

Optical inspection of a component

Description

5 Background

A component inspection is described here, which in particular can also be part of a component handling device. This component inspection is explained in interaction with the component handling device. Details of this are defined in the claims; the description and the drawing also contain relevant information about the system and the mode of operation as well as about variants of the system.

10 A component here is, for example, a (electronic) semiconductor component, also referred to as a "chip" or "die". Such a component usually has a prismatic shape, a substantially polygonal, for example quadrangular (rectangular or square) cross-section with several lateral surfaces as well as a bottom surface and a top surface. The shell surfaces as well as the bottom surface and the top surface of the component are hereinafter generally referred to as side surfaces. The bottom surface and the top surface are also referred to as end surfaces. With four lateral surfaces and two approximately square end faces, the component has an approximately

15 cuboid shape, since the height/thickness of the component is generally less than the edge lengths of the lateral surfaces in the longitudinal/transverse direction of the component. The component may also have a number of lateral surfaces different from four. The semiconductor component is manufactured, for example, using planar technology from a semiconductor single crystal wafer (for example silicon) through a

20 large number of steps, with several hundred ICs on the Si wafer at the end of the process. By scribing, breaking or sawing (with laser or by mechanical material removal), the wafer is divided into individual components, each comprising one or more integrated circuits. A component can also be an optical component (prism, mirror, lens, etc.). Overall, a component can have any geometric shape.

30 From the operational practice of the applicant, so-called pick-up and set-down devices are known, in which components are individually picked up from a substrate with a pick-up tool and subsequently set down on a carrier or in a transport container or the like. Between picking up the component from the substrate and

35 depositing the component, an inspection of the component usually takes place. For this purpose, images of one or more external side surfaces of the component are recorded with one or more imaging sensors and evaluated by means of automated image processing.

EP 0 906 011 A2 concerns a device for removing and loading electrical components on a substrate. The device comprises a rotatable transfer device which removes the electrical components from a feed module at a pick-up position and transfers them to a suction belt for further processing at a first transfer position. By means of a rotatable placement head, the components are picked up from the suction belt and transported to a second transfer position.

WO 02/054480 A1 relates to a device for optically inspecting various surfaces of a chip to be mounted. The device comprises a first, upper transport drum, which is arranged to remove the chips from a feed unit and transport them to a first transfer position. The chips are held in suction apertures formed on the peripheral surface of the upper transport drum, and moved by rotating the upper transport disk. The device further comprises a second, lower transport disk formed corresponding to the upper transport disk, which receives the removed chips at the first transfer position and transports them to a second transfer position. The device enables inspection of the chips by cameras arranged laterally next to the transport discs, which inspect the chips on their upper and lower sides. The chips are transferred unflipped relative to their original orientation to a sorting device for further processing.

US 4,619,043 discloses an device and a method for removing and attaching electronic components, in particular chips, to a printed circuit board. The device comprises a transport means for picking up the chips in pick-up units and for transporting the picked-up chips to a first transfer position. The conveying means comprises a conveying chain and a rotatable sprocket, which are engaged together. The device further comprises a rotatable mounting tool having placement heads for picking up the chips at the first transfer position. The fastening tool is further adapted to convey the picked-up chips to a second transfer position by means of a rotary movement, whereby the chips are turned over.

JP 2-193813 relates to a device for picking up and turning over electronic components inspected by inspection devices. The device comprises a feeding unit from which electronic components are taken by a first rotating body and arranged at its circumference. A rotary motion of the rotating body transports the components to a first transfer position, turning them about their longitudinal or transverse axis. The device further comprises a second rotating body, which picks up the removed electronic components at the first transfer position and transports them to a second transfer position. Thereby, a further turning of the electronic components about their

longitudinal or transverse axis takes place. The device allows inspection of different sides of the components.

Technical problem

- 5 Components are inspected visually, among other things, before being housed in a ceramic or plastic package and having external connections made. During the disassembly of the wafer into individual components, mechanical stresses occasionally occur, particularly at the lower edge of the component, namely in its interior, which cause a circuit layer to detach from adjacent layers. The separation of
10 the wafer into individual components also leads to unevenness on the separated sidewall, in particular on the edge of the sidewall facing away from the laser. This separation area/edge is also referred to as a laser groove (LG) when the wafer is cut by laser. Common imaging sensors are usually not able to detect such defects. Defects (breakouts) on the component in the laser groove area are to be detected by
15 suitable inspection. By detecting, for example, a detachment of a semiconductor or metal layer from the silicon body, the defective component can be sorted out of the further processing sequence and thus a reduction in the lifetime of the later products can be avoided.
- 20 At the same time, the demands of the semiconductor processing industry to be able to optically detect ever smaller defects in the components are increasing. The optical detection of some types of defects is possible with adapted lenses and coordinated illumination of the components to be inspected. However, the lenses available reach their limits when it comes to the required image sharpness and the associated
25 decreasing depth of field.

Due to the scattering of the positions of the components on the holder tool and the shallow depth of field of the lenses, the quality of the optical inspection is limited. Defects are detected with a lower probability on out-of-focus components. This means that defective components are incorrectly not recognized as non-functional
30 and are further processed / packaged.

Further technological background is also provided in EP 2 075 829 B1, EP 1 470 747 B1, JP 59 75 556 B1, WO 2014 112 041 A1, WO 2015 083 211 A1, WO 2017 022 074 A1, WO 2013 108 398 A1, WO 2013 084 298 A1, WO 2012 073 285 A1, US
9,510,460 B2, JP 49 11 714 B2, US 7,191,511 B2, JP 55 10 923 B2, JP 57 83 652 B2,
35 JP 2007 095 725 A, JP 2012 116 529 A, JP 2001-74664 A, JP 1-193630 A, US 5,750,979, DE 199 13 134 A1, JP 8 227 904 A, DE 10 2015 013 500 A1, DE 10 2017 008 869 B3, DE 10 2019 125 127 A1 illustrated.

Underlying task

The solution presented here is intended to provide an improved, safe and fast inspection of components at high throughput compared to the state of the art.

5

Proposed solution

10 A device and a method are disclosed here. The device is used for optical inspection of a component located on a holder. The fixture is designed and intended to pick up the component at a delivery point, to convey it along a conveying path to a deposit point, and to deposit it at the deposit point. A light source is configured and intended to emit light incident at a first acute angle to the optical axis of an imaging sensor on a first of the faces of the component when the component located at the holder is oriented with the first of its faces at least approximately normal (about $90^\circ \pm$ about 10°) to the optical axis of the imaging sensor. The imaging sensor is configured and
15 intended to optically inspect at least one of the side surfaces of the component conveyed by the holder and/or at least one region in the interior of the component proximate a second of the end surfaces and proximate respective ones of the side surfaces. The imaging sensor is configured and intended to detect light emerging from the first of the end faces of the component and to signal a distribution of the
20 intensity of the emerging light to an evaluation device. The evaluation device is set up and intended, depending on the signaled distribution of the intensity of the emerging light, to detect unevenness at least in sections on a side surface of the component and/or to detect detachments of at least one layer in sections in the region of a second of the end surfaces.

