

Optical examination device and optical examination method

Description

5 Background

An optical examination device for a component and an optical examination method for a component are described here. The examination device has a first and a second examination region.

10 Here, a component is, for example, an (electronic) semiconductor component, also referred to as a "chip" or "die". Such a component has a substantially polygonal, for example quadrangular (rectangular or square) cross-section, with a plurality of circumferential surfaces and a front surface and a covering surface. The circumferential surfaces and the two (lower and upper) covering surfaces of the
15 component are referred to below generally as lateral surfaces. The component may also have a number of circumferential surfaces differing from four.

In so-called pick and place devices, the components are picked up by a secure holder and subsequently set down on a carrier or in a transport container or the like. Before
20 the component is set down, an inspection of the component usually takes place. For this purpose, images of one or more lateral surfaces of a component are picked up using a camera, in order to generate an image of lateral surfaces of the component for inspection purposes.

25 Such secure holders securely hold a component during the transportation and during the acquisition of an image of a, for example the lower, covering surface of the component. Thus, DE 10 2008 018 586 A1 shows an optical acquisition device for the acquisition of a surface of a component which is transported from a first to a second workstation, a camera directed at at least one first surface of the component, a light
30 source, which emits short-wave light beams to the first surface. A second light source emits long-wave light beams to at least one second surface of the component. The camera receives the first and second light beams reflected at the surfaces. The second surface(s) are oriented differently to the first surface(s), as is the case for example in parallelepipedal components with a lower side and a total of
35 four lateral surfaces.

Further technological background can be gathered from the documents
WO 1995 021 376 A1, DE 199 34 619 A1, US 6 094 263 A, US 6 862 365 B1 and
US 2008 0 253 643 A1.

5 Object

An optical examination device for a component should be able to quickly acquire
differently oriented lateral surfaces of a component, and be simply adaptable to
different requirements.

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Solution

This object is achieved by an optical examination device for a component, which
device has a first and a second examination region. The device has an imaging
15 device for optically acquiring lateral surfaces of a component. This imaging device is
designed to acquire an image of one of the lateral surfaces of a component in the
first examination region and to acquire an image of a plurality of the lateral surfaces
of a component in the second examination region. This examination device has a
component conveyor. The component conveyor has a holding device for a
20 component. The conveyor is designed to convey a held component along a
component path. The component path can lead to the first examination region, from
the first examination region to the second examination region, and away from the
second examination region. The imaging device has an image acquisition device,
which is designed to be directed at a lateral surface of a component at the first
25 examination region, and an image coupling-in device, which is designed to couple an
image of a plurality of the lateral surfaces of a component from the second
examination region into the image acquisition device. The component conveyor is
designed to substantially continuously or intermittently convey a component along
the component path.

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While a first and a second examination region are defined above, this is not intended
to fix a chronological sequence or an order (first an image acquisition in the first and
then an image acquisition in the second examination region). Rather, cases in which
the reverse order is more favourable are also conceivable.

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The lateral surface(s) of a component which are acquired in the first examination
region may differ from the plurality of the lateral surfaces of the component which

are acquired in the second examination region. The first examination region and the second examination region may be spaced from one another along the component path by at least half of the side lengths of the component to be examined.

Alternatively or additionally, the two examination regions may also be spaced from one another approximately by at least the dimension of the place of contact between component conveyor and component to be examined.

One aspect of this optical examination device provides that the component conveyor with a component completes the component path from the first examination region to the second examination region substantially without stopping. In so doing, during the movement first in the first examination region one or more lateral surfaces of a component are acquired and then in the second examination region a plurality of the lateral surfaces of the component are optically acquired by the imaging device and subsequently evaluated by image processing methods.

A variant of this optical examination device provides that the image acquisition device has one or more cameras in order to acquire an image of a component at the first examination region separately from an image of a component at the second examination region. One camera is to be preferred over a plurality of cameras (for example two) only when spatially confined conditions exist and/or costs are important.

In a variant of the optical examination device, the image acquisition device may also be designed to be directed along a first light path at a lateral surface of a component at the first examination region. The image coupling-in device may be designed to couple an image of a plurality of the lateral surfaces of a component from the second examination region into the first light path, directed towards the image acquisition device. This variant allows the images of both examination regions to be acquired using one camera.

