

MODULE, SYSTEM AND METHOD FOR PROCESSING OF AN OPTICAL DEVICE

FIELD

[0001] Embodiments described herein relate to modules, systems and methods for
5 processing an optical device, wherein the optical device comprises or consists of a
waveguide. The optical device can be configured for use in augmented reality applications.

BACKGROUND

[0002] Virtual reality is generally considered to be a computer-generated simulated
environment in which a user has an apparent physical presence. A virtual reality experience
10 can be generated in 3D and viewed with a head-mounted display (HMD) such as glasses or
other wearable display devices that have near-eye display panels as lenses for displaying a
virtual reality environment that replaces an actual environment.

[0003] Augmented reality, however, enables an experience in which a user can still see
through the display lenses of the glasses or other HMD device to view the surrounding
15 environment, yet also see images of virtual objects that are generated for display and appear
as part of the environment. Augmented reality can include any type of input, such as audio
and haptic inputs, as well as virtual images, graphics, and video that enhance or augment the
environment that the user experiences. As an emerging technology, augmented reality is
beset with many challenges and design constraints.

20 [0004] In order to allow for a computer-generated virtual image to be combined with a
real-world image of the environment so as to provide an augmented reality experience,
optical combiners may be used. Such optical combiners may involve waveguides that
include a substrate having a plurality of optical structures formed thereon. Since the optical
structures are small (e.g. nano-sized), fragile structures that are easily damaged or
25 contaminated, the handling of waveguides may be challenging.

[0005] The production of the optical devices can comprise a plurality of processes
performed by different devices. In particular, a plurality of different stand-alone devices is
used. The optical devices can be loaded and unloaded onto each of the stand-alone devices,
e.g. by use of tray feeders. The loading and unloading can take place via the same transport

area. Since a bi-directional transportation takes place, waiting times may occur. For instance, while the optical device is moved towards the stand-alone device, a movement of another optical device from the stand-alone device is not possible. Waiting times can increase the duration of the production process. The cycle times of stand-alone devices can differ. An
5 increasing demand for tray feeders may prevent a faster production process.

[0006] In light of the above, there is a need for an improved module, system and method for processing an optical device, comprising or consisting of a waveguide, particularly a waveguide for augmented reality applications.

SUMMARY

10 [0007] According to an embodiment, a module for processing of an optical device is provided, wherein the optical device comprises or consists of a waveguide. The module comprises a transport device, wherein the transport device extends along a transportation direction from a front end to an opposing terminal end, wherein the transport device is configured to move the optical device along the transportation direction from the front end
15 to the terminal end via an intermediate position. The module comprises a first and a second manufacturing unit configured to act on the optical device. The module comprises a positioning apparatus arranged and configured to take the optical device from the transport device when the optical device is at the intermediate position, and to provide the optical device to the first manufacturing unit.

20 [0008] According to a further embodiment, a system for processing an optical device is provided, wherein the optical device comprises or consists of a waveguide. The system comprises a first module according to an embodiment, and a second module according to an embodiment. The first module and the second module are arranged in sequence, wherein the terminal end of the first module is connected with the front end of the second module, such
25 that the system is arranged and configured to move the optical device from the front end of the first module to the terminal end of the second module via the intermediate position of the first module and the intermediate position of the second module.

[0009] According to a further embodiment, a method for processing of an optical device is provided, wherein the optical device comprises or consists of a waveguide. The method

comprises providing the optical device to a front end of a transport device, and moving the optical device along a transportation direction from the front end to an intermediate position by a transport device. The method comprises taking the optical device from the transport device using a positioning apparatus and providing the optical device to a first manufacturing unit. The method comprises processing the optical device using the first manufacturing unit, generating a pre-processed optical device. The method comprises processing the pre-processed optical device using the second manufacturing unit, generating a processed optical device. The method comprises moving the processed optical device from the second manufacturing unit to the transport device using the positioning apparatus, and moving the processed optical device along the transportation direction from the intermediate position to a terminal end using the transport device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In order for the manner in which the above recited features of the present disclosure are to be able to be understood in detail, a more detailed description of the disclosure, briefly summarised above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

- FIGs 1(a)-(b) show an example of a waveguide,
- FIG. 2 shows a waveguide stack including several waveguides,
- FIG. 3 shows a schematic view of an embodiment of a module,
- FIG. 4 shows a schematic view of a further embodiment of a module,
- FIG. 5 shows a schematic view of an embodiment of a module comprising a receptacle,
- FIG. 6 shows a schematic view of an embodiment of a module comprising a further optical device,
- FIG. 7 shows a schematic view of an embodiment of a module comprising a further rotary table,

FIG. 8 shows a schematic view of an embodiment of a system comprising a first module and a second module,

FIG. 9 shows a schematic view of an embodiment of a system comprising a sorter unit.

