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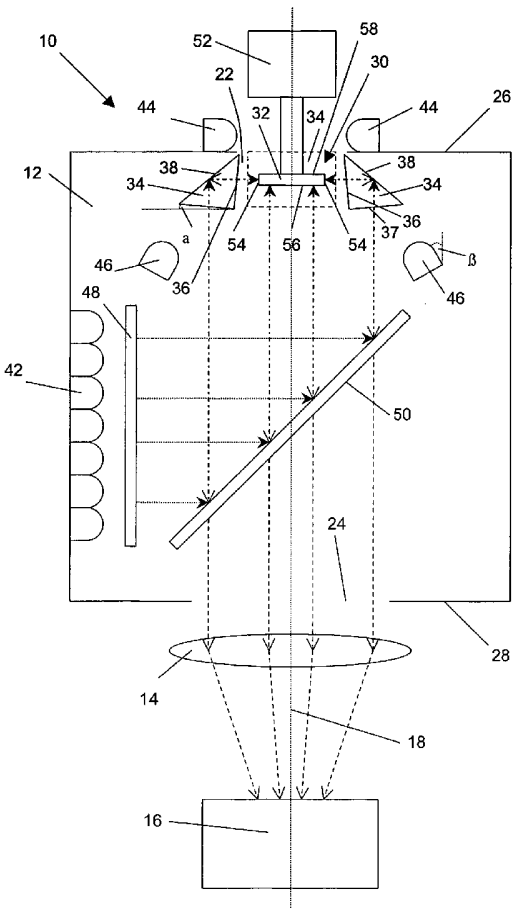

(57) Abstract: A multiple surface viewer (10) provides views of several surfaces of an object. Light is reflected onto a beam splitter (50) which reflects it towards a plurality of reflectors (34) and onto a front surface (56) of an object (32) under inspection. The reflectors (34) reflect the light onto side surfaces (54) of the object (32). The image of the front surface (56) is reflected back to the beam splitter (50), as are images of the side surfaces (54), via the reflectors (34). The various images pass through the beam splitter (50) to a focusing lens (14), which focuses the composite image onto an image capture device (16). The multiple surface viewer (10) captures images of multiple views of an object (32), without needing to rotate or flip the object (32).

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Multiple Surface Viewer

Field of the Invention

The present invention relates to an optical device for viewing multiple surfaces of an object simultaneously.

Background

During the production of semiconductor devices, for instance components such as Quad Flat No-Lead (QFN) units, it is necessary to sample the components and investigate them for quality control. This usually involves inspecting those faces of the components with functional formations on them to ensure they are present, are not broken, do not overlap where not desired etc. Inspection devices exist in the form of viewers which provide magnified images of the relevant surfaces for human inspection.

For many products, for instance QFN units, the object being sampled has a plurality of surfaces that require investigation. QFN units are usually made in large numbers in a single semiconductor substrate. QFN units are singulated from the substrate as parallelpiped blocks of variable unit size. The units have contacts on a front major surface, and on each of the four side surfaces.

Common inspection devices only capture one view at a time. To capture the other views, either the device has to be moved to another viewing location, or the sample has to be flipped, or the viewer has to be moved. Thus the different faces are viewed in series, with viewing time for each face. As such, it is time consuming, thereby potentially causing work inefficiency.

US Patent No. 5,694,250, issued to Charles H. Anderson on 2 December 1997, discusses an optical guide for splitting an image in a horizontal direction and projecting the split image in a vertically staged orientation. Such optical guide is only for capturing images from a surface plane which is in two-dimensions.

SUMMARY

According to one aspect of the present invention there is provided a multiple surface viewing apparatus for providing images of a plurality of surfaces of an object having surfaces in at least different first and second planes. The apparatus comprises: first means for directing light, second means for directing light, third means for directing light, first means for receiving light and an image surface. The first means for directing light directs light at one or more first surfaces of an object, the one or more first surfaces extending in one or more first planes. The second means for directing light redirects light reflected from the one or more first surface of the object, to travel in a first direction. The third means for directing light directs light at a second surface of the object in a second plane, the first and second planes being different. The first means for receiving light receives light reflected from the second surface of the object travelling in a second direction and light reflected from the one or more first surfaces of the object travelling in the first direction. The image surface is in a third plane and receives the received light of the first and second surfaces, to generate an image therefrom.

According to a second aspect of the present invention, there is provided a multiple surface viewer for providing images of a plurality of surfaces of an object having surfaces in at least different first and second planes. The apparatus comprises: a plurality of reflectors, a beam splitter and an image generating device. The plurality of reflectors reflect light at a plurality of first surfaces of an object in a plurality of first planes and reflect light reflected from the first surfaces of the object, to travel in a first direction. The beam splitter reflects light travelling in a third direction at the plurality of reflectors and at a second surface of the object in a second plane, the first and second planes being different, and transmits light reflected from the second surface of the object travelling in a second direction and light reflected from the plurality of first surfaces of the object travelling in the first direction. The image generating device generates an image from light of the first and second surfaces transmitted by the beam splitter, the images being generated in a same third plane.

According to a third aspect of the present invention, there is provided a method of providing images of a plurality of surfaces of an object having surfaces in at least

different first and second planes. The method comprises: directing light at one or more first surfaces, redirecting light, directing light at a second surface, receiving light and generating an image. The one or more first surfaces are first of an object in one or more first planes. Redirecting light redirects light reflected from the first surface of the object, to travel in a first direction. The second surface is a second surface of the object in a second plane, the first and second planes being different. Receiving light receives light reflected from the second surface of the object travelling in a second direction and light reflected from the one or more first surfaces of the object travelling in the first direction. Generating an image generates the image from the received light of the first and second surfaces, the images being generated in a same third plane.