25

Emitting light at an acute angle to the optical axis of an imaging sensor onto an end face of the component means that this light has a principal axis of radiation in space along which the light has at least nearly the greatest radiance, this principal axis of radiation including the acute angle ($< 90^\circ$) with the optical axis of an imaging sensor
30 oriented normal to the first of the end faces of the component.

30

The device disclosed herein can be used to detect

- (i) unevenness on one or more detached sidewalls of the device, and/or
- (ii) a detachment of a semiconductor or metal layer from the silicon body on the
35 conveying path between the delivery point and the deposition point at the same

35

inspection position and with the same imaging sensor. Also

(iii) defects on the end faces of the component can be detected in this way, as they create a black area in the image of the imaging sensor; again, the beams do not penetrate the component and are consequently not reflected at the side faces.

5

In a variant of the device, the holder is guided from the delivery point to the deposit point along a conveyor path on which the component conveyed through the holder passes an optical device comprising one or more deflecting and/or focusing devices arranged and intended to direct light emerging from the first of the faces of the component toward the imaging sensor.

10

In a variant of the device without the fixture, the laser groove is to be detected on a component already placed in a pocket. In this variant, the entire optical assembly is oriented to face the pocket from above, for example, and inspects one of the component's end faces.

15

In a variant of the device, the light source is arranged and intended to provide at least one light strip incident at the acute angle in an edge region of the component on the first of the end faces of the component.

20

In a variant of the device, the acute angle of light directed at the component is determined as a function of the refractive index of the material of the component, the wavelength, and/or the height of the component between about -45° and about $+45^\circ$, between about $+5^\circ$ and about $+45^\circ$, between about $+15^\circ$ and about $+45^\circ$, between about $+25^\circ$ and about $+45^\circ$, or between about $+30^\circ$ and about $+45^\circ$.

25

In a variant of the device, the light source is adapted to emit infrared light with a wavelength between about 780 nm and about 1000 nm, and in the case that the component has a silicon-containing substrate material and the temperature of the substrate material is about $300\text{ }^\circ\text{K} \pm \text{about } 10\text{ }^\circ\text{K}$, the acute angle of the light directed onto the component is about $33^\circ \pm \text{about } 3^\circ$. Depending on the substrate material of the component, light with higher wavelengths can also be used, for example SWIR (short wave IR) up to about 1500 nm.

30

In a variant of the device, the acute angle α_1 of the light directed onto the component is determined in such a way that, in the case of a component inspected as being in order, the light (i) is reflected inside the component on a side surface of the component to be inspected, and/or (ii) is reflected inside the component in the

35

region of an end surface of the component facing the pick-up, and (iii) emerges as outgoing light at the acute angle α_2 to the optical axis of the imaging sensor from the end face of the component facing away from the holder towards the imaging sensor in such a way that the magnitude of the second acute angle α_2 deviates at most slightly from that of the first acute angle α_1 .

In a variant of the device, the deviation of the magnitude of the second acute angle from that of the first acute angle, which is at most slight, is no more than about $\pm 10^\circ$.

In a variant of the device, the acute angle of the light directed onto the component is determined such that, when the component is inspected as being OK, the light is reflected (i) inside the component at a side surface of the component to be inspected, and (ii) inside the component in the region of an end surface of the component facing the holder, and (iii) emerges as outgoing light at the acute angle to the optical axis of the imaging sensor from the end surface of the component facing away from the holder towards the imaging sensor.

In a variant of the device, the holder is part of a first turning device, which is set up to rotate about a first turning axis and, in doing so, to pick up the component at the first delivery point, to convey it to the first deposit point, and to deposit it at the first deposit point. In a variant of the device, the holder is part of a second turning device, which is set up and intended to rotate about a second turning axis and thereby take over the component at a takeover point from a holder of the first turning device, convey it to a second deposit point, and deposit it at the second deposit point. In a variant of the device, the first turning axis and the second turning axis are spaced apart from each other, and offset from each other by an angle of about 90° . In a variant of the device, the holder of the first turning device and the holder of the second turning device are aligned with each other at the transfer point in such a way that the component is to be transferred from the first turning device to the second turning device.

In a variant of the device, the distance between the holder (with the component) passing through the optical device and the light deflecting and/or focusing devices is to be varied (for example by adjusting devices or by adjusting drives) in such a way that the component conveyed by the holder can be detected optically by the imaging sensor at least between the first and the second of the end faces of the component along the optical axis of the imaging sensor. In other words, in a variant of the

device, the optics (light redirecting and/or scattering/ and/or focusing and/or polarizing means) for the imaging sensor are to be focused such that the optics feed an image to the imaging sensor from the interior, such as the space near the second of the end faces of the component. In this way, the layer delaminations at the
5 second of the component's end faces can be reliably detected, displayed and evaluated.

In a variant of the device, a support unit with a through aperture located in the support unit is provided for supporting a plurality of, for example, four light
10 deflection devices. In a variant, the light deflection devices are arranged around the through aperture. The support unit is to be moved or adjusted along the optical axis of the imaging sensor, whereby the entirety of the plurality of light redirecting devices is to be displaced along the optical axis of the imaging sensor. In a variant of the device, an adjustment means for a selection of the plurality of light redirecting
15 devices is provided to displace said selection along the optical axis of the imaging sensor. In a variant of the device, the support unit is arranged and intended to support at least one light source for each of the light deflection devices arranged around the through aperture, the at least one light source being arranged, and preferably adjustable, on the support unit in such a way that light emitted by it falls,
20 preferably through the through aperture, onto the first of the end faces of the component to be inspected as it passes the optical device.

In order to achieve optimal focusing of the imaging sensor on a region of interest of the component, in a variant the support unit together with all (for example four) light
25 deflection devices (for example prisms or mirrors) is moved by means of a servo drive between the imaging sensor and the component, preferably along the optical axis of the imaging sensor. The two light deflection devices, which are not adjustable (in distance to the component), are optimally focused by the drive of the carrying unit. In another variant, the support unit is also preferably to be moved along the
30 optical axis of the imaging sensor. Then, in the case of a component that is not square in plan view (i.e., for example, rectangular in plan view) and whose four side surfaces and/or an area near the end surface located on the holder are to be inspected with the device, two opposing light deflection devices can be readjusted in each case by a further servo drive arranged on the support unit. The two adjustable
35 light deflection devices (at a distance from the component) are focused by the additional servo drive.

