disclosed system, the present invention overcomes the limitations of conventional wafer marking recognition devices, which, despite
5 having marking recognition capabilities, cannot adjust the light angle. Specifically, when different semiconductor wafers are processed using such conventional recognition devices, variations in wafer size or marking positions may lead to incorrect recognition or an increased risk of misjudgment. Additionally, environmental light sources can cause glare, further hindering
10 accurate recognition. By addressing these issues, the present invention provides a practical and advanced improvement, achieving the advantages described above.

The foregoing objectives and summary provide only a brief introduction to the present invention. To fully appreciate these and other objects of the present invention as well as the invention itself, all of which will become apparent to
15 those skilled in the art, the following detailed description of the invention and the claims should be read in conjunction with the accompanying drawings.

Throughout the specification and drawings identical reference numerals refer to identical or similar parts.

Many other advantages and features of the present invention will become
20 manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which a preferred structural embodiment incorporating the principles of the present invention is

shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective diagram showing a wafer optical recognition system according to a first embodiment of the present invention.

FIG. 2 is a sectional diagram showing the wafer optical recognition system of
5 FIG. 1.

FIG. 3 is a perspective break-down diagram showing the wafer optical recognition system of FIG. 1.

FIG. 3A is a block diagram showing the wafer optical recognition system of FIG. 1.

10 FIG. 4 is a schematic sectional diagram showing the application of the wafer optical recognition system of FIG. 1 on a wafer.

FIG. 5 is a sectional diagram showing a wafer optical recognition system according to a second embodiment of the present invention.

FIG. 6 is a perspective break-down diagram showing a wafer optical
15 recognition system according to a third embodiment of the present invention.

FIG. 6A is a perspective break-down diagram showing a focus adjustment device of the wafer optical recognition system of FIG. 6.

FIG. 7 is a sectional diagram showing the wafer optical recognition system of FIG. 6.

20 FIG. 8 is a schematic sectional diagram showing the adjustment of the wafer optical recognition system of FIG. 6.

FIG. 9 is a schematic sectional diagram showing the application of the wafer

optical recognition system of FIG. 6 on a wafer.

FIG. 10 is a schematic sectional diagram showing the enhancement of lighting of the wafer optical recognition system of FIG. 6 on a wafer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following descriptions are exemplary embodiments only, and are not intended to limit the scope, applicability or configuration of the invention in any way. Rather, the following description provides a convenient illustration for
5 implementing exemplary embodiments of the invention. Various changes to the described embodiments may be made in the function and arrangement of the elements described without departing from the scope of the invention as set forth in the appended claims.

As shown in FIGS. 1 to 4, a first embodiment of the present invention
10 includes the following components:

An imaging device 1 is provided for capturing graphical and textual information A1 on a semiconductor wafer A.

A light-emitting device 2 is positioned on one side of the imaging device 1, which includes multiple light-emitting elements 21.

15 A circuit board 3 is located on one side of the light-emitting device 2 and connected to both the imaging device 1 and the light-emitting device 2. The circuit board 3 is responsible for acquiring the captured image data 11, recognizing the graphical and textual information A1, and controlling the operation of the light-emitting elements 21, allowing them to function
20 independently or collectively.

An AI (artificial intelligence) chip 31 is installed on the circuit board 3,

which recognizes the graphical and textual information A1 and is capable of learning and recording the graphical and textual information A1 contained in the image data 11.

5 A light refraction device 4 is positioned on one side of the light-emitting device 2 to refract the light emitted by the light-emitting elements 21.

A support structure 51 provided, on which both the imaging device 1 and the light-emitting device 2 are mounted.

The graphical and textual information A1 and image data 11 refer to an identification of the semiconductor wafer A and may include at least one of text,
10 numbers, or graphics.

The imaging device 1 is either a video camera or a photographic camera.

The light-emitting elements 21 are LEDs light-emitting diodes, which, in this embodiment, are arranged in a set of eight evenly spaced LEDs surrounding the imaging device 1. In this embodiment, the imaging device 1 is positioned at
15 the exact center of the arranged light-emitting elements 21.

The light refraction device 4 is a convex lens.