The apparatus of the first two aspects may be operated using the method of the third aspect.

BRIEF DESCRIPTION

Further features of the present invention will readily be apparent from the following detailed description of a non-limitative example, with reference to the accompanying drawings, in which:-

Figure1 is a schematic cross sectional view of a multiple surface viewer according to one embodiment;

Figure 2 is a flow diagram showing a process of capturing an image of multiple views of an object using the multiple viewer of Figure 1;

Figure 3 is a perspective view of a QFN unit for imaging; and

Figure 4 is a schematic image of a QFN unit, as captured by the viewer of Figure 1.

DETAILED DESCRIPTION

Where the same reference numeral appears in more than one of the accompanying drawings, it is used to denote the same element.

By way of non-limiting summary of the main embodiment, as described below, a multiple surface viewer 10 provides views of several surfaces of an object. Light is reflected onto a beam splitter 50 which reflects the light towards a plurality of reflectors 34 and onto a second, front surface 56 of an object 32 under inspection. The reflectors 34 reflect the light onto first, side surfaces 54 of the object 32. The image of the front surface 56 is reflected, straight back to the beam splitter 50 from the front surface 56. The images of the side surfaces 54 are also reflected, back to the beam splitter 50, via the reflectors 34. The various images pass through the beam splitter 50 to a focusing lens 14, which focuses the composite image onto an image capture device 16. The multiple surface viewer 10 captures images of multiple views of an object, without needing to rotate or flip the object.

Figure 1 is a schematic cross sectional view of a multiple surface viewer 10 according to an embodiment of the present invention. The multiple surface viewer 10 includes a view generator housing 12, a focusing lens 14 and an image capturing device, exemplified here by a CCD camera 16.

The view generator housing 12 has first and second apertures 22, 24 in first and second opposing parallel sides 26, 28, respectively. Although no such line, as such, exists in the viewer, a centre line 18 is shown extending through the centres of the first and second apertures 22, 24. The first aperture 22 gives access to a viewing position 30 within the view generator housing 12 for receiving an object 32 for investigation. The second aperture 24 opposes a second means for receiving light, in this embodiment a focusing lens 14, which is arranged a short distance outside the housing 12. The second aperture 24 and the focusing lens 14 are arranged generally parallel to each other, with the focusing lens 14 centred on the second aperture 24 (and on the centre line 18).

Four first and second means for reflecting light are positioned around and centring on the viewing position 30 (and on the centre line 18). The first and second

means for reflecting light are reflectors, in this example in the form of right-angled prisms 34, The purpose of the reflectors is to redirect light to the first, side surfaces 54 of the object 32, in first planes, and to redirect light reflected from the side surfaces of the object 32 in a first direction. Central axes through the right-angled prisms 34 are mounted in the same plane (extending perpendicular to the plane of Figure 1), with each central axis orthogonal to its two nearest neighbours. Each prism is tilted relative to the plane containing the central axes, by an amount α. The prisms are tilted such that for the faces 36 of the prisms facing the object 32, the edges nearest the first aperture 22 are closer to the centre line 18 than the edges further from the first aperture 22. The angle α is about 1.5°. The reason for the tilt is to improve the definition of a particular edge of the object 32, which, otherwise might be unclear. For the arrangement in Figure 1, the prisms are tilted to reflect light slightly in to the viewer, which is towards the second, inward facing surface 56 of the object 32, in a second plane. This leads to greater definition of the edges joining the front surfaces to the side surfaces 54 of the object 32. If it is the rear edges that need greater detail, the prisms are tipped in the other direction. Different prisms may be tilted through different amounts or even in different directions.

The facing outer faces 36 of opposing right-angled prisms 34 are substantially parallel to each other in this embodiment (although out by 2α). The reflecting surfaces 38 of opposing right-angled prisms 34 are almost at right angles to each other (although out by 2α). The two pairs of opposing faces 36 of the opposing right-angled prisms 34 are generally perpendicular to the plane of the focusing lens 14 (although each is out by α) and are centred on the focusing lens 14 (as well as on the second aperture 14). The third, inward facing surfaces 37 of the prisms 34 extend generally parallel to each other, with variations up to α from a common plane, and out by 2α relative to each other for opposing prisms 34.

A light source, in this example in the form of a first series of LEDs 42, extends along one inner wall of the housing 12. A first additional light source, in this example in the form of a first set of additional LEDs 44 is mounted outside the housing 12 around the outside of the first aperture 22, spaced apart by the at least the width of the object 32, in this embodiment about the width of the aperture 22. The LEDs of the first set of additional LEDs 44 are centred on the centre 18 line, extended. A second additional

light source, in this example in the form of a second set of additional LEDs 46 is mounted inside the housing 12, inward of the right-angled prisms 34. The LEDs of the second set of additional LEDs 46 are spaced apart by a distance close to that which extends between the furthest distanced points of each pair of opposing right-angled prisms 34. The LEDs of the second set of additional LEDs 46 are centred on the centre line 18. The LEDs of the second set of additional LEDs 46 are also tilted relative to the centre line 18 by an angle β, which in this embodiment is about 30°. The purpose of this is to improve contrast on the inward facing surface 56 of the object 32