Also disclosed herein is an optical component inspection method for inspecting a component located at a holder, comprising the steps of:

- picking up the component at a discharge location, conveying it along a conveying path to a deposit location, and depositing it at the deposit location;
- emit light from a light source that is incident on a first of the faces of the component at a first acute angle to the optical axis of an imaging sensor;
- 5 - orient the light source such that, when a component is inspected as being OK with respect to unevenness on a side surface of the component and/or delamination of at least one layer in the region of a second of the end faces, the light emerges from the first of the end faces of the component at a second acute angle to the optical axis of the imaging sensor such that the magnitude of the second acute angle differs at
- 10 most slightly from that of the first acute angle;
- using the imaging sensor to optically inspect at least one of the side surfaces of the component conveyed by the holder and/or at least one region in the interior of the component close to a second of the end surfaces and close to respective ones of the side surfaces;
- 15 - using the imaging sensor to detect the light emerging from the first of the end surfaces of the component and to signal a distribution of the intensity of the emerging light to an evaluation device;
- using the evaluation device, depending on the signaled distribution of the intensity of the emerging light, to detect, at least in sections, unevenness on a side surface of
- 20 the component and/or, at least in sections, detachment of at least one layer in the region of a second of the end surfaces.

In a variant of the method, the holder guides the component from the delivery point to the deposit point along a path in which the component conveyed by the holder

25 passes an optical device comprising one or more deflecting and/or focusing devices that direct light emerging from the first of the component's end faces toward the imaging sensor.

In a variant of the method, at least one light strip is provided from the light source,

30 the light strip being incident on the first of the faces of the component at the acute angle in an edge region of the component.

In a variant of the method, the acute angle of light directed at the component is determined as a function of the refractive index of the material of the component,

35 the wavelength and/or the height of the component, between about -45° and about $+45^\circ$, between about $+5^\circ$ and about $+45^\circ$, between about $+15^\circ$ and about $+45^\circ$, between about $+25^\circ$ and about $+45^\circ$, or between about $+30^\circ$ and about $+45^\circ$.

In a variant of the method, infrared light is emitted from the light source with a wavelength between about 780 nm and about 1000 nm (or (short wave IR) up to about 1500 nm), and in the case that the component has a silicon-containing substrate material and the temperature of the substrate material is about 300 °K ± about 10 °K, the acute angle (α_1) of the light directed onto the component is determined to be about $33^\circ \pm$ about 3° . This determination can be achieved, for example, by temporary, one-time or component-specific adjustment of the orientation of the light source by means of an adjustment drive or an adjustment setting device.

In a variant of the method, the deviation of the magnitude of the second acute angle from that of the first acute angle, which is at most slight, is no more than about $\pm 5^\circ$.

In a variant of the method, the acute angle of the light directed onto the component is determined such that, for a component inspected as "OK", the light is reflected (i) inside the component at a side surface of the component to be inspected, and (ii) inside the component in the region of an end surface of the component facing the holder, and (iii) as outgoing light at the acute angle to the optical axis of the imaging sensor emerges from the end face of the component facing away from the holder towards the imaging sensor (with at most a slight deviation of the magnitude of the second acute angle from that of the first acute angle by no more than about $\pm 5^\circ$).

In a variant of the method, the holder rotates at a first turning device about a first turning axis, and in doing so picks up the component at the first delivery point, conveys the component to the first deposit point, and deposits the component at the first deposit point; and/or rotates the holder at a second turning device about a second turning axis, and thereby takes over the component at a takeover point from a holder of the first turning device, conveys the component to a second deposit point, and deposits the component at the second deposit point, wherein the first turning axis and the second turning axis are spaced apart from one another, and are offset from one another by an angle of approximately 90° , and wherein at the transfer point the receiving means of the first turning device and the receiving means of the second turning device are aligned with one another in such a way that the component is to be transferred from the first turning device to the second turning device.

In a variant of the method, the holder is guided from the delivery point to the deposit point along a path where the component conveyed by the holder passes an

optical device, and/or one or more light redirecting and/or focusing devices of the optical device direct light emerging from the first of the component's end faces toward the imaging sensor.

5 In a variant of the method, the holder passing through the optical device and the light deflecting and/or focusing devices are varied in their distance from each other such that the component conveyed by the holder is optically detected by the imaging sensor at least in its interior between the first and the second of the end faces of the component along the optical axis of the imaging sensor.

10

In a variant of the method, a support unit equipped with a through-hole located in the support unit carries a plurality of, for example, four light-deflecting devices; the light-deflecting devices are arranged around the through-hole; the support unit is moved or adjusted along the optical axis of the imaging sensor, thereby displacing the entirety of the plurality of light-deflecting devices along the optical axis of the imaging sensor; an adjusting means displaces a selection of the plurality of light deflecting means along the optical axis of the imaging sensor; and/or the support unit carries at least one light source for each of the light deflecting means arranged around the through aperture, wherein the at least one light source is arranged, and preferably adjusted, on the support unit such that light emitted thereby falls, preferably through the through aperture, onto the first of the end faces of the component to be inspected as it passes the optical means.

15

20

25

By at least one light source to each of the light redirecting devices arranged around the through-aperture are meant, for example, LED lines with 1 - 10 (IR) LEDs. However, it is also possible to direct the light from one or a few light sources ((IR) LEDs) by means of light guides to the light deflection devices arranged around the through-aperture, or to shine the light directly onto the component by means of the (IR) light from the light guides. Depending on the spatial conditions, coaxial illumination can also be used instead of the LED array if there is more space available.

30

Thus, the arrangement presented here forms an integrated handling/inspection device. Imaging sensors inspect all or almost all top and/or side surface(s) of a component.

35

The device presented here picks up components from a component supply (wafer disk) arranged, for example, horizontally in the upper area of the device with an

ejector unit that is, for example, stationary. Relative to this ejection unit, the component supply moves in the plane. The ejection unit causes the components to be released individually from the component supply by a needle or without contact (e.g. by a laser beam) and to be picked up by a holder. The ejected components are fed to one or more inspection processes and finally deposited. Bad parts can be rejected in the process. The optical inspection of the component, which is integrated into the transfer process, is divided into several inspection processes. The conveying/transport of the components takes place while the holders of the turning devices hold one component at a time. A held component passes through individual examination processes during transport. The acquired (image) data from the imaging sensors can also be used to coordinate the position control of the manipulators (holders) and the receiving points. The component conveyor is set up to convey a component along its path in a substantially continuous or clocked manner.

The arrangement and procedure presented here functionally combines two aspects: Handling and Inspection. These two functions are temporally and spatially interwoven for the fast and precise qualitative assessment of several / all side surfaces and/or the interior of the components, while these are quickly taken singly from the component supply and precisely deposited at the receiving point(s) classified as good parts by the inspection.