In a variant of the optical examination device, the image acquisition device may also have a first image deflection device, which is designed to deflect an image of a plurality of the lateral surfaces of a component to the image coupling-in device.

In a variant of this optical examination device, the first image deflection device is movable together with the component conveyor along the component path. The component conveyor has a holding device in order to pick up a component and hold

it as it is being conveyed along the component path. The first image deflection device may be movable to and fro between two positions with respect to the holding device. In a first position, the first image deflection device is distant from the region of the holding device. In a second position, the first image deflection device is in the region of the holding device in order to enable the acquisition of an image of lateral surfaces of a component. Since the first image deflection device is movable away from the holding device, the picking-up and/or the setting-down of a component is not impeded by the first image deflection device.

The image acquisition device may have in the second examination region a second image deflection device, which is stationary relative to the component conveyor.

Both the first and the second image deflection device may in this case have one or more mirrors, optical prisms, lenses or the like.

The image acquisition device may have in the second examination region an image focusing device which focuses an image of a plurality of the lateral surfaces of a component from the second examination region onto the camera(s) or the image coupling-in device. The image focusing device may be one or more mirrors, optical prisms, lenses or the like.

The optical examination device may be equipped with first and second light source arrangements at both examination regions. In this case, the first light source arrangement may be designed to emit light with a first wavelength range for illuminating at least one section of the component. The second light source arrangement may be designed to emit light with a second wavelength range for illuminating at least one section of the component.

The wavelength range of the light of the second light source arrangement may at least partially differ from the wavelength range of the light of the first light source arrangement. The wavelength range of the light of the second light source arrangement may, however, also correspond to the wavelength range of the light of the first light source arrangement. Thus, the light of the first light source arrangement may be red, and the light of the second light source arrangement may be blue. The reverse assignment or another wavelength pairing (for example infrared and visible light) may, however, also be chosen.

A variant of this optical examination device provides that the two light source arrangements are each switched on briefly by a control arrangement at the moment when the component conveyor with the component is situated in the respective first or second examination region, so that the lateral surfaces of a component can be illuminated with a short flash of light.

The component conveyor can be designed to convey a component at a speed of about 0.1 m/s to about 5 m/s along the component path, the component conveyor remaining no longer than 5 ms at one place. Preferably, the component conveyor with a component does not stop along the component path, but moves continually. In a preferred variant, the component conveyor is constantly moving. It may be expedient, only in particular cases, for the component conveyor to stop at one place in order, for example, to take two pictures of the same sides having 2 different illumination properties. In this case, the residence time may also be longer than 5 ms.

A method for optically examining a component in a first and in a second examination region has the following steps: picking up a component using a holding device of a component conveyor; conveying a component held in the holding device along a component path to the first examination region; optically acquiring an image of at least one of the lateral surfaces of a component using an imaging device in the first examination region; conveying a component held in the holding device along the component path from the first examination region to the second examination region; optically acquiring an image of a plurality of the lateral surfaces of a component using an imaging device in the second examination region; conveying a component held in the holding device along the component path away from the first examination region from the second examination region; and the component conveyor substantially continuously conveying a component along the component path.

In this method, an image acquisition device of the imaging device may be directed at a lateral surface of a component at the first examination region, and the image of a plurality of the lateral surfaces of a component may be coupled from the second examination region by an image coupling-in device into the image acquisition device.

The image acquisition device may acquire an image of a component at the first examination region separately from an image of a component at the second examination region using one or more cameras.

The image acquisition device may be directed along a first light path at a lateral surface of a component at the first examination region, and the image coupling-in device may couple an image of a plurality of the lateral surfaces of a component from the second examination region into the first light path, directed towards the image acquisition device.

An image of a plurality of the lateral surfaces of a component may be deflected to the image coupling-in device using a first image deflection device.

The first image deflection device may be moved together with the component conveyor along the component path.

An image focusing device of the image acquisition device in the second examination region may focus an image of a plurality of the lateral surfaces of a component from the second examination region onto one of the cameras or the camera or the image coupling-in device.