The recognition of the graphical and textual information A1 is performed using OCR Optical Character Recognition technology. OCR refers to the process of processing and recognizing images or videos containing textual content,
20 extracting the embedded text and layout information.

The circuit board 3 includes a processing module 32, which can be an IC integrated circuit chip. The processing module 32 is capable of recognizing the

graphical and textual information A1 and receiving user commands to control the switching on and off of the light-emitting elements 21.

For recognizing the graphical and textual information A1 on the semiconductor wafer A, the process begins by placing the semiconductor wafer
 5 A in front of the imaging device 1. At this point, all light-emitting elements 21 are initially activated to emit light 211. The light 211 passes through the light refraction device 4, creating a refraction effect similar to a diffusion function, which broadens the illuminated area. Consequently, the image data 11 captured by the imaging device 1 will approximate the illuminated area of the light 211.
 10 For example, when all light-emitting elements 21 are turned on, if the graphical and textual information A1 in the image data 11 is clearly visible and successfully recognized by the OCR technology of the processing module 32, it indicates accurate recognition of graphical and textual information A1. However, if all light-emitting elements 21 are turned on, but the graphical and textual
 15 information A1 in the image data 11 cannot be recognized by the OCR technology of the processing module 32, it suggests that recognition may have failed due to insufficient light 211 or glare issues. In this case, the user can utilize a computer interface or a physical control panel to issue commands to the processing module 32, allowing it to adjust the light-emitting elements 21 and
 20 modify the lighting mode.

Taking the glare issue as an example, since the light refraction device 4 is a convex lens, the light 211 emitted by the light-emitting elements 21 undergoes

refraction. As a result, based on the position of the imaging device 1, the image data 11 captured may be affected by the refracted light 211, causing glare on the graphical and textual information A1. When glare occurs, the graphical and textual information A1 in the image data 11 becomes unclear, preventing the processing module 32 from recognizing it accurately. To address this, the user can control the operation of the light-emitting elements 21 via the processing module 32. For example, instead of activating all eight light-emitting elements 21, the user can activate only the top three light-emitting elements 21, or only the left vertical three light-emitting elements 21, or only two light-emitting elements 21 from the top row and two from the bottom row, etc. This demonstrates that each light-emitting element 21 can be individually or collectively controlled by the processing module 32. The purpose of adjusting the above various light-emitting modes is to optimize illumination for clear recognition. If activating the top three light-emitting elements 21 still does not provide a clear image of the graphical and textual information A1, the user can switch to a different mode, such as activating only the left vertical three light-emitting elements 21. In other words, the user can freely adjust the light-emitting elements 21 through the processing module 32 based on the requirements, achieving the most suitable light 211 angle to ensure successful recognition of the graphical and textual information A1 by the processing module 32.

The AI chip 31 can record the graphical and textual information A1 each time the processing module 32 completes an OCR process. Alternatively, users

can manually define and store graphical and textual information A1 such as text in the record to assist in accelerating recognition results. In other words, when the processing module 32 is combined with the AI chip 31, it forms an AI-powered OCR system. If the graphical and textual information A1 recognized by the processing module 32 is somewhat unclear, which may result in increased processing time, the AI chip 31 will assist by performing recognition matching. By reading the stored graphical and textual information A1 records, the AI chip 31 compares them with the unclear graphical and textual information A1. Once a match is found, the AI chip 31 retrieves the corresponding graphical and textual information A1 record, thereby significantly enhancing the recognition speed and accuracy.

In the second embodiment of the present invention, as shown in FIG. 5, it is clearly visible that a light directional device 6 is positioned between the light-emitting device 2 and the light refraction device 4. In the present embodiment, the imaging device 1 is located below the light directional device 6, meaning that the imaging device 1 and the light-emitting device 2 are positioned at a right-angle relative to each other, as illustrated in the figure. One side surface of the light directional device 6 allows light to pass through to the opposite side, while light entering from the other side is blocked and cannot pass through. This configuration ensures that the light emitted by the light-emitting device 2 can pass through the light directional device 6 and the light refraction device 4 to illuminate the graphical and textual information A1. Meanwhile, the imaging

device 1, positioned on the opposite side of the light directional device 6, captures the graphical and textual information A1 using a reflection effect. This design allows the imaging device 1 to be positioned flexibly rather than being constrained to a fixed location. Additionally, by incorporating the light

5 directional device 6, the imaging device 1 can be moved away from the light-emitting device 2, which helps enhance the clarity of the captured image data 11.