A diffuser 48 extends in front of the first series of LEDs 42, between the first series of LEDs 42 and the middle of the housing 12. A third means for directing light, exemplified here by a beam splitter 50, is mounted in the middle of the housing 12, centred on the centre line 18, and is level with the first series of LEDs 42 and the diffuser 48. The beam splitter 50 is arranged at an angle of 45° to the centre line 18 and to the diffuser 48. The beam splitter 50 is arranged to redirect or reflect beams coming in a third direction, from the diffuser 48, in a fourth direction towards the right-angled prisms 34 and the viewing position 30. The beam splitter also passes or transmits the reflected beams coming from the right-angled prisms 34 and the viewing position 30, without deflection. In a direction orthogonal to the centre line 18, the beam splitter 50 extends a distance that is wider than the gap between opposing right-angled prisms 34. Moreover, in this embodiment this distance, is also wider than the distance between the furthest spaced points of two opposing right-angled prisms 34. In a direction parallel to the centre line 18, the beam splitter 50 extends a distance that is slightly longer than the length of the first series of LEDs 42. In this embodiment this distance is also slightly longer than the length of the diffuser 48. The beam splitter 50 may, for example, be a mirror-type beam splitter.

The image surface is exemplified by the CCD camera 16, arranged on the other side of the focusing lens 14 from the housing 12, and receives the image via the focusing lens 14, in a third plane. The CCD camera 16 is also centred on the centre line 18, extended.

The object 32 being inspected is inserted into and held in place in the viewing

position 30 by a nozzle 52, which nozzle 52 may be robotically controlled. The object 32 is held to be centred on the centre line 18, between the right-angled prisms 34. Where the object 32 is a parallelepiped, it is held with four side faces 54 facing the four right-angled prisms 34, one side face 54 per prism 34. The side faces 54 are held parallel to the inner facing surfaces 36 of their respective right-angled prisms 34. The inward facing surface 56 of the object 32, facing into the housing 12 through the first aperture 22, may be a major surface, for instance the front surface of the object 32, or a minor surface. The inward facing surface 56 is held generally perpendicular to the centre line 18. The final, outward facing surface 58 is the one to which the support arm is attached.

The above described arrangement is intended to allow the viewing of the four side faces 54 and the inward facing surface 56 of an object 32 held or mounted in the viewing position 30, as is described below.

The nozzle 52 holds and inserts the object 32 into the viewing position 30 via the first aperture 22; the first series of LEDs 42 and the first and second sets of additional LEDs 44, 46 are switched on to provide illumination; the CCD camera 16 is also turned on (step S102). Light from the first series of LEDs 42 passes through the diffuser 48 (step S104). The diffuser 48 is used to distribute the light evenly. The light from the first series of LEDs 42 (via the diffuser 18), hits the second, front surface of the beam splitter 50 and is reflected forwards towards the right-angled prisms 34 and the object 32 (step S106). The light emitted from LEDs of the first series of LEDs 42 closest to the first side 26 of the housing 12 (and to the object 32 and to the right-angled prisms 34) passes across the centre line 18 before reaching the beam splitter 50. This light is reflected through 90° by a region near the end of the beam splitter 50, the right hand end, furthest from the first series of LEDs 42 and closest to the first side 26 of the housing 12 (and to the object 32 and to the right-angled prisms 34). The light emitted from LEDs of the first series of LEDs 42 closest to the second side 28 of the housing 12 (and furthest from the object 32 and from the right-angled prisms 34) does not travel as far as the centre line 18 before reaching the beam splitter 50. This light is reflected through 90° by a region near the end of the beam splitter 50, the left hand end, closest to the first series of LEDs 42 and to the second side 28 of the housing 12 (and furthest from the object 32 and from the right-angled prisms 34).

The first and second sets of additional LEDs 44, 46 provide additional light, some of which will appear in the final image produced.

For the two prisms 34 shown in side view in Figure 1, the light entering along a line in the direction of the axis of the prism comes from a line at a constant level across the beam splitter 50. For the other two prisms 34, one of which is shown in front view in Figure 1, the light entering along a line in the direction of the axis of the prism comes from a line rising up along the beam splitter 50 (going diagonally up from left to right in Figure 1).

The light reflected by the beam splitter 50 travels towards the first end of the viewer housing 12. Light reflected by the ends of the beam splitter 50 passes into the two pairs of opposing right-angled prisms 34, where it is reflected through $(90 - 2\alpha)°$ by the reflecting surfaces 38 of the prisms 34 and is directed onto the four first, side faces 54 of the object 32 that face those two pairs of opposing right-angled prisms 34 (step S108). Light reflected by the middle of the beam splitter 50 is directed straight onto the inward facing surface 56 of the object 32 (step S110).

The light which reaches the side faces 54 of the object 32 is reflected directly back to the opposing right-angled prisms 34 that reflected it at the object 32 and is reflected through $(90- 2\alpha)°$ by the reflecting surfaces 38 back towards the beam splitter 50 (step S112). Likewise the light which reaches the inward facing surface 56 of the object 32 is reflected in a second direction (which is the same as the first direction) back towards the beam splitter 50, although this is direct reflection (step S114). The reflected light (image) from the object 32, whether from the side faces 54 of the object 32, via the right-angled prisms 34, or directly from the inward facing surface 56 of the object 32 passes through the beam splitter 50 without deflection (step S116).