Light with a first wavelength range may be emitted for illuminating at least one section of the component in the first examination region and light with a second wavelength range may be emitted for illuminating at least one section of the component in the second examination region. In this case, the wavelength range of the light of the second light source arrangement may at least partially differ from the wavelength range of the light of the first light source arrangement, or the wavelength range of the light of the second light source arrangement may correspond to the wavelength range of the light of the first light source arrangement.

The light source arrangement could lie between the camera and the image coupling-in device, i.e. for example the mirror. It is also possible for the light source arrangement to be directed directly at the regions of the component which are to be imaged.

The two light source arrangements may each be switched on briefly by a control arrangement at the moment when the component conveyor with the component is moving along the movement path and in so doing is situated in the respective first or second examination region, so that the lateral surfaces of a component can be illuminated with a short flash of light.

The component conveyor in this case may convey a component at a speed of about 0.1 m/s to about 5 m/s along the component path, the component conveyor remaining no longer than 5 ms at one place. Although it is desired not to stop the component conveyor at all along the component path, it may in isolated cases lead to improved image quality. In such a case, it may be advisable or expedient to stop the component conveyor along the component path and acquire the images of the component.

Brief description of the figures

Further features, characteristics, advantages and possible modifications will become clear to a person skilled in the art from the following description, in which reference is made to the appended drawings. In the drawings, the Figs. show schematically an optical examination device for a component, the examination device having a first and a second examination region.

Fig. 1 shows schematically a method step, with which a component is picked up from a substrate in a region preceding the first examination region;

Fig. 2 shows schematically a method step, in which an image of at least one of the lateral surfaces of the component held in the holding device is optically acquired by an imaging device in the first examination region;

Fig. 2a shows a real image of a component, as acquired in the first examination region;

Fig. 3 shows schematically a method step, in which an image of a plurality of the lateral surfaces of the component held in the holding device is optically acquired by an imaging device in the second examination region;

Fig. 3a shows a real image of a component, as acquired in the second examination region;

Fig. 3b shows a schematic plan view of the mirrors, with which an image of a plurality of the lateral surfaces is optically acquired by an imaging device in the second examination region; and

5 Fig. 4 shows schematically a method step, in which the component held in the holding device is set down.

Detailed description of the figures

10 Fig. 1 illustrates an optical examination device 10 for a component 12. This optical examination device 10 has a component conveyor 14, which has a holding device 16 for the component 12. In the variant illustrated here, the holding device 16 for the component 12 is a suction pipette controlled by a control device ECU. The component conveyor 14 is designed to pick up a component 12 from a substrate 18
15 using the suction pipette at a picking-up position POS A, to convey it along a component path 20 into a first examination region POS B, from the first examination region POS B to a second examination region POS C, and away from the second examination region POS C into a setting-down region POS D.

20 In order to bring the component 12 for optical examination into the first and second examination region, it is first picked up by the holding device 16 of the component conveyor 14 and brought along the component path 20 to the first examination region POS B.

25 Fig. 2 illustrates how the component 12 is optically acquired by an imaging device 22 in the first examination region POS B as it is being conveyed along the component path 20. To be more precise, an image of one of the lateral surfaces - here the lower covering surface 12a - of the component 12 is acquired in the first examination region POS B. The imaging device 22 has an image acquisition device 24 with a
30 camera, in order to acquire an image of the component 12 at the first examination region POS B separately from an image of the component 12 at the second examination region POS C. The image acquisition device 24 is directed at the one lateral surface 12a, i.e. the lower covering surface, of the component 12 along a first light path 26 at the first examination region POS B.

35 The imaging device 22 has an image coupling-in device 28, which is configured here in the form of a dichroic mirror. The image coupling-in device 28 is designed to

couple an image of a plurality of the lateral surfaces - here the lateral surfaces 12b, 12c, 12d, 12e of the component 12 - into the first light path 26, directed towards the image acquisition device 24, from the second examination region POS C. For this purpose, the dichroic mirror is inclined obliquely (here at an angle of about 45°)
5 relative to the first light path 26.

The dichroic mirror reflects only part of the light spectrum and transmits the rest of the light spectrum. In doing so, it separates the incident light according to the wavelength. The mirror to be used here may be dichroic; but other variants are also
10 possible. What is crucial is that the image coupling-in device 28 transmits only part of the light and reflects part of it. A dichroic mirror optimises the luminous efficiency by a factor of about 2, which simplifies the image acquisition by the camera.