5 DETAILED DESCRIPTION

[0011] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same components. Generally, only the differences with respect to individual embodiments are described. Each example is provided
10 by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Furthermore, features illustrated or described as part of one embodiment can be used on or in conjunction with other embodiments to yield yet a further embodiment. It is intended that the description includes such modifications and variations.

[0012] Embodiments described herein involve optical devices. A device may be
15 considered an optical device if the optical properties of the device are relevant for the method or apparatus in which the device is used. At least a portion of an optical device can be made of a transparent material, such as glass or plastic. Some optical devices may be configured to change the properties, e.g. the propagation direction, of light. For example, an optical device may include optical structures for changing the propagation direction of light. Other
20 optical devices may be unstructured and allow light to pass therethrough substantially unaltered. An optical device as described herein may be an optical device for use in augmented reality applications. An optical device can also be called an optical element. Examples of optical devices include waveguides and transparent cover elements, such as cover glasses, as described herein. An optical device can comprise a waveguide. The optical
25 device can comprise a plurality of waveguides, particularly stacked waveguides. In an embodiment, the optical device consists of one waveguide. In an embodiment, the optical device consists of a plurality of waveguides.

[0013] An optical device as described herein, such as a waveguide or a transparent cover element, can be a thin piece of material. An optical device can be a plate element, including

a plate element having a flat surface or a plate element having a curved surface. An optical device can have a first major surface and a second major surface opposite the first major surface. An optical device may be a substantially two-dimensional device, wherein a thickness of the optical device between the first major surface and the second major surface can be much smaller (e.g. 1 % or less) than a dimension, such as a length or width, of the first or second major surface. For example, the thickness of an optical device may be 1 mm or less, 500 μm or less, or 300 μm or less.

[0014] Figs. 1(a)-(b) show an exemplary waveguide 10. As shown in Fig. 1(a), the waveguide 10 may include a substrate 110, which may be a thin piece of transparent material, such as glass or plastic. At least one grating structure, such as a grating structure 112 and a grating structure 114, may be disposed on the substrate 110. The waveguide 10 may include an input-coupling region 102 defined by the grating structure 112. The waveguide 10 may include an output-coupling region 104 defined by the grating structure 114. Light, in particular light corresponding to a virtual, computer-generated image, may be coupled into the waveguide 10 at the input-coupling region 102. The light may propagate through the waveguide 10 until the light reaches the output-coupling region 104. At the output-coupling region 104, the light may exit the waveguide 10. Furthermore, also at the output-coupling region 104, light from the external, real-world surroundings may be transmitted through the waveguide 10 (as shown by the dashed line), allowing the user to see a combination of a virtual image and a real-world image. The waveguide 10 may be a waveguide combiner for providing an augmented reality experience to a user.

[0015] Fig. 1(b) shows a grating structure 120 of a waveguide 10 in more detail. The grating structure 120 may be the grating structure 112 or the grating structure 114 shown in Fig. 1(a), and may accordingly serve to provide an input-coupling region or an output-coupling region of the waveguide 10. The grating structure 120 may be formed on a major surface 12 of the substrate 110. The grating structure 120 may include a plurality of optical structures 122. The optical structures 122 may be configured to change a propagation direction of light incident on the grating structure 120. The optical structures 122 may have dimensions, e.g. width and/or height, that lie in the sub-micron and even nanometer range. The optical structures may be arranged adjacent to each other with a gap therebetween. As shown in Fig. 1(b), the optical structures 122 may be shaped, for example, as slanted fins.

[0016] The disclosure is not limited to the exemplary waveguide 10 shown in Figs. 1(a)-(b) and applies in the same manner to other waveguides. For example, a waveguide may have more than two grating structures (e.g. the waveguide may have one or more intermediate regions defined by further grating structures), the arrangement and shape of the optical structures 122 may be different from the example shown in Fig. 1(b), the waveguide
5 may have grating structures disposed on both sides of the waveguide, and so on.

[0017] A waveguide as described herein may include a substrate. A waveguide may include a plurality of optical structures formed on the substrate. The optical structures may have sub-micro-dimensions, e.g. nano-sized dimensions. The plurality of optical structures
10 may form one or more grating structures on the substrate. A waveguide can be a waveguide combiner. A waveguide combiner may be configured for combining a virtual computer-generated image with a real-world image of a surrounding environment. A waveguide may be an augmented reality waveguide combiner.