The image light which has passed through the beam splitter 50 enters on the focusing lens 14, which focuses the image onto the CCD camera 16 (step S118). The CCD camera 16 captures the image light and generates an image signal to allow the magnified image to be displayed for viewing and allowing inspection (step S120), as

appears in Figure 4.

Figure 3 is a perspective view of a QFN unit 30 for surface imaging by the multiple surface viewer 10. The QFN unit 30 has four side surfaces 54, a inward facing surface 56, and a rear surface (not shown). The inward facing surface 56 has contact portions 152 down two opposing edges. The contact portions extend over to the side surfaces 54 that abut those opposing edges, as side contact portions 154. The other two side surfaces 54 have end contact portions 156, which do not extend onto any other surface.

Figure 4 shows a resulting image 200 captured by the image capturing device, CCD camera 16. The resulting image 200 is a composite image including a central image portion 202, of the inward facing surface 56 of the object 32, surrounded by four side image portions 204, of the four side faces 54 of the object 32. In the image of Figure 4, the object 32 is a QFN. The front contact portions 152 on the inward facing surface 56 extend as side contact portions 154 onto two of the side faces 54 of the object 32 and therefore appear in the central image portion 202 and in two of the four side image portions 204. The other two side image portions 204 contain images of the end contact portions 156.

It is understood that the side images in the side image portions 204 are inverted relative to the original view of the object 32. The edges of the four side faces 54 of the object 32 that are shared with the inward facing surface 56 of the object 32, in Figure 4, are furthest from the image of the inward facing surface 56. This is because of the way the prisms 34 reflect the images of the side faces 54 in the above embodiment. Depending on the application, inverters, such as convex lenses, may be used to invert the images of the side faces 54 as necessary, for instance between the object 32 and the prisms 34 or between the prisms 34 and the beam splitter 50.

The purpose of the right-angles prisms 34 is as reflectors, for guiding or redirecting images of the side surfaces 54 of the object 32 to the image capturing device. Other optical beam-guides, for example an ordinary mirror, which may serve the same or a similar function may be used as a reflector instead.

The above embodiment is intended for projecting images of four side surfaces 54 and a front facing surface 56 of an object 32. Therefore four reflectors are used. However, the invention may be used with other numbers, relative angles and/or arrangements of reflectors if other views are desired. For instance for inspecting an object with only three side surfaces, there might be three reflectors. If the object were equilateral triangular, the three reflectors might be angled at 60° relative to each other. For five side surfaces, there might be five reflectors, for instance angled at 108° relative to each other.

Moreover, the invention may also be used to inspect the outer surface (or surfaces) of an object. An embodiment of such an arrangement might use another two reflectors (or possibly another two sets) outward of the object relative to the beam splitter 50. One of the additional reflectors would reflect the beam towards the centre line (in the same way a reflector in the embodiment of Figure 1 does), and the second additional reflector would reflect that beam onto the back, outer surface of the object. The return path would be the same. Such an arrangement would require a gap to allow the beam to pass out of the housing, for instance a bigger gap between one of the reflectors for a side surface and the object.

The image capturing device in the above embodiment is exemplified by a CCD camera. Other devices that capture images may be used, whether CCD devices, CMOS cameras or otherwise, whether they capture the images electronically or otherwise and black and white or colour. The viewer 10 may even be a projector, such that the composite image of the various faces of an object are projected onto a screen.

In the above embodiment of Figure 1, the main light source 42 is directed at the front of the beam splitter 50 and the reflected image passes straight through the beam splitter 50. In another alternative embodiment, the light is generated from behind the beam splitter 50 and passes straight through it towards the reflectors and object. The returned image is then reflected to the side by the beam splitter 50. In effect, this would reverse the positions of the first series of LEDs 42 with the diffuser 18 with respect to the focusing lens 14 and the image capturing device 16.

In the above embodiment, there are a main light source 42 and additional light sources 44, 46. The additional light sources 44, 46 may be omitted from the above (and other embodiments). Further the light sources in the above embodiment are LEDs. However, other light sources may be used, for instance fluorescent, laser or incandescent light sources. The light colour or colours that are used may depend upon what it is that is being looked for. White light is difficult to balance; it is good for distinguishing colours but not particular features. The main and additional light sources 42, 46 may also be different colours from each other to achieve different effects. For instance the main light source 42 may be blue and the second additional light source 46 may be green, which would bring out the features on the forward surface of the object 32. Another example has the main light source 42 red (as well as the first additional light source 44) and the second light source 46 blue. The features highlighted by the second light source 46 (for instance sloping edges on the inward facing surface 56) would appear brighter in the end image, where the image capturing device is more sensitive to the light of the second light source 46, as a CCD camera is with blue light. Where there are two or more wavelengths of light, the image capturing device is generally colour sensitive. Moreover, embodiments are not limited to visible light. Invisible light, for instance ultra-violet may be used instead where it can show up cracks or other defects in the image, which is then processed to visible light if it is to be inspected by a person.

It is understood by those skilled in the art that even though numerous variations of the preferred embodiment of the present invention have been set forth in the foregoing description, this disclosure is illustrative only. Other modifications may be made, especially in matters of structure, arrangement of parts and/or steps within the principles of the invention to the full extent indicated by the broad general meaning of the appended claims without departing form the scope of the invention.