The component 12, passing through the first examination region POS B along a component path 20, is illuminated by a first light source arrangement 30 in the first examination region POS B. The first light source arrangement 30 irradiates the component 12 with a light spectrum which the dichroic mirror transmits along the first light path 26 to the image acquisition device 24. Thus, the image acquisition device 24 can pick up the image of the component 12, as illustrated schematically in
15 Fig. 2. Fig. 2a shows a real image of the lateral surface - the lower covering surface 12a - of the component 12, as acquired in the first examination region POS B.

In order to bring the component 12 for optical examination from the first to the second examination region POS C, it is brought by the holding device 16 of the component conveyor 14 along the component path 20 to the second examination region POS C.
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Fig. 3 illustrates how the component 12 is optically acquired by the imaging device 22 in the second examination region POS B as it is being conveyed along the component path 20. To be more precise, an image of one of the lateral surfaces 12b, 12c, 12d, 12e of the component 12 is acquired in the second examination region POS C.
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In the second examination region POS C, the image of the component 12 at the second examination region POS C is acquired separately from the image of the component 12 at the first examination region POS B.
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For this purpose, the image acquisition device of the optical examination device has a first image deflection device 32, which is movable together with the component conveyor 14 along the component path 20. The first image deflection device 32 is formed here by four mirrors 32a, 32b, 32c, 32d which are arranged in a manner surrounding the holding device 16 of the component conveyor 14 along the periphery of the holding device 16. For this purpose, the four mirrors 32a, 32b, 32c, 32d of the first image deflection device 32 are inclined obliquely (here at an angle of about 45°) to the lateral surfaces 12b, 12c, 12d, 12e of the component 12 (see also Fig. 3b). The first image deflection device 32 is displaceable relative to the holding device 16 of the component conveyor 14 between a first (in the Figs. upper) position and a second (in the Figs. lower) position. For this purpose, the first image deflection device 32 is connected to the component conveyor 14 via two linear actuators 34a, 34b in the longitudinal direction. In the first - retracted - position, the first image deflection device 32 is displaced away from the holding device 16 of the component conveyor 14 to such an extent that in the picking-up position POS A a component 12 can be picked up from a substrate 18 unimpeded. In the second - advanced - position, the first image deflection device 32 is displaced relative to the holding device 16 of the component conveyor 14 to such an extent that the (circumferential) lateral surfaces 12b, 12c, 12d, 12e of the component 12 held by the holding device 16 are surrounded by the first image deflection device 32.

In the second examination region POS C, there are arranged second light source arrangements 38 which illuminate the (circumferential) lateral surfaces 12b, 12c, 12d, 12e of the component 12 held by the holding device 16 with a light spectrum which the dichroic mirror reflects. In the second examination region Pos C there is situated furthermore a second image deflection device 36, stationary relative to the component conveyor 14, in the form of a mirror. This second image deflection device 36 deflects light, coming from the first image deflection device 32, onto the dichroic mirror of the image coupling-in device 28. The dichroic mirror reflects the light along the first light path 26 towards the image acquisition device 24.

The image acquisition device has an image focusing device in the form of a lens arrangement 40 in the second examination region POS C. The lens arrangement 40 has an actuating drive 42 and focuses the image, coming from the second image deflection device 34, of a plurality of the lateral surfaces of the component 12 from the second examination region POS C onto the dichroic mirror of the image coupling-in device 28 or the downstream image acquisition device 24. Since the second light

source arrangements 38 are oriented such that the (circumferential) lateral surfaces 12b, 12c, 12d, 12e of the component 12 held by the holding device 16 are illuminated, the lower covering surface 12a of the component 12 is practically not acquired in the second examination region POS C. This can also be seen in Fig. 3a, which shows a real image of the the (circumferential) lateral surfaces 12b, 12c, 12d, 12e of the component 12 held by the holding device 16, as acquired in the second examination region POS C.

The two light source arrangements are each switched on briefly by a control arrangement ECU at the moment when the component conveyor with the component 12 is situated in the respective first and second examination region. For this purpose, position sensors (not illustrated further) can be situated at the two examination regions. Alternatively to this, the control arrangement ECU, which is also coupled to the drive of the component conveyor, can evaluate the drive signals of the latter in order to determine when the component conveyor is situated in the suitable positions in the two examination region to illuminate the lateral surfaces of a component with a brief flash of light.