[0018] In an optical system, such as an augmented reality device, several waveguides may
15 be stacked on top of each other to form a waveguide stack. For example, each waveguide in the waveguide stack may be configured for manipulating light in a respective wavelength range, which is beneficial for providing colour images.

[0019] Fig. 2 shows an example of a waveguide stack 200. The waveguide stack 200 may include a cover glass 202a (bottom cover glass), a waveguide 10a, a waveguide 10b, a waveguide 10c and a cover glass 202b (top cover glass) stacked in this order. An adhesive
20 204a may be disposed between the cover glass 202a and the waveguide 10a. Adhesives 204b, 204c and 204d may be disposed between waveguides 10a and 10b, between waveguides 10b and 10c, and between waveguide 10c and cover glass 202b, respectively. Each of the waveguides 10a-c may be a waveguide as described herein, such as a waveguide 10 shown
25 in Figs. 1(a)-(b).

[0020] A cover glass, such as cover glasses 202a-b, may be a protective glass. A cover glass may shield a surface of a waveguide adjacent to the cover glass, for example to prevent a grating formed on said surface from being contacted or contaminated. It may be the case that a cover glass itself has no optical structures, such as a grating.

[0021] An adhesive, such as adhesives 204a-d, may be configured to attach adjacent optical devices of a waveguide stack to each other. For example, adhesive 204a may be configured to attach cover glass 202a to waveguide 10a. An adhesive may be a pressure sensitive adhesive (PSA). An adhesive may be a pre-formed adhesive, such as a pre-formed PSA. An adhesive may have an elongated shape. For example, an adhesive may be an adhesive tape. An adhesive may function as a spacer providing a gap, particularly an air gap, between adjacent optical devices of the waveguide stack. Due to the adhesive, it may be the case that said adjacent optical devices do not contact each other and are bonded substantially parallel to each other.

10 [0022] The waveguide stack 200 shown in Fig. 2 includes a total of three waveguides. The disclosure is not limited thereto. A waveguide stack may include 1 or more, 2 or more, or 3 or more waveguides. For example, a waveguide stack may include a total of one waveguide and one cover glass stacked together.

15 [0023] Further, instead of cover glasses, transparent cover elements made of materials other than glass may be used in a waveguide stack. Throughout the present disclosure, a cover glass may be replaced by a transparent cover element.

[0024] According to embodiments described herein, a waveguide stack may be formed. Forming the waveguide stack may include placing a cover glass 202a on a support, placing an adhesive 204a on the cover glass 202a, placing a waveguide 10a on the adhesive 204a, placing an adhesive 204b on the waveguide 10a, and so on, in this order. Before placing a respective cover glass, waveguide, or adhesive on a preceding component in the (partial) stack, alignment operations may be performed to ensure that the components are correctly positioned within the waveguide stack. In order to provide a high-quality waveguide stack that is suitable for providing a sharp image, a high alignment precision of the different optical devices in a stack is beneficial.

[0025] Different embodiments of modules 300 for processing optical devices are illustrated in Figs 3 to 7. The module 300 comprises a transport device 302, a first manufacturing unit 310, a second manufacturing unit 312, and a positioning apparatus 308.

[0026] A module 300 can be arranged and configured for the production of the optical device. The module 300 can be arranged and configured for the processing of the optical device. The module 300 can be arranged and configured for the inspection of the optical device. The module 300 can be arranged and configured for back end of line processes for
5 eyepiece production.

[0027] The transport device 302 extends along a transportation direction 304 from a front end 320 to an opposing terminal end 322. The transportation direction 304 can extend along a longitudinal extension direction of the transport device 302. The transport device 302 can connect the front end 320 and the terminal end 322.

10 [0028] An optical device can be supplied to the transport device 302. The optical device can be arranged on a tray. The optical device can be provided to the transport device 302. The tray can be a waveguide tray. A plurality of optical devices can be arranged on a tray. The tray can be supplied to the transport device 302.