CLAIMS

1. Multiple surface viewing apparatus for providing images of a plurality of surfaces of an object having surfaces in at least different first and second planes, the apparatus comprising:

first means for directing light (34), for directing light at one or more first surfaces (54) of an object (32), the one or more first surfaces (54) extending in one or more first planes;

second means for directing light (34), for redirecting light, reflected from the one or more first surfaces (54) of the object (32), to travel in a first direction;

third means for directing light (50), for directing light at a second surface (56) of the object (32) in a second plane, the first and second planes being different;

first means for receiving light (50) reflected from the second surface (56) of the object (32), travelling in a second direction, and light reflected from the one or more first surfaces (54) of the object (32), travelling in the first direction; and

an image surface (16), in a third plane, for receiving the received light of the first and second surfaces, to generate an image therefrom.

2. Apparatus according to claim 1, wherein the first and second directions are the same.

3. Apparatus according to claim 1 or 2, wherein at least one of the first and second means for directing light comprise reflector means (34).

4. Apparatus according to any one of the preceding claims, wherein the first and second means for directing light (34) are the same.

5. Apparatus according to any one of the preceding claims, wherein the first means for directing light (34) further comprises the second means for directing light (34).

6. Apparatus according to claim 5, wherein the first means for directing light comprises one or more reflecting prisms (34).

7. Apparatus according to claim 6, wherein the one or more reflecting prisms (34) are right-angled prisms.

8. Apparatus according to any one of the preceding claims, wherein the first means for directing light (34) comprise one or more reflecting surfaces (38) arranged at an angle of around 45° to the first direction.

9. Apparatus according to claim 8, wherein the one or more reflecting surfaces (38) are arranged at an angle of around 43.5° to 46.5° to the first direction.

10. Apparatus according to any one of the preceding claims, wherein the first means for directing light (34) comprise a plurality of third surfaces (37) which are substantially parallel to each other.

11. Apparatus according to claim 10, wherein the third surfaces (37) are angled at no more than 3° to each other.

12. Apparatus according to claim 10 or 11, wherein the first direction is not contained within the third surfaces (37).

13. Apparatus according to any one of claims 10 to 12, wherein the light reflected by the one or more first surfaces (54) of the object (32) passes through the third surfaces (37).

14. Apparatus according to any one of the preceding claims, wherein the third plane is flat.

15. Apparatus according to any one of the preceding claims, further comprising fourth means for directing light (50), for directing light to the first means for directing light (34), for directing the light at the one or more first surfaces (54) of the object (32).

16. Apparatus according to claim 15, wherein at least one of the third means for directing light and the fourth means for directing light comprise reflector means (50).

17. Apparatus according to claim 15 or 16, wherein the third and fourth means for directing light (50) are the same.

18. Apparatus according to any one of claims 15 to 17, wherein the third means for directing light (50) further comprises the fourth means for directing light (50).

19. Apparatus according to any one of the preceding claims, wherein the third means for directing light comprise a beam splitter (50).

20. Apparatus according to claim 19, wherein the beam splitter (50) further comprises the first means for receiving light.

21. Apparatus according to claim 20, wherein the beam splitter (50) is arranged to pass light travelling in the first direction.

22. Apparatus according to claim 20 or 21, wherein the beam splitter (50) is arranged to reflect light travelling in a third direction.

23. Apparatus according to claim 22, wherein the beam splitter (50) is arranged to reflect light travelling in a third direction in a fourth direction opposite to the first direction.

24. Apparatus according to any one of the preceding claims, further comprising means for generating light (42, 44, 46).

25. Apparatus according to claim 24, when dependent on any one of claims 18 to 23, wherein the means for generating light (42) is operable to direct light to the beam splitter (50) in a third direction.

26. Apparatus according to claim 22, 23 or 25, or according to claim 24 when dependent on claim 22, wherein the first and third directions are orthogonal to each other.

27. Apparatus according to any one of claims 24 to 26, wherein the means for generating light is operable to produce light of different wavelengths at different positions within the apparatus.

28. Apparatus according to any one of the preceding claims, further comprising a second means for receiving light (14), for receiving light from the first means for receiving light (50) and directing the light received from the first means for receiving light (50) to the image surface (16).

29. Apparatus according to claim 28, wherein the second means for receiving light comprises a focusing lens.

30. Apparatus according to any one of the preceding claims, wherein the image surface comprises a CCD or CMOS imaging device (16).

31. Apparatus according to any one of the preceding claims, wherein the image surface (16) comprise a camera.

32. Apparatus according to any one of the preceding claims, wherein the image surface (16) is arranged to generate the image as a composite image, including images of the first and second surfaces (54, 56) of the object (32) simultaneously.

33. Apparatus according to any one of the preceding claims, operable and arranged, if the object is a parallelepiped object (32), to generate an image of four side surfaces (54) and a connecting front surface (56) of the object (32).

34. Apparatus according to any one of the preceding claims, wherein the object (32) is a semiconductor device or component.

35. A multiple surface viewer for providing images of a plurality of surfaces of an object having surfaces in at least different first and second planes, the apparatus

comprising:

a plurality of reflectors (34) for reflecting light at a plurality of first surfaces (54) of an object (32) in a plurality of first planes and for reflecting light reflected from the plurality of first surfaces (54) of the object (32), to travel in a first direction;

a beam splitter (50) for reflecting light travelling in a second direction at the plurality of reflectors (34) and at a second surface (56) of the object (32) in a second plane, the first and second planes being different, and for transmitting light reflected from the second surface (56) of the object (32), travelling in a second direction, and redirected light reflected from the plurality of first surfaces (54) of the object (32), travelling in the first direction; and

an image generating device for generating an image from light of the first and second surfaces (54, 56) transmitted by the beam splitter (50), the images being generated in a same third plane.