In the third embodiment of the present invention, as illustrated in FIGS. 6 to 10, it is clear that the present embodiment differs from the previously described

10 embodiment in that it includes a focus adjustment device 7 positioned on one side of the imaging device 1 to adjust its focal distance. The focus adjustment device 7 includes an adjustment driving component 71 that is fixedly connected to the imaging device 1. The adjustment driving component 71 includes several fixing elements 711 that are fixedly connected to the imaging device 1, several

15 sliding channels 712 positioned on one side of the fixing elements 711, a driving channel 713 located between the sliding channels 712, a threaded adjustment channel 714 positioned on one side of the driving channel 713. Additionally, on the side of the adjustment driving component 71 that faces away from the imaging device 1, a positioning component 72 is provided. The positioning

20 component 72 includes several guiding pins 721 that fit within the sliding channels 712, and a positioning socket 722 corresponding to the position of the driving channel 713. Inside both the driving channel 713 and the positioning

socket 722, an elastic element 73 is housed. Furthermore, an adjustment element 74 is inserted through the positioning component 72, adjustment driving component 71, and elastic element 73. The imaging device 1 and the light-emitting device 2 are mounted on the support structure 51. The support structure 51 and the positioning component 72 are secured together with an outer casing 52. Additionally, a reflective device 8 is positioned in front of the imaging device 1. This reflective device 8 is located on a side of the light directional device 6 different from those facing the light-emitting device 2 and the light refraction device 4. At least one side of the light refraction device 4 is equipped with an illumination enhancement module 91, which is electrically connected to the circuit board 3. The circuit board 3 is electrically connected to a power supply component 92. The circuit board 3 is also data-linked to a connector 93 that complies with network communication protocols.

The fixing elements 711 can be screw holes, allowing a screw to pass through and secure the imaging device 1 to the fixing elements 711, thereby fixing the imaging device 1 and the adjustment driving component 71 together.

The threaded adjustment channel 714 can be a screw hole, while the adjustment element 74 can be a screw, enabling the adjustment element 74 to be threaded into and rotated within the threaded adjustment channel 714.

The driving channel 713 and the positioning socket 722 correspond to each other, forming a housing space that accommodates the elastic element 73. One end of the elastic element 73 presses against the bottom of the positioning socket

722, while the other end presses against the bottom of the driving channel 713. This configuration creates tensile force between the adjustment driving component 71 and the positioning component 72, pushing them in opposite directions.

5 The reflective device 8 can be a mirror. In the present embodiment, the light-emitting device 2, light directional device 6, and light refraction device 4 are positioned on the same plane, arranged horizontally. Additionally, the light directional device 6 and the reflective device 8 are arranged vertically. The reflective device 8 and the imaging device 1 are arranged horizontally, as shown
10 in the figures.

 Since the imaging device 1 and the light-emitting device 2 are mounted on the support structure 51, their stability is significantly enhanced. For example, the imaging device 1 is more stable and less prone to shaking, which helps improve the clarity of the graphical and textual information. This also accelerates the
15 recognition speed of the circuit board 3 when processing the graphical and textual information, resulting in a notable performance improvement. The light-emitting device 2 also benefits from increased stability, ensuring a steady light output and minimizing fluctuations of light 211 that could cause glare in the image data. Additionally, graphical and textual information A1 located near the
20 edges of the semiconductor wafer A is less likely to suffer from insufficient illumination.

 As the support structure 51, positioning component 72, and outer casing 52

are securely locked together, the entire system becomes portable, removing geographic restrictions and greatly enhancing convenience for transportation and deployment.