[0029] The transport device 302 is configured to move the optical device along the
15 transportation direction 304 from the front end 320 to the terminal end 322 via an intermediate position 324. The transport device 302 can be configured to transport the optical device along the transportation direction 304 from the front end 320 to the terminal end 322 via an intermediate position 324. The transport device 302 can be configured to carry the optical device from the front end 320 to the terminal end 322 along the transportation
20 direction 304 via an intermediate position 324. The transport device 302 can be configured to move the optical device from the front end 320 to the intermediate position 324 and from the intermediate position 324 to the terminal end 322. The transport device 302 can be configured to carry the optical device from the front end 320 to the intermediate position 324 and from the intermediate position 324 to the terminal end 322. The transport device
25 302 can be configured to move an individual optical device. The transport device 302 can be configured to move a plurality of optical devices separately. The transport device 302 can be configured to handle waveguides individually. The transport device 302 can be configured to move the tray, particularly the tray on which the optical device is arranged. The transport device 302 can be configured to move a plurality of trays. The transport device
30 302 can be configured for unidirectional movement along the transportation direction 304. The transport device 302 can be configured for unidirectional movement of the optical

device from the front end 320 to the terminal end 322. The transport device 302 can be configured for unidirectional movement of the tray from the front end 320 to the terminal end 322.

[0030] The intermediate position 324 can be located between the front end 320 and the terminal end 322. Along the transportation direction 304, the intermediate position 324 can be located between the front end 320 and the terminal end 322. The intermediate position 324 can be downstream of the front end 320. The intermediate position 324 can be located upstream of the terminal end 322. The front end 320 can be arranged opposite the terminal end 322. Related to the transportation direction 304, the front end 320 can be arranged opposite the terminal end 322. The front end 320 and the terminal end 322 can face away from each other (see Figs 3, 5, 6, 7).

[0031] The front end 320 can be arranged and configured such that the optical device can be provided to the transport device 302 via the front end 320. The front end 320 can be a loading section. The terminal end 322 can be arranged and configured such that the optical device can be removed from the transport device 302 via the terminal end 322. The terminal end 322 can be an unloading region. In an embodiment, the front end 320 is accessible by a tray feeder. In an embodiment, the terminal end 322 is accessible by a tray feeder. The front end 320 can be an inlet of the tray. The terminal end 322 can be an outlet of the tray. In an embodiment, the front end 320 and the terminal end 322 are each accessible by a tray feeder. In an embodiment, the front end 320 is accessible by a robot. In an embodiment, the front end 320 is accessible by a pick-and-place robot. In an embodiment, the terminal end 322 is accessible by a robot. In an embodiment, the terminal end 322 is accessible by a pick-and-place robot. In an embodiment, the front end 320 and the terminal end 322 are each accessible by a robot. In an embodiment, the front end 320 and the terminal end 322 are each accessible by a pick-and-place robot.

[0032] The transport device 304 can be configured such that a portion extending between the front end and the intermediate position differs from a further portion extending between the intermediate position and the terminal end. The transport device 304 can be configured such that a path from the front end to the intermediate position differs from a further path from the intermediate position to the terminal end.

[0033] The loading region and the unloading region can be spatially separated. The loading region and the unloading region can be arranged at opposite sides. An advantage can be that optical devices can be provided continuously and waiting times can be reduced.

[0034] The first manufacturing unit 310 is configured to act on the optical device. The
5 second manufacturing unit 312 is configured to act on the optical device. In an embodiment, the first manufacturing unit 310 and the second manufacturing unit 312 are arranged consecutively. The second manufacturing unit 312 can be arranged downstream of the first manufacturing unit 310. The first manufacturing unit 310 can be configured to act on the optical device and produce a pre-processed optical device. In an embodiment, the second
10 manufacturing device 312 can be configured to act on the pre-processed optical device and produce a processed optical device.

[0035] An advantage can be that a manufacturing process can be divided into smaller steps, particularly steps of shorter cycle times. An advantage can be to divide the manufacturing process into smaller steps of uniform cycle times. Waiting times can advantageously be
15 reduced. The productivity may be advantageously improved. The cycle time can be a duration during which the first manufacturing unit and the second manufacturing unit act on the optical device.

[0036] In an embodiment, the first manufacturing unit 310 is configured to visually inspect the optical device. The pre-processed optical device can be the visually inspected
20 optical device.

[0037] The positioning apparatus 308 is arranged and configured to take the optical device from the transport device 302 when the optical device is provided at the intermediate position 324. The positioning apparatus 308 can be arranged and configured to pick the optical device from the transport device 302 when the optical device is provided at the intermediate position
25 324. The positioning apparatus 308 can be arranged and configured to receive the optical device from the transport device 302 when the optical device is provided at the intermediate position 324. The positioning apparatus 308 can be arranged and configured to remove the optical device from the transport device 302 when the optical device is provided at the intermediate position 324. The positioning apparatus 308 can be arranged and configured to
30 unload the optical device from the transport device 302 when the optical device is provided

at the intermediate position 324. The positioning apparatus 308 can supply the optical device taken from the transport device 302 to the first manufacturing unit 310. The positioning apparatus 308 can provide the optical device taken from the transport device 302 to the first manufacturing unit 310. The positioning apparatus 308 can feed the optical device taken from the transport device 302 to the first manufacturing unit 310. The positioning apparatus 308 can be configured to take the optical device from a tray when the tray is at the intermediate position 324.