36. A viewer according to claim 35, comprising apparatus according to any one of claims 1to 34.

37. A method of providing images of a plurality of surfaces of an object (32) having surfaces (54, 56) in at least different first and second planes, the method comprising:

directing light at one or more first surfaces (54) of an object (56) in one or more first planes;

redirecting light reflected from the one or more first surfaces (54) of the object (32), to travel in a first direction;

directing light at a second surface (56) of the object (32)in a second plane, the first and second planes being different;

receiving light reflected from the second surface (56) of the object (32), travelling in the first direction and light reflected from the one or more first surfaces (54) of the object (32), travelling in a second direction; and

generating an image from the received light of the first and second surfaces (54, 56), the images being generated in a same third plane.

38. A method according to claim 37, wherein the one or more first surfaces (54) comprise a plurality of first surfaces (54), at least two of which are orthogonal or parallel

to each other.

39. A method according to claim 37 or 38, wherein the one or more first surfaces (54) comprise four first surfaces (54) arranged in a rectangle.

40. A method according to any one of claims 37 to 39, wherein the one or more first surfaces (54) are orthogonal to the second surface (56).

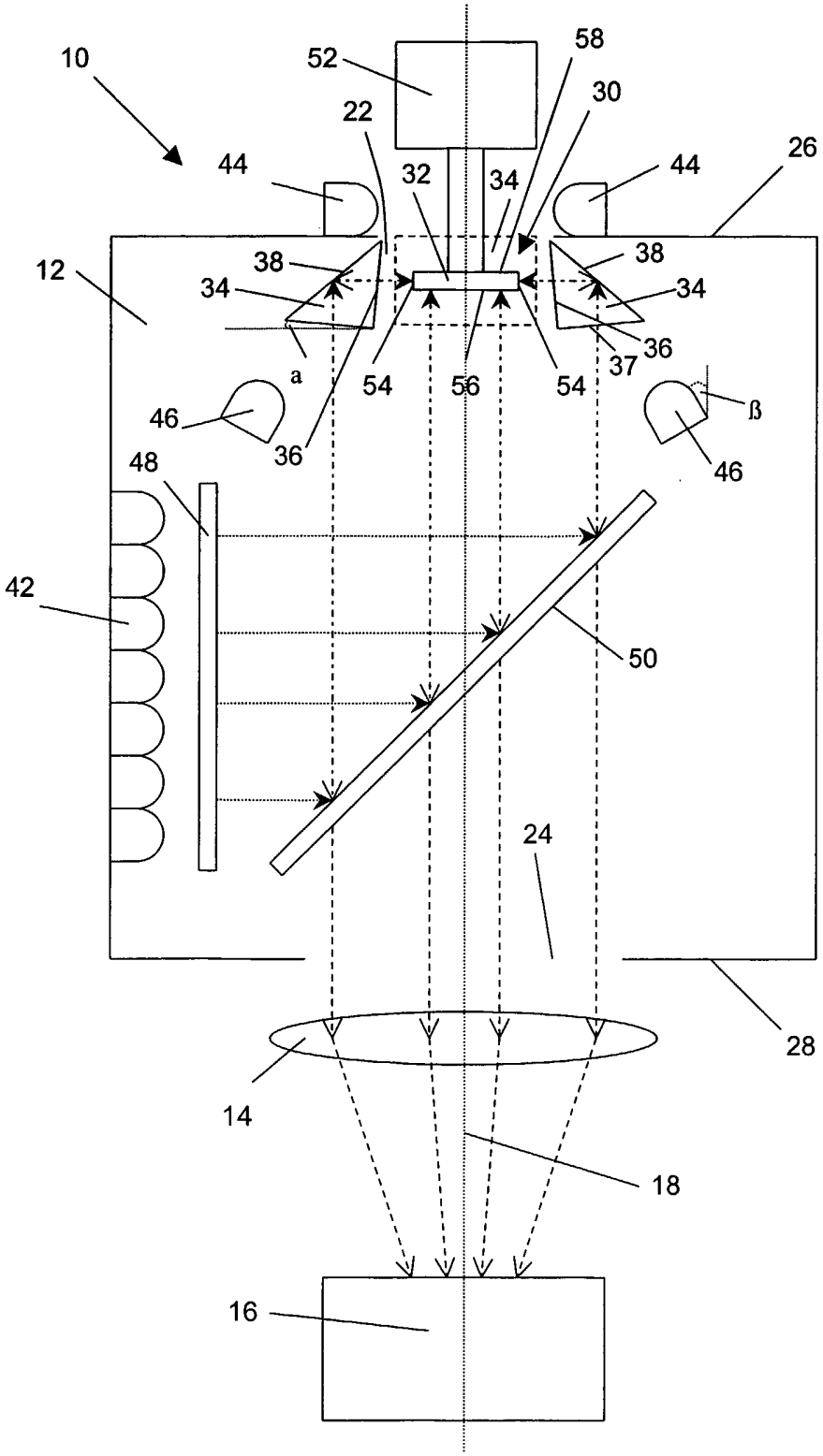
41. A method according to any one of claims 37 to 40, wherein the first direction is parallel to the one or more first surfaces (54).

42. A method according to any one of claims 37 to 41, wherein the third plane is parallel to one of the planes of the one or more first planes and second plane.

43. Apparatus according to any one of claims 1 to 34, operable in accordance with the method of any one of claims 37 to 42.

44. Multiple surface viewing apparatus constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

45. A method of providing images of a plurality of surfaces of an object substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.