To adjust the focus of the imaging device 1, for example, when the focus
 5 distance of the imaging device 1 shifts, a manual tool B can be used to engage with the adjustment element 74. As the manual tool B rotates, it drives the adjustment element 74 to rotate as well. The adjustment element 74, in turn, drives the threaded adjustment channel 714 of the focus adjustment device 7, causing it to rotate. During this process, the nut section of the adjustment element
 10 74 presses against the outer side of the positioning component 72. The screw section extends into both the positioning component 72 and the adjustment driving component 71. Since the adjustment element 74 is restricted jointly by its nut section and the positioning component 72, it does not move forward. Instead, the adjustment driving component 71 moves forward or backward as the
 15 adjustment element 74 rotates. Additionally, the elastic element 73 provides assistance, making the adjustment process smoother and easier for the user. Thus, when the imaging device 1 becomes defocused, the user can manually adjust the focus using the focus adjustment device 7, ensuring that the image data remains in optimal condition, with clear and visible graphical and textual information at
 20 all times.

Regarding the light path and the image data capture path, the light 211 emitted by the light-emitting elements 21 sequentially passes through the light

directional device 6 and the light refraction device 4 before illuminating the graphical and textual information on the semiconductor wafer A. The image data captured by the imaging device 1 follows a path C in this sequence: light refraction device 4, light directional device 6, reflective device 8, and imaging device 1. In summary, the imaging device 1 utilizes the vertical arrangement of the reflective device 8 and the light directional device 6 to allow the imaging device 1 to be positioned below the light-emitting device 2 while still capturing the environment outside the light refraction device 4. This positional design enables adjustments to the overall size of the system, allowing for different configurations based on spatial requirements, ensuring that the setup meets specific size constraints as needed.

In the case of insufficient lighting, when the graphical and textual information on the semiconductor wafer A is deviated, preventing the light-emitting device 2 from adequately illuminating it, or when the original brightness of light 211 is insufficient, the processing module 32 of the circuit board 3 can control the illumination enhancement module 91 to provide additional lighting. In other words, since the illumination enhancement module 91 is positioned at a specific angle, it can effectively illuminate graphical and textual information that is either too deviated or lacking brightness. This compensates for the limited illumination angle or insufficient brightness of the light-emitting device 2. In the present embodiment, a single illumination enhancement module 91 is used as an example. However, if multiple modules

are implemented, they can be distributed around the light refraction device 4 to enhance illumination coverage.

Additionally, the power supply component 92, exemplified as a power socket, provides the necessary external power supply to the circuit board 3.

- 5 However, if an external power source is unavailable, the system can be powered by a built-in battery.

Furthermore, any data received by the circuit board 3, including image data, can be transmitted to an external device, such as a computer system, via an electrical connection to the connector 93. This enables remote control for the user,
10 offering high convenience and practicality. If a connector 93 is not available, a wireless transmission module can be added to the circuit board 3 for wireless data transfer to external devices, through Wi-Fi or Bluetooth antennas.

Therefore, the wafer optical recognition system of the present invention improves upon conventional technology through the following key innovations:

- 15 1. By utilizing the light refraction device 4 and the circuit board 3 to control multiple light-emitting elements 21, the light emission pattern can be adjusted as needed. The light refraction device 4 ensures that light 211 is distributed over a wider area, making the graphical and textual information A1 on the semiconductor wafer A more visible. As a result, the image data 11 captured by
20 the imaging device 1 is clearer, preventing issues such as insufficient light 211 or glare caused by incorrect angles of light 211.

2. The circuit board 3 is equipped with OCR technology, providing rapid,

accurate, and stable recognition of graphical and textual information A1.

3. The focus adjustment device 7 allows users to manually adjust the focus if the image data 11 captured by the imaging device 1 is unclear due to focus deviation, ensuring consistently sharp images.

5 4. The integration of adjustment driving component 71, fixing elements 711, sliding channels 712, driving channel 713, threaded adjustment channel 714, positioning component 72, guiding pins 721, positioning socket 722, elastic element 73, and adjustment element 74 allows for smooth and stable adjustments. The sliding channels 712 and guiding pins 721 work together to prevent
10 excessive shaking, ensuring the image data 11 remains in optimal condition, with clear graphical and textual information A1.