The component handling device has two turning devices, preferably operated in a controlled manner, preferably arranged essentially orthogonally (90° plus minus up to 15°) to each other and approximately star-shaped or wheel-shaped. The turning devices could also have a rectangular shape. Each of these turning devices carries a number of holders which, in some variants, can also be moved radially with respect to their axis of rotation in order to feed the components, each fixed on a holder by negative pressure, within a pivoting angle between component transfer and transfer to one or more process stations for inspection, rejection of bad parts and, if necessary, further stations.

In the device presented here, the star-shaped or wheel-shaped turning devices carry the components on radially outward-facing holders arranged on the (imaginary) circumference of one or both turning devices. This is to be seen in contrast to such devices in which the holders of one or both turning devices are oriented parallel to their axis of rotation.

The (upper/lower) top and/or (lateral) lateral surface(s) of a component detected by the imaging sensors in the individual examination processes can be different top and/or lateral surfaces of the component.

5 One aspect of the optical inspection provides for the component conveyor with a component to complete the conveyor path with essentially no or near standstill. In this case, the imaging sensor captures the desired images during the movement or during the minimal downtime. These images are then evaluated using image processing methods. A variant of this optical acquisition / examination provides that
10 one or more color cameras or black-and-white cameras are provided as imaging sensors.

The imaging sensors may have one or more mirrors, optical prisms, lenses, polarizing filters or the like as light deflecting and/or scattering and/or focusing and/or
15 polarizing devices, etc., for this purpose.

The light sources can be switched on briefly by a control arrangement in each case at the moment when the image with the component is located in the respective detection range of the imaging sensor, so that the component can be exposed with a
20 brief flash of light for detection by the respective imaging sensor. Alternatively, permanent illumination can be used.

In a variant, the device is assigned a dispensing device which is set up to dispense one component at a time from the structured component supply to a holder of the
25 first turning device positioned accordingly by the control system. This can be a component ejector which ejects the component through the wafer carrier film by means of a needle, or a laser pulse generator which specifically reduces the adhesive force of the component on the carrier film and thus detaches the component from the carrier film. In a variant, a position and/or property sensor is assigned to the
30 dispensing device, which is set up to detect the position of the dispensing device relative to the component to be dispensed and/or position data of the component to be dispensed and/or properties of the component to be dispensed and to make them available to the controller for actuating the dispensing device.

35 In the device, in a variant, the holders of the first and/or the second turning device are set up to be extended and retracted in a controlled manner radially with respect to the axis of rotation or the center of rotation of the respective turning device, and/or to be subjected to negative pressure and/or positive pressure in a controlled

manner for receiving and discharging a component to be conveyed, and/or to be immovable about their respective radial axis of movement, or to be rotated about their respective radial axis of movement through a rotation angle in a controlled manner.

5

In a device of this type, in a variant, linear drives assigned to the holders of the first and/or the second turning device are provided for radial extension/retraction at the dispensing point, the transfer point between the first and second turning devices.

10

These linear drives engage in the correspondingly positioned holders from outside the respective turning devices and radially extend and retract the respective holder. In another variant, these linear drives merely extend the respective holders, while a return spring retracts the respective holders. In a further variant, a bidirectional or unidirectional radial drive is assigned to each of the holders.

15

In a variant of the component handling device, valves provide a supply of negative pressure and positive pressure to each of the individual holders individually and according to position in order to realize the functions: (i) suction of the component, (ii) holding of the component, (iii) depositing of the component with or without a controlled blow-off impulse, and/or free blow-off of the component, either freely or

20

under position control.

In a variant of the device, position and property sensors are assigned in each case to the first turning device between the dispensing point and the transfer point, and/ or to the second turning device between the transfer point and the deposit point. These

25

sensors are set up to record position data and/or properties of the conveyed component and/or position data for position control of the manipulators (pick-ups) and the receiving points and to make them available for the control system.

30

In a variant of the component handling device, an integer number of n holders are assigned to the first and/or the second turning device. The number of holders of the first turning device and the number of holders of the second turning device can be the same or different.

35

In a variant of the component handling device, the first, second and/or third axes each include an angle of 90° plus/minus a maximum of 10° or 15° with respect to each other.

The position and property sensors can be imaging sensors with straight-line or bending optical axes.

5 In a variant of the component handling device, the first and/or second turning devices are at least approximately star-shaped or wheel-shaped. The turning devices can be precision-mounted and their positioning along the respective axes or about the respective axes can be effected by means of axially arranged linear or rotationally acting drive, paired with a high-resolution (for example rotational or linear) encoder. The respective holders can be arranged distributed around the outer circumference and have radially outward-facing suction contact points for the components to be conveyed.

15 One advantage of the axially offset arrangement of the turning devices relative to one another by about 90° is that, during the conveying process, the components perform a 90° rotation about the holder axis relative to the respective movement plane of the holder (or turning device axis) when being transferred from one turning device to the next, without the holder itself having to be mounted so that it can be moved in rotation. This change in orientation of the components in turn enables a significantly simplified inspection of the four component cut surfaces (= component side surfaces). For this purpose, a camera system arranged orthogonally to the plane of movement of the fixture (i.e. in the axial direction of the turning device) and preferably at a very short distance from the component cut surfaces (= lateral surfaces of the component) itself is used.

25 The variants presented here are more cost-effective compared to the state of the art and offer higher component throughput, more time for inspections and have fewer moving masses.

Brief description of the figures

30 Further features, characteristics, advantages and possible variants will become clear to a person skilled in the art from the following description, in which reference is made to the accompanying drawings. Here, Figs. schematically show an optical inspection device for a component.

35 Fig. 1 shows a schematic side view of a device for optical inspection of a component which is conveyed by a turning device from a delivery position to a deposit position.

Figs. 2 - 4 show the detailed situation Z circled in Fig. 1 for penetration of the component by light and the light path as well as its variants inside the component rotated 90° counterclockwise.

- 5 Fig. 2a explains the detail situation Y when the light beam enters/exits the first end face S1 and is reflected from the second end face S2 of the component B.

Detailed description of the figures

10 Fig. 1 illustrates an optical component inspection device 100 for inspecting a component B in the form of electronic semiconductor chips located at a holder 12. The component inspection device 100 presented here takes over the components B from a component supply BV, for example a wafer wafer, which is arranged horizontally in the upper region of the component inspection device 100 and is not shown in more detail. Possible input-output material at both positions could be tape
15 or wafer, waffle pack, JEDEC tray, etc., or a mixture, e.g. wafer to tape or vice versa. Wafer to wafer or roll to roll solutions are also possible.