10
52
58
30
22
44
32
34
44
26
12
38
38
34
34
36
37
a
54
56
54
ß
46
36
46
48
42
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28
14
18
16

Figure 1

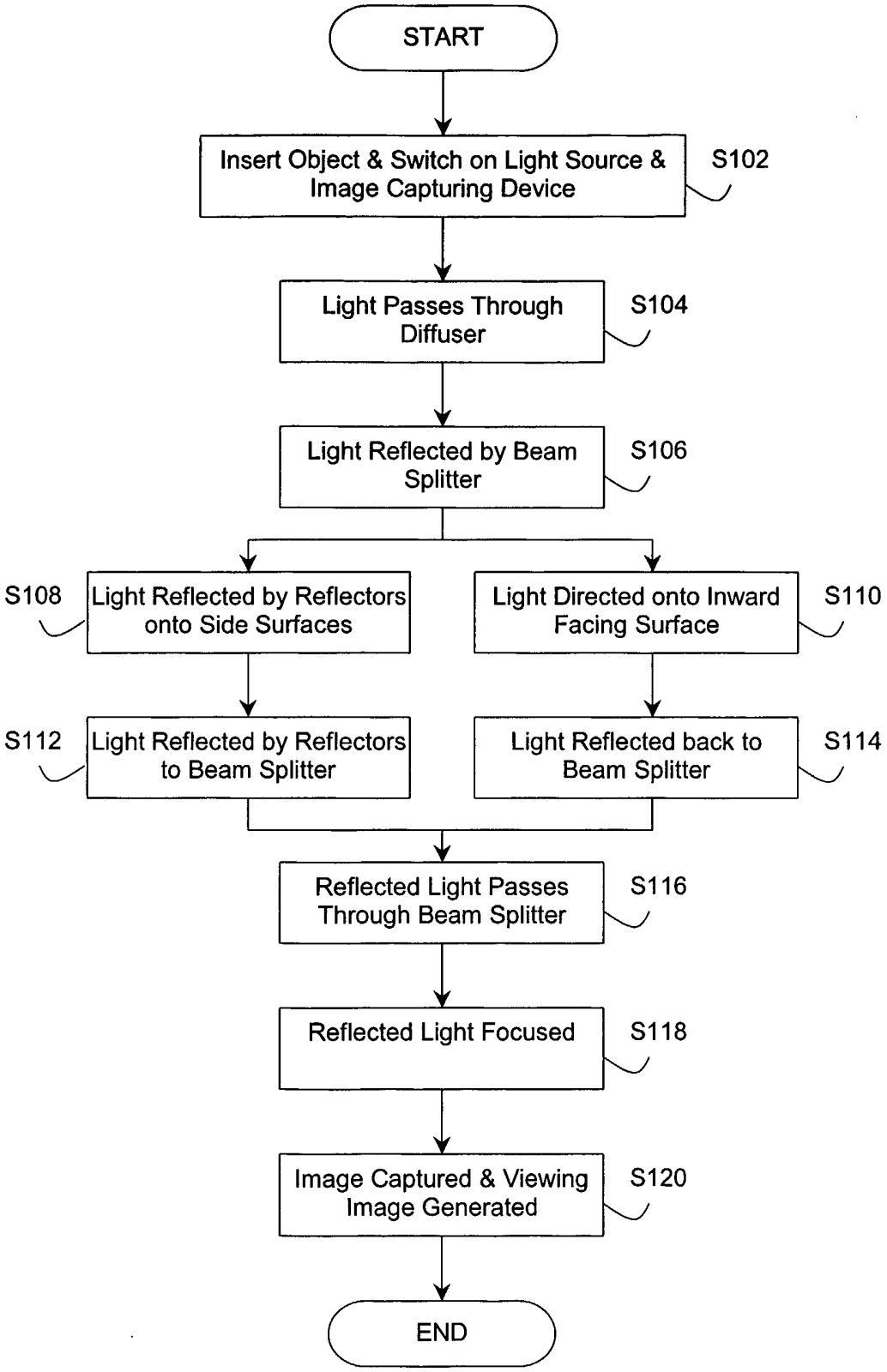
START
Insert Object & Switch on Light Source & Image Capturing Device
S102
Light Passes Through Diffuser
S104
Light Reflected by Beam Splitter
S106
S108
Light Reflected by Reflectors onto Side Surfaces
Light Directed onto Inward Facing Surface
S110
S112
Light Reflected by Reflectors to Beam Splitter
Light Reflected back to Beam Splitter
S114
Reflected Light Passes Through Beam Splitter
S116
Reflected Light Focused
S118
Image Captured & Viewing Image Generated
S120
END