5. The support structure 51 enhances the stability of the imaging device 1, reducing vibration and improving the clarity of graphical and textual information A1. This also speeds up the recognition process on the circuit board 3,
15 significantly enhancing system performance. Additionally, the outer casing 52 provides portability by allowing for easy repositioning without location constraints. It also protects internal components—including the imaging device 1, light-emitting device 2, circuit board 3, light refraction device 4, light directional device 6, reflective device 8, and illumination enhancement module 91—from
20 external impacts and environmental contaminants.

6. The light directional device 6 allows the imaging device 1 to be positioned separately from the light-emitting device 2, effectively reducing the

overall size of the light-emitting device 2.

7. With the vertical arrangement of the reflective device 8 and the light directional device 6, the imaging device 1—even when positioned below the light-emitting device 2—can still capture the external environment of the light refraction device 4. This positional design allows for flexible installation to meet specific spatial constraints.

8. The AI chip 31 enhances recognition speed by assisting in data processing and comparison, improving overall efficiency.

9. The illumination enhancement module 91 effectively illuminates deviated graphical and textual information A1, compensating for the limited coverage of the light-emitting device 2. The power supply component 92 ensures a stable power supply to the circuit board 3, maintaining consistent performance. Additionally, the connector 93 allows for remote control, providing high convenience and usability for users.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claim, it is not intended to be limited to the details above, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and in its operation can be made by those skilled in the art without departing in any way from the claims of the present invention.

I CLAIM:

1. A wafer optical recognition system, comprising:
 - an imaging device for capturing graphical and textual information on a semiconductor wafer;
 - 5 a light-emitting device positioned on one side of the imaging device, which comprises a plurality of light-emitting elements;
 - a circuit board located on one side of the light-emitting device and connected to both the imaging device and the light-emitting device for acquiring image data captured by the imaging device,
 - 10 recognizing the graphical and textual information contained in the image data, and controlling operation of the light-emitting elements, allowing them to function independently or collectively; and
 - a light refraction device positioned on one side of the light-emitting device to refract light emitted by the light-emitting elements.
- 15 2. The wafer optical recognition system according to claim 1, wherein a focus adjustment device is positioned on one side of the imaging device to adjust the focal distance of the imaging device.
3. The wafer optical recognition system according to claim 2, wherein the focus adjustment device comprises an adjustment driving component
- 20 that is fixedly connected to the imaging device; the adjustment driving component comprises a plurality of fixing elements that are fixedly connected to the imaging device, a plurality of sliding channels

- positioned on one side of the fixing elements, a driving channel located between the sliding channels, and a threaded adjustment channel positioned on one side of the driving channel; on a side of the adjustment driving component that faces away from the imaging device,
- 5 a positioning component is provided; the positioning component comprises a plurality of guiding pins that fit within the sliding channels, and a positioning socket corresponding to the driving channel; inside both the driving channel and the positioning socket, an elastic element is housed; and an adjustment element is inserted through the
- 10 positioning component, adjustment driving component, and elastic element.
4. The wafer optical recognition system according to claim 3, wherein the imaging device and the light-emitting device are mounted on a support structure; and the support structure and the positioning component are
- 15 secured together with an outer casing.
5. The wafer optical recognition system according to claim 1, wherein both the imaging device and the light-emitting device are mounted a support structure.
6. The wafer optical recognition system according to claim 1, wherein a
- 20 light directional device is positioned between the light-emitting device and the light refraction device.
7. The wafer optical recognition system according to claim 6, wherein a

reflective device is positioned in front of the imaging device; the reflective device is located on a side of the light directional device different from those facing the light-emitting device and the light refraction device.

- 5 8. The wafer optical recognition system according to claim 1, wherein the graphical and textual information is recognized by an artificial intelligence (AI) chip configured on the circuit board; and the AI chip is capable of learning and recording the graphical and textual information contained in the image data.
- 10 9. The wafer optical recognition system according to claim 1, wherein at least one side of the light refraction device is equipped with an illumination enhancement module, which is electrically connected to the circuit board.
- 15 10. The wafer optical recognition system according to claim 1, wherein the circuit board is electrically connected to a power supply component; and the circuit board is data-linked to a connector that complies with a network communication protocol.