An ejection unit 110 operates here with a needle 112 controlled by a controller or it operates, for example, contactlessly with a laser beam to release the components B
20 individually from the component supply BV so that they are fed to a first turning device 130. This first turning device 130 is in the form of a star or wheel and has, on its periphery, a plurality of holders 132 (eight in the example shown) for the separated components B. Each holder 132 is adapted, when it is closest to the ejection unit 110 at the 0° position of the first turning device 130, to receive the
25 component B from the component supply BV at a delivery point 136, to convey it along a conveying path 140 to a deposition point 138, and to deposit it at the deposition point 138 at the 180° position of the first turning device 130.

The holders 132 are arranged facing radially outward on the (imaginary)
30 circumference of the star-shaped or wheel-shaped first turning device 130 and carry the components B. In the variant shown, the holders 132 are suction pipettes which are controlled with respect to the axis of rotation 134 of the first turning device 130 and can be extended and retracted radially. The traverse control and the vacuum lines are not shown in Fig. 1 for the sake of clarity. Thus, these holders 132 can
35 convey the components B, each fixed to one of the holders 132, within a swivel angle - here between 0° and 180° - between the component discharge point 136 and the component deposit point 138.

The first turning device 130 rotates the component B, controlled by the control system not further illustrated, about its axis of rotation to a first transfer point by a first predetermined angle, here 180° . In the process, the component B is turned about its longitudinal or transverse axis.

5

As illustrated in Fig. 1, the optical component inspection device 100 for optically inspecting the component B is arranged at the first turning device 130 in the inspection position (at 90° of the first turning device 130 in Fig. 1). A first imaging sensor 150 centrally directed to a first end face S1 of the component B remote from the holder 132 is used for inspecting the component B with light from an IR light source 154 and a visible light source 152. Light from the IR light source 154 passes through a Fresnel lens assembly 156 and is deflected 90° by a semi-transparent mirror 158 inclined 45° with respect to the optical axis. The semi-transparent mirror 158 also allows visible light from the light source 152 to pass through in a straight line. Both light beams (IR and visible light) pass through a diffuser 160 and strike another semi-transparent mirror 162 inclined at 45° to the optical axis, through which they are deflected by 90° in the direction of the component B. The light deflected in the direction of component B passes through a third semitransparent mirror 164 inclined at 45° to the optical axis OA and impinges on the first end face S1 of component B along optical axis OA. The light reflected therefrom is detected as an image by the imaging sensor 150 through the further semi-transparent mirror 162 and through the third semi-transparent mirror 164.

10

15

20

25

The holder 132 is guided from the delivery point 136 to the deposit point 138 along a path 140, along which the component conveyed by the holder passes the optical device described above with its light deflection and/or bundling devices. This optical device directs the light emerging from the first end face S1 of the component B towards the first imaging sensor 150.

30

35

The optical component inspection device 100 in Fig. 1 further comprises a plurality of light sources 170 that emit light, in particular IR light, that is incident on the first of the end faces S1 of the component B at a first acute angle α_1 with respect to the optical axis OA of a second imaging sensor 180 when the component B located at the holder 132 is oriented with the first of its end faces S1 at least approximately normal (about $90^\circ \pm$ about 10°) to the optical axis OA of the imaging sensor 180. The imaging sensor 180 can thus be used to optically inspect at least one of the side surfaces S3, S4 of the component B conveyed through the holder 132 and at least one region in the interior of the component B near a second of the end surfaces S2

and near respective ones of the side surfaces S3, S4. At least one of the side surfaces is inspected from the inside for its irregularities in the solution shown here by reflecting the light rays off the inner side of the side surface (see also Fig. 4). Thus, no further imaging sensor is required to inspect external unevenness. All laser groove damage can thus be inspected using the same light beams and imaging sensor. In the variant shown here, the two imaging sensors 150 and 180 are similar or identical in design. Depending on the light used, the spectral sensitivity of the imaging sensors 150 and 180 is matched to the respective light sources.

As illustrated in Fig. 1, there is a support unit 190 arranged radially outside the 90° position of the first turning device 130. This support unit 190 has a substantially L-shaped form, whereby a leg of the L oriented towards the holder 132 is aligned approximately parallel to a component located on the holder 132. In this leg of the L of the support unit 190 oriented toward the holder 132 is a through aperture 194 through which the optical axis OA extends centrally. A plurality of, in this case four, light deflection devices 196 in the form of prisms are arranged at the edge of the through aperture 194. The support unit 190 is to be moved or adjusted along the optical axis OA of the imaging sensor 150 by a drive 192, whereby the entirety of the light deflection devices 196 is to be displaced along the optical axis OA. A further adjustment device 198 is provided for a selection of the plurality, here 2 of the 4, of light redirecting devices 196 to be displaced along the optical axis OA. Thus, in each case, two light deflection devices 196 located opposite each other at the periphery of the through aperture 194 are to be focused together on the desired image plane in/at the component B.

The support unit 190 thus supports both the light deflecting devices 196 and the respective light sources 170. The light coming in each case from one of the light sources 170 falls (through the through aperture 194) at the angle α_1 onto the first end face S1 of the component B, penetrates through the first end face S1 into the component B, is reflected inside the component at the inner side of the corresponding side face S3, S4 .. to the inner side of the second end face S2 and from there back to the first end face S1, provided that (i) the respective side face has a continuously smooth cut surface, and (ii) no layers of the semiconductor structure in the component B peel off at the inner side of the second end face S2, in particular in the edge or edge region to the respective side face. At the first end face S1, the light exits the component B again at the angle α_2 and falls (through the through aperture 194) at the angle α_2 onto the associated one of the light redirecting devices 196. From there, the light reaches the third semi-transparent

mirror 164, which is inclined at 45° to the optical axis and redirects the light onto a fourth light redirecting device (prism) 202, which is inclined at 45° to the optical axis and in turn feeds the light to the imaging sensor 180. Light from both light sources 152 and 154 also passes through the through aperture 194. A portion of the beams from the IR light source 154 are also co-deflected at the prisms 196 and may serve secondarily for laser groove inspection. These light beams also pass through the through aperture 194. In this case, the IR light source 170 (IR ring light) is the primary IR light source for laser groove inspection and is positioned at an angle to further better illuminate and target the laser groove areas for inspection.

In the variant shown here, each of the light sources 170 is to be oriented so that, when a component B is inspected as being "in order" with respect to irregularities on a side surface S3, S4 of the component B and/or detachments of at least one layer in the region of a second of the end faces S2, the light emerges from the first of the end faces S1 of the component B at a second acute angle α_2 to the optical axis of the imaging sensor 180 in such a way that the magnitude of the second acute angle α_2 deviates at most slightly from that of the first acute angle α_1 . In the variant shown in Fig. 1 ff, the two angles α_1 and α_2 are practically identical.