In this arrangement, the first light source arrangement emits a red light, and the second light source arrangement emits a blue light, as the light spectrum. With a

The component conveyor 14 transports the components 12, for example, at a speed of about 1.5 - 2 m/s (for example about 1.75 m/s), without stopping from the POS A (after the picking-up) up to the POS D (before the setting-down). Owing to the compact overall arrangement, the first and second examination regions can lie very close to one another (approx. 20 mm to 50 mm, for example 35 mm between the position of the picking-up of the first image and the position of the picking-up of the second image). Thus, the control arrangement ECU activates the second light source arrangement about 20 ms after the first light source arrangement. The present arrangement thus allows an optimum design of the field of view for the respective image acquisition conditions. For this purpose, in the first examination region the, generally more critical to assess, lower lateral surface of the component can be depicted larger than the (circumferential) lateral surfaces to be acquired in the second examination region. Overall, in the first examination region POS B the image acquisition is optimally adapted to the lower lateral surface of the component, and in the second examination region POS C the image acquisition is optimally adapted to the (circumferential) lateral surfaces of the component. Since the component

conveyor 14 can transport the components 12 along the component path 20 without stopping, while the image acquisition in the two examination regions is taking place, the throughput can be considerably increased compared with conventional arrangements.

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Fig. 4 illustrates how the component 12 at the end of the component path 20 is set down in the setting-down region POS D in a so-called indexer. For this purpose, during the transportation to the setting-down region POS D, the first image deflection device 32 is displaced away from the holding device 16 of the component conveyor 14 to such an extent into the first - retracted - position that a component 12 can be set down in the indexer unhindered by the suction pipette.

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Claims

1. Optical examination device for a component (12), which device has a first and a second examination region (POS B, POS C), having

- an imaging device (22) for optically acquiring lateral surfaces (12a, 12b, 12c, 12d, 12e) of a component (12), the imaging device (22) being designed
 - to acquire an image of one of the lateral surfaces of a component (12) in the first examination region (POS B) and
 - to acquire an image of a plurality of the lateral surfaces of a component (12) in the second examination region (POS C);
- a component conveyor (14), which
 - has a holding device for a component (12), and which
 - is designed to convey a held component (12) along a component path (20);
- the imaging device (22) having
 - an image acquisition device (24), which is designed to be directed at a lateral surface (12a) of a component (12) at the first examination region (POS B), and
 - an image coupling-in device (28), which is designed to couple an image of a plurality of the lateral surfaces (12b, 12c, 12d, 12e) of a component (12) from the second examination region (POS C) into the image acquisition device (24) and
- the component conveyor (14) being designed to substantially continuously convey a component along the component path (20).

2. Optical examination device according to Claim 1, the image acquisition device (24) having one or more cameras in order to acquire an image of a component (12) at the first examination region (POS B) separately from an image of a component (12) at the second examination region (POS C).

3. Optical examination device according to Claim 1 or 2, the image acquisition device (24) being designed to be directed along a first light path (26) at a lateral surface (12a) of a component (12) at the first examination region (POS B), and the image coupling-in device (28) being designed to couple an image of a plurality of the lateral surfaces (12b, 12c, 12d, 12e) of a component (12) from the second examination region (POS C) into the first light path (26), directed towards the image acquisition device (24).

4. Optical examination device according to the preceding claim, the imaging device (22) having a first image deflection device (32), which is designed to deflect an image of a plurality of the lateral surfaces (12b, 12c, 12d, 12e) of a component (12) to the image coupling-in device (28).

5. Optical examination device according to the preceding claim, the first image deflection device (32) being movable together with the component conveyor (14) along the component path (20), the component path (20) preferably extending at least to the first examination region (POS B), from the first examination region (POS B) to the second examination region (POS C) and away from the second examination region (POS C).

6. Optical examination device according to one of the preceding claims, the imaging device (22) having in the second examination region (POS C) a second, stationary image deflection device (36), relative to which the component conveyor (14) is movable.