Figure 2

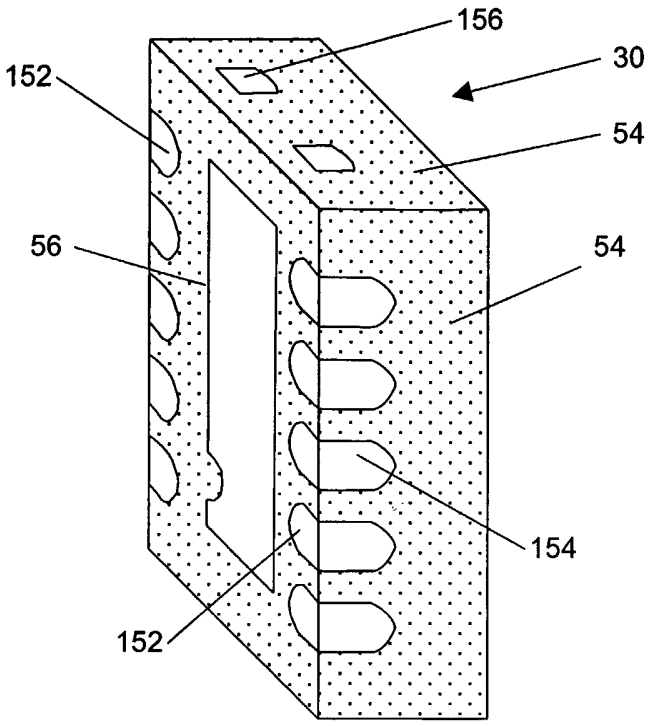

Figure 3

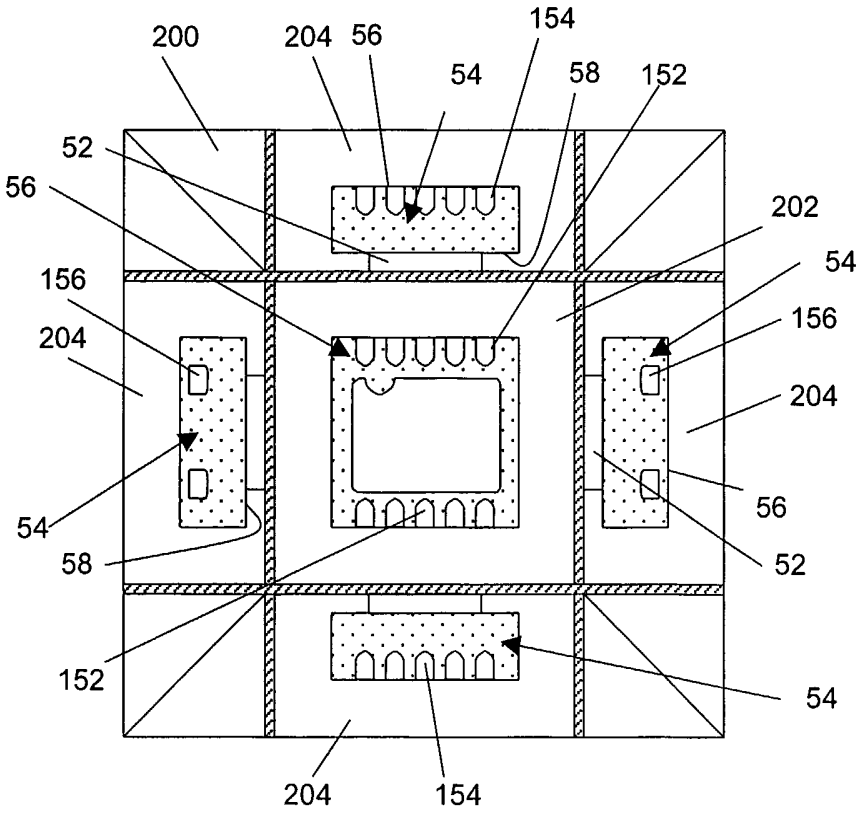

Figure 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SG2004/000106

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N21/88 G01N21/95

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 573 987 B2 (SHIRES MARK R) 3 June 2003 (2003-06-03) column 1, lines 52-63; figures 1,7,8 column 2	1-45
X	DE 198 23 358 A (BI BER BILDERKENNUNGSSYSTEME G ; FOERDERUNG ANGEWANDTER INFORMA (DE)) 18 November 1999 (1999-11-18) abstract; figures 1,2	1-45

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

'A' document defining the general state of the art which is not considered to be of particular relevance

'E' earlier document but published on or after the international filing date

'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

'O' document referring to an oral disclosure, use, exhibition or other means

'P' document published prior to the international filing date but later than the priority date claimed

'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

'&' document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 October 2004	03/11/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Scheu, M

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SG2004/000106

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	STANKE G ET AL: "High-precision and versatile optical measurement of different sides of ICs in the confectioning process using only one viewpoint" INDUSTRIAL ELECTRONICS SOCIETY, 1998. IECON '98. PROCEEDINGS OF THE 24TH ANNUAL CONFERENCE OF THE IEEE AACHEN, GERMANY 31 AUG.-4 SEPT. 1998, NEW YORK, NY, USA,IEEE, US, 31 August 1998 (1998-08-31), pages 2425-2427, XP010308357 ISBN: 0-7803-4503-7 page 2425	1-45
A	US 6 359 694 B1 (SCHNELLINGER STEFAN ET AL) 19 March 2002 (2002-03-19) figure a	1,34,35, 37

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/SG2004/000106

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6573987 B2	04-07-2002	US 2002085199 A1	04-07-2002
		WO 03060488 A1	24-07-2003
		US 2002135757 A1	26-09-2002
		EP 1358473 A2	05-11-2003
		WO 02054139 A2	11-07-2002
DE 19823358 A	18-11-1999	DE 19823358 A1	18-11-1999
		AU 4361999 A	06-12-1999
		WO 9960386 A1	25-11-1999
		EP 1078250 A1	28-02-2001
US 6359694 B1	19-03-2002	CN 1113234 B	02-07-2003
		WO 9924818 A1	20-05-1999
		DE 59807091 D1	06-03-2003
		EP 1031026 A1	30-08-2000
		JP 3400788 B2	28-04-2003
		JP 2001522997 T	20-11-2001