In Fig. 1, the light source 170 on the support unit 190 is located on the side of the through aperture 194 away from the holder 132. Thus, both the light from the light source 170 and the light returning to the imaging sensor 180 pass through the through-hole 194. In a variant not further illustrated, the light source 170 is arranged on the support unit 190 on the side of the through-hole 194 facing the holder 132. In this case, only the light returning to the imaging sensor 180 passes through the through aperture 194.

The detailed situation Z circled in Fig. 1 concerning the penetration of the component B by light and the light path as well as its variants inside the component B are illustrated in Figs. 2 - 4 (rotated 90° counterclockwise). Fig. 2a explains the detailed situation Y when the light beam enters/exits the first end face S1 and is reflected by the second end face S2 of the component B.

Thus, Fig. 2 shows the path through an undamaged component B in which light coming from one of the light sources 170 is (b) depending on the refractive index (n) of the material - in the example silicon Si - of the component B, the temperature and the wavelength of the light deflected by the first end face S1 penetrates into the

component B, (c) is reflected inside the component on the inside of the corresponding side face S3, S4.... is reflected onto the inner side of the second end face S2, (d) is reflected from there back to the first end face S1, (e) depending on the refractive index of the material of the component B, the temperature and the wavelength of the light, deflected, emerges at the angle α_2 from the first end face S1 of the component B to the associated one of the light deflection means 196, and takes the path to the imaging sensor 180, provided that (i) the respective side face has a continuously smooth cut surface, and (ii) no layers of the semiconductor structure in the component B are detached (from each other) at the inner side of the second end face S2 (in particular in the edge or edge region to the respective side face). This results in an emerging light pattern Light Light Light, H H H. It is to be understood that this light pattern, illustrated here merely from four light beams, can also be represented with intervening dark stripes in the case of a component inspected as being in order, depending on the geometric conditions. If the light pattern is interrupted at individual points along the length of the light strip 170v, this indicates a local layer detachment or unevenness.

In this case, the acute angle α_1 of the light directed to the component B is determined between about -45° and about $+45^\circ$, between about $+5^\circ$ and about $+45^\circ$, between about $+15^\circ$ and about $+45^\circ$, between about $+25^\circ$ and about $+45^\circ$, or between about $+30^\circ$ and about $+45^\circ$, depending on the refractive index n of the material of the component B, the wavelength and/or the height of the component. In the variant shown in Figs, the light source 170 is adapted to emit infrared light having a wavelength between about 780 nm and about 1000 nm (for example, 900 nm). Light with SWIR (short wave IR) up to about 1500 nm can also be used. Since components B generally have a silicon-containing substrate material, and the temperature of the substrate material is about $300^\circ\text{K} \pm \text{about } 10^\circ\text{K}$, the acute angle α_1 of the light directed onto the component is determined to be about $33^\circ \pm \text{about } 3^\circ$ in the variant illustrated here.

The imaging sensor 180 detects the light emerging from the first end face S1 of the component B and signals a distribution of the intensity of the emerging light to an evaluation device not further illustrated, a computer unit programmed for image data processing. In particular, depending on the signaled distribution of the intensity of the light emerging from the first end face S1 of the component B, the evaluation device detects unevenness at least in sections on a side face of the component B and/or detachment of at least one layer in sections in the region of a second end face S2.

As illustrated in Fig. 2, the light source 170 provides a light strip 170v that is incident on the first end surface S1 of the component B at the first acute angle α_1 in an edge region of the component B to be inspected.

5

In the present configuration, the light source 170 provides the infrared light with a wavelength of about 900 nm; the component has a silicon-containing substrate material and the temperature of the substrate material is about $300\text{ }^{\circ}\text{K} \pm \text{about } 10\text{ }^{\circ}\text{K}$; in this case, the first acute angle α_1 of the light directed to the component B is about $33^{\circ} \pm \text{about } 3^{\circ}$. SWIR (short wave IR) up to about 1500 nm can also be used.

10

The deviation of the magnitude of the second acute angle α_2 from that of the first acute angle α_1 is no more than about $\pm 5^{\circ}$.

15

Fig. 3 illustrates how a flat or smooth cut surface on the side of the component B, in conjunction with a detachment in the edge region between the side surface and the second end surface S2 of the component B, affects the light pattern detected by the imaging sensor 180. It is evident that the light from the smooth side surface is deflected completely onto the second end surface S2. However, in the region of the layer separation SA in the edge region between the side surface and the second end surface S2 of the component B, the light is not reflected to the first end surface S1. This results in the light pattern Dark Dark Light Light, D D H H.

20

25

Fig. 4 illustrates how an uneven cut surface on the side of the component B in the edge region between the side surface and the second end surface S2 of the component B affects the light pattern detected by the imaging sensor 180. Obviously, the light is completely deflected from the side surface, which is smooth in the upper region, to the second end surface S2, and is reflected from there to the first end surface S1. However, in the edge region between the side surface and the second end surface S2 of the component B, the light is not deflected to the second end surface S2, and consequently is not reflected to the first end surface S1. This results in the light pattern Dark Dark Light Light, D D H H.

30

35

In the variant illustrated in Fig. 1, the holder 132 is part of the first turning device 130, which rotates about the first turning axis 134. The component B is picked up at the first delivery point, conveyed to the first deposit point, and deposited there. In a variant not shown further, the holder 132 is part of a second turning device that

rotates about a second turning axis and picks up the component B at a holder point from a holder of the first turning device 130, conveys it to a second deposit point, and deposits it at the second deposit point. The first turning axis and the second turning axis are spaced apart from each other (in the Z direction) and offset from each other by an angle of approximately 90°. At the transfer point, the holder of the second turning device and the holder of the second turning device are aligned with each other in such a way that the component is to be transferred from the first turning device to the second turning device.

The variants of the device described above, as well as its construction and operating aspects, are merely intended to provide a better understanding of the structure, operation and features; they do not limit the disclosure to the variants, for example. The Figs. are partially schematic, with significant features and effects shown, in some cases significantly enlarged, to illustrate the functions, operating principles, technical variants and features. In this regard, any mode of operation, principle, technical variant and feature disclosed in the Fig. or in the text may be freely and arbitrarily combined with any claims, feature in the text and in the other Fig., other modes of operation, principles, technical variants and features contained in or resulting from the present disclosure, so that all conceivable combinations are attributable to the described approach. Combinations between all individual variants in the text, that is, in each section of the description, in the claims, and also combinations between different variants in the text, in the claims, and in the Figs. are included. Also, the claims do not limit the disclosure and thus the possible combinations of all disclosed features with each other. All disclosed features are also explicitly disclosed herein individually and in combination with all other features.