7. Optical examination device according to one of the preceding claims, the imaging device (22) having in the second examination region (POS C) an image focusing device (38) which focuses an image of a plurality of the lateral surfaces (12b, 12c, 12d, 12e) of a component (12) from the second examination region (POS C) onto the camera(s) (24) or the image coupling-in device (28).

8. Optical examination device according to one of the preceding claims, having first and second light source arrangements (30, 38) at both examination regions (POS B, POS C).

9. Optical examination device according to one of the preceding claims,

- the first light source arrangement (30) being designed to emit light with a first wavelength range for illuminating at least one section of the component (12) and
- the second light source arrangement (38) being designed to emit light with a second wavelength range for illuminating at least one section of the component (12).

10. Optical examination device according to one of the preceding claims, the wavelength range of the light of the second light source arrangement (38) at least partially differing from the wavelength range of the light of the first light source arrangement (30).

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11. Optical examination device according to one of the preceding claims, the wavelength range of the light of the second light source arrangement (38) corresponding to the wavelength range of the light of the first light source arrangement (30).

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12. Optical examination device according to one of the preceding claims, the two light source arrangements each being switched on briefly by a control arrangement (ECU) at the moment when the component conveyor (14) with the component (12) is situated in the respective first or second examination region (POS B, POS C), so that the lateral surfaces of a component can be illuminated with a short flash of light.

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13. Optical examination device according to one of the preceding claims, the component conveyor (14) being designed to convey a component at a speed of about 0.1 m/s to about 5 m/s along the component path (20), the component conveyor (14) remaining no longer than 5 ms at one place.

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14. Method for optically examining a component in a first and in a second examination region, having the steps

- picking up a component using a holding device of a component conveyor;
- conveying a component held in the holding device along a component path to the first examination region;
- optically acquiring an image of at least one of the lateral surfaces of a component using an imaging device in the first examination region;
- conveying a component held in the holding device along the component path from the first examination region to the second examination region;
- optically acquiring an image of a plurality of the lateral surfaces of a component using an imaging device in the second examination region;
- conveying a component held in the holding device along the component path away from the first examination region from the second examination region;

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- the component conveyor substantially continuously conveying a component along the component path.

15. Method according to Claim 14, an image acquisition device of the imaging device
5 being directed at a lateral surface of a component at the first examination region, and the image of a plurality of the lateral surfaces of a component being coupled from the second examination region by an image coupling-in device into the image acquisition device.

10 16. Method according to Claim 14 or 15, the image acquisition device acquiring an image of a component at the first examination region separately from an image of a component at the second examination region using one or more cameras.

15 17. Method according to one of Claims 14 to 16, the image acquisition device being directed along a first light path at a lateral surface of a component at the first examination region, and the image coupling-in device coupling an image of a plurality of the lateral surfaces of a component from the second examination region into the first light path, directed towards the image acquisition device.

20 18. Method according to one of Claims 14 to 17, an image of a plurality of the lateral surfaces of a component being deflected to the image coupling-in device using a first image deflection device.

25 19. Method according to one of Claims 14 to 18, the first image deflection device being moved together with the component conveyor along the component path.

30 20. Method according to one of Claims 14 to 19, an image focusing device of the imaging device or of the image acquisition device in the second examination region focusing an image of a plurality of the lateral surfaces of a component from the second examination region onto one of the cameras or the camera or the image coupling-in device.

35 21. Method according to one of Claims 14 to 20, light with a first wavelength range being emitted for illuminating at least one section of the component in the first examination region and light with a second wavelength range being emitted for illuminating at least one section of the component in the second examination region, and the wavelength range of the light of the second light source arrangement at

least partially differing from the wavelength range of the light of the first light source arrangement, or the wavelength range of the light of the second light source arrangement corresponding to the wavelength range of the light of the first light source arrangement.

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22. Method according to one of Claims 14 to 21, the two light source arrangements each being switched on briefly by a control arrangement at the moment when the component conveyor with the component is situated in the respective first or second examination region, so that the lateral surfaces of a component can be illuminated with a short flash of light.

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23. Method according to one of Claims 14 to 21, the component conveyor conveying a component at a speed of about 0.1 m/s to about 5 m/s along the component path, the component conveyor preferably remaining no longer than 5 ms at one place.

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