Claims

1. An optical component inspection device (100) for inspecting a component (B) located at a holder (132), wherein
- 5 - the holder (132) is set up and intended to receive the component (B) at a delivery point (136), to convey it along a conveying path (140) to a deposition point (138), and to deposit it at the deposition point (138);
- 10 - a light source is arranged and intended to emit light which is incident at a first acute angle (α_1) to the optical axis of an imaging sensor on a first of the end faces of the component when the component (B) located at the holder is oriented with the first of its end faces at least approximately normal (about $90^\circ \pm$ about 10°) to the optical axis of the imaging sensor;
- 15 - the imaging sensor is set up and intended to optically inspect at least one of the side surfaces of the component conveyed through the holder (132) and/or at least one region in the interior of the component near a second of the end surfaces and near the respective side surfaces;
- 20 - the imaging sensor (180) is set up and intended to detect the light emerging from the first of the end faces of the component and to signal a distribution of the intensity of the emerging light to an evaluation device (ECU); and
- 25 - the evaluation device (ECU) is set up and intended, as a function of the signaled distribution of the intensity of the emerging light, to detect, at least in sections, unevennesses on a side face (S3, S4....) of the component and/or sectional detachments of at least one layer in the region of a second of the end faces (S2).
2. The optical component inspection device (100) for inspecting a component located on a holder according to claim 1, wherein.
- 30 - the pick-up (132) is guided from the delivery point to the deposit point on a path on which the component (B) conveyed through the pick-up (132) passes an optical device comprising one or more deflecting and/or bundling devices arranged and intended to deflect light emerging from the first end face (S1) of the component towards the imaging sensor (180).
3. The optical component inspection device (100) for inspecting a component located at a holder (132) according to claim 1 or 2, wherein
- 35 - the light source (170) is arranged and intended to supply at least one light strip (170v) which is incident at the first acute angle (α_1) in an edge region of the component onto the first end face (S1) of the component.

4. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 1 - 3, wherein the light source (170) is oriented such that

- the acute angle (α_1) of the light directed onto the component (B) is determined in such a way that, in the case of a component (B) inspected as being in order, light coming from the light source (170) is

(a) falls at the angle (α_1) onto the first end face (S1) of the component,

(b) depending on the refractive index (n) of the material of the component, the temperature and the wavelength of the light deflected by the first end face (S1)

penetrates into the component (B),

(c) is reflected inside the component at the

inner side of the corresponding side surface onto the inner side of the second end surface (S2),

(d) is reflected from the inner side of the second end surface (2) back to the first end surface (S1),

(e) depending on the refractive index (n) of the material of the component, the temperature and the wavelength of the light, is deflected and emerges at the angle (α_2) from the first end face of the component to the associated one of the light deflection means, and takes the path to the imaging sensor (180), provided that

(i) the respective side face has a substantially smooth cut surface throughout, and

(ii) no layers of a semiconductor structure in the component (B) peel off at the inner side of the second end face (S2).

5. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any of claims 1 to 4, wherein

- the first acute angle (α_1) of the light directed onto the component (B) is determined as a function of the refractive index of the material of the component, the wavelength and/or the height of the component between about -45° and about $+45^\circ$, between about $+5^\circ$ and about $+45^\circ$, between about $+15^\circ$ and about $+45^\circ$, between about $+25^\circ$ and about $+45^\circ$, or between about $+30^\circ$ and about $+45^\circ$.

6. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 1 to 5, wherein

- the light source is arranged to emit infrared light with a wavelength between about 780 nm and about 1000 nm (or SWIR (short wave IR) up to about 1500 nm), and in the case that the component (B) comprises a silicon-containing substrate material and the temperature of the substrate material (Si) is about $300^\circ\text{K} \pm \text{about } 10^\circ\text{K}$, the first acute angle (α_1) of the light directed onto the component (B) is about

33° ± about 3°, and/or

- the incident light emerges at the second acute angle (α_2) to the optical axis of the imaging sensor (180) from the first end face of the component facing away from the holder (132) towards the imaging sensor (180) in such a way that the magnitude of the second acute angle (α_2) deviates at most slightly from that of the first acute angle (α_1).

7. The optical component inspection device (100) for inspecting a component located at a holder (132) Claim 6, wherein

- the deviation of the magnitude of the second acute angle from that of the first acute angle, which may be slight, is not more than about $\pm 10^\circ$.

8. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 1 - 7, wherein

- the holder (132) is part of a first turning device which is arranged to rotate about a first turning axis and thereby to pick up the component (B) at the first delivery location, to convey it to the first deposit location, and to deposit it at the first deposit location; and/or

- the holder (132) is part of a second turning device which is set up and intended to rotate about a second turning axis and at the same time to take over the component (B) at a takeover point from a holder (132) of the first turning device, to convey it to a second depositing point, and to deposit it at the second depositing point, wherein the first turning axis and the second turning axis are spaced apart from one another and are offset from one another by an angle of approximately 90° , and wherein at the transfer point the holder (132) of the second turning device and the holder (132) of the first turning device are aligned with one another in such a way that the component (B) is to be transferred from the first turning device to the second turning device.

9. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 2 - 8, wherein

- the pick-up (132) is guided from the delivery point to the deposit point on a path on which the component (B) conveyed by the pick-up (132) passes an optical device, and/or

- the optical device comprises one or more light redirecting and/or focusing means arranged and intended to redirect light emerging from the first of the end faces of the component towards the imaging sensor (180).

10. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 2 - 9, wherein
- the distance between the holder (132) passing through the optical device and the light deflecting and/or focusing devices is to be varied in such a way that the component (B) conveyed by the holder (132) can be optically detected by the imaging sensor at least between the first and the second of the end faces of the component along the optical axis of the imaging sensor.

11. The optical component inspection device (100) for inspecting a component located at a holder (132) according to any one of claims 2 - 10, wherein
- a support unit (190) with a through aperture (194) located in the support unit (190) is provided for supporting a plurality, for example, of four light deflecting devices (196),
- the light deflecting devices (196) are arranged around the through aperture (194),
- the support unit (190) is to be moved or adjusted along the optical axis (OA) of the imaging sensor (180), whereby the entirety of the plurality of light deflection devices (196) is to be displaced along the optical axis (OA) of the imaging sensor (180);
- an adjustment device (198) for a selection of the plurality of light deflection devices (196) is arranged to displace this selection along the optical axis (OA) of the imaging sensor (180); and/or
- the support unit (190) is arranged and intended to support at least one light source (170) for each of the light deflection means (196) arranged around the through aperture (194), the at least one light source (170) being arranged, and preferably adjustable, on the support unit (190) in such a way that light emitted by it falls, preferably through the through aperture (194), onto the first of the end faces (S1) of the component to be inspected as it passes the optical means.

12. An optical component inspection method for inspecting a component located at a holder (132), comprising the steps of:

- picking up the component (B) at a discharge location, conveying it along a conveying path to a deposition location, and depositing it at the deposition location;
- emit light from a light source (170) that is incident on a first of the end faces (S1) of the component at a first acute angle (α_1) with respect to the optical axis of an imaging sensor (180);
- orient the light source (170) such that, in the case of a component (B) inspected as being in order with respect to unevenness on a side surface of the component and/or detachment of at least one layer in the region of a second of the end surfaces (S2), the light emerges from the first of the end surfaces (S1) of the component at a

second acute angle (α_2) to the optical axis of the imaging sensor (180) such that the magnitude of the second acute angle (α_2) deviates at most slightly from that of the first acute angle (α_1);

- using the imaging sensor (180) to optically inspect at least one of the side surfaces of the component conveyed through the holder (132) and/or at least one region in the interior of the component near a second of the end surfaces and near respective ones of the side surfaces;

- using the imaging sensor (180) to detect the light emerging from the first end face (S1) of the component and to signal a distribution of the intensity of the emerging light to an evaluation device (ECU);

- using the evaluation device (CU), as a function of the signaled distribution of the intensity of the emerging light, to detect, at least in sections, unevenness on a side face of the component and/or, at least in sections, detachments from at least one layer of a semiconductor structure in the component (B) in the region of its second end face (S2).

13. The optical component inspection method for inspecting a component located on a holder (132) according to claim 12, comprising the step of:

- guide the holder (132) from the delivery point to the deposit point on a path on which the component (B) conveyed through the holder (132) passes an optical device comprising one or more deflecting and/or focusing means which direct light emerging from the first of the end faces of the component towards the imaging sensor (180).

14. The optical component inspection method for inspecting a component located on a holder (132) according to claim 12 or 13, comprising the step of:

- supplying at least one light strip from the light source, the light strip falling at the acute angle (α_1) in an edge region of the component onto the first end face (S1) of the component.

15. The optical component inspection method for inspecting a component located on a holder (132) according to claim 12, 13 or 14, comprising the step of:

- the acute angle (α_1) of the light directed onto the component (B) is determined as a function of the refractive index (n) of the material of the component, the wavelength and/or the height of the component, between about -45° and about $+45^\circ$, between about $+5^\circ$ and about $+45^\circ$, between about $+15^\circ$ and about $+45^\circ$, between about $+25^\circ$ and about $+45^\circ$, or between about $+30^\circ$ and about $+45^\circ$.

16. The optical component inspection method for inspecting a component located on a holder (132) according to claim 15, comprising the step of:

- emit infrared light from the light source having a wavelength between about 780 nm and about 1000 nm or SWIR (short wave IR) to about 1500 nm, and in the case where the component (B) has a silicon-containing substrate material and the temperature of the substrate material is about 300 °K $\pm$ about 10 °K, determine the acute angle (α_1) of the light directed to the component (B) to be about 33° $\pm$ about 3°.

17. The optical component inspection method for inspecting a component located on a holder (132) according to any one of claims 12 to 16, wherein:

- the deviation of the magnitude of the second acute angle (α_2) from that of the first acute angle (α_1), which may be slight, is not more than about $\pm 5^\circ$.

18. The optical component inspection method for inspecting a component located on a holder (132) according to any one of claims 12 to 17, wherein:

- the acute angle (α_1) of the light directed onto the component (B) is determined in such a way that, for a component (B) inspected as being in order, light coming from one of the light sources (170)

(a) falls at the angle (α_1) onto the first end face (S1) of the component,

(b) depending on the refractive index of the material of the component, the temperature and the wavelength of the light deflected by the first end face (S1) penetrates into the component (B),

(c) is reflected inside the component on the inside of the corresponding side face

onto the inside of the second end face, (d) is reflected from the inside of the second end face back to the first end face S1,

(e) depending on the refractive index of the material of the component, the temperature and the wavelength of the light, deflected at the angle α_2 , emerges from the first end face of the component to the associated one of the light deflection

devices, and takes the

path to the imaging sensor (180), provided that

(i) the respective side face has

an at least approximately continuously smooth cut surface, and

(ii) no layers of the semiconductor structure in the component (B) peel off on the inside of the second end face.

19. The optical component inspection method for inspecting a component located on a holder (132) according to any one of claims 12 to 18, wherein:

- the holder (132) rotates about a first turning axis at a first turning device, thereby picking up the component (B) at the first delivery location, conveying it to the first deposit location, and depositing it at the first deposit location; and/or

5 - the receiving means (132) rotates about a second turning axis at a second turning device and in so doing receives the component (B) at a transfer point from a receiving means (132) of the first turning device, conveys it to a second depositing point, and deposits it at the second depositing point, the first turning axis and the second turning axis being spaced apart from one another, and are offset from one another by an angle of approximately 90° , and wherein at the transfer point the
10 holder (132) of the first turning device and the holder of the second turning device are aligned with one another in such a way that the component (B) is to be transferred from the first turning device to the second turning device.

20. The optical component inspection method for inspecting a component located on
15 a holder (132) according to any one of claims 12 to 19, wherein:

- the pick-up (132) is guided from the delivery point to the deposit point along a path on which the component (B) conveyed by the pick-up (132) passes an optical device, and/or

20 - one or more light redirecting and/or focusing means of the optical device direct light emerging from the first of the end faces of the component towards the imaging sensor (180).

21. The optical component inspection method for inspecting a component located on
25 a holder (132) according to any one of claims 12 to 20, wherein:

25 - the receiving means (132) passing through the optical means and the light deflecting and/or focusing means are varied in their distance from one another in such a way that the component (B) conveyed by the receiving means (132) is optically detected by the imaging sensor (180) at least in its interior between the first and the second of the end faces of the component along the optical axis of the
30 imaging sensor (180).

22. The optical component inspection method for inspecting a component located on
a holder (132) according to any one of claims 12 to 21, wherein:

35 - a support unit (190), with a through aperture (194) located in the support unit, supports a plurality of, for example, four light deflection devices,

- the light deflection devices are arranged around the through aperture,

- the support unit (190) is moved or adjusted along the optical axis of the imaging

sensor, whereby the entirety of the plurality of light deflection devices is displaced along the optical axis of the imaging sensor (180);

- an adjusting device (198) displaces a selection of the plurality of light deflecting devices along the optical axis of the imaging sensor;

5 and/or- the support unit (190) carries at least one light source (170) for each of the light redirecting means arranged around the through aperture (194), the at least one light source (170) being arranged, and preferably adjusted, on the support unit in such a way that light emitted by it, preferably through the through aperture, falls
10 onto the first end face (S1) of the component to be inspected as it passes the optical means.