[0038] The positioning apparatus 308 can be arranged or arrangeable laterally beside the transport device 302. The positioning apparatus 308 can be arranged or arrangeable vertically above the transport device 302.

[0039] An advantage of a module according to the invention can be that the loading region and the unloading region are spatially separated from each other such that a loading process and an unloading process can be performed separately from each other, particularly independently of each other. In an embodiment, the loading process and the unloading process can be performed simultaneously.

[0040] In an embodiment, the module comprises standard functional components. In an embodiment, the module comprises a straight conveyor for tray or waveguides, a waveguide handling robot, a working chamber and a rotary table for automation.

[0041] The transport device 302 can comprise a linear section. The linear section can also be referred to as a straight section. In an embodiment, the transport device consists of a linear section (see Figs 3, 5, 6, 7). The transport device 302 can comprise a curved section. In an embodiment, the transport device 302 consists of a curved section (see Fig. 4). The invention is not limited to the illustrated examples. The transport device 302 can comprise a linear section and a curved section. The transport device 302 can have a J-shape. In an embodiment, the transport device comprises a plurality of linear sections. A first linear section and a second linear section can be arranged at an angle to each other. The transport device 302 can have a L-shape. In an embodiment, the transport device 302 comprises a plurality of curved sections. A curvature of a first curved section can differ from a curvature of a second curved section. The transport device 302 can have an S-shape.

[0042] In an embodiment, the linear section is arranged and configured such that the front end 320 and the terminal end 322 are arranged spaced apart from each other. In an embodiment, the curved section is arranged and configured such that the front end 320 and the terminal end 322 are arranged spaced apart from each other. In an embodiment, the linear section and the curved section are arranged and configured such that the front end 320 and the terminal end 322 are arranged spaced apart from each other. In an embodiment, the front end 320 and the terminal end 322 are spatially separated from each other. In an embodiment, the transport device 302 is configured such that the loading region and the unloading region are separated from each other. In an embodiment, the loading region and the unloading region are arranged at different locations.

[0043] An advantage can be that the loading region and the unloading region are spatially separated from each other. Advantageously, the module can be easily adapted to the external spatial conditions and/or further processing steps.

[0044] The transport device 302 can extend along a longitudinal extension direction from the front end 320 to the terminal end 322. The transport device 302 can extend linearly along the longitudinal extension direction (see Figs 3, 5, 6, 7). In an embodiment, the transport device 302 extends in a curved manner along the longitudinal extension direction (see Fig. 4). The transportation direction 304 can extend along the longitudinal extension direction.

[0045] In an embodiment, the transport device 302 comprises a conveyor. The transport device 302 can be a conveyor. In an embodiment, the transport device 302 comprises a rail system. The transport device 302 can be a rail system. In an embodiment, the transport device 302 comprises a shuttle system. The transport device 302 can be a shuttle system. In an embodiment, the transport device 302 comprises a linear actuator. The transport device 302 can be a linear actuator. In an embodiment, the transport device 302 comprises a rotary actuator. The transport device 302 can be a rotary actuator.

[0046] According to an embodiment, the transport device 302 comprises a conveyor and a rail system. According to an embodiment, the transport device 302 comprises a conveyor and a shuttle system. According to an embodiment, the transport device 302 comprises a conveyor and a linear actuator. According to an embodiment, the transport device 302 comprises a conveyor and a rotary actuator. According to an embodiment, the transport

device 302 comprises a rail system and a shuttle system. According to an embodiment, the transport device 302 comprises a rail system and a linear actuator. According to an embodiment, the transport device 302 comprises a rail system and a rotary actuator. According to an embodiment, the transport device 302 comprises a shuttle system and a linear actuator. According to an embodiment, the transport device 302 comprises a shuttle system and a rotary actuator. According to an embodiment, the transport device 302 comprises a linear actuator and a rotary actuator.

[0047] In an embodiment, the conveyor is a straight conveyor. In an embodiment, the conveyor is a straight tray conveyor. The transport device 302 can be a contactless conveyor. The transport device 302 can be a contactless conveyor with suspension-from-above.

[0048] The transport device 302 can be configured and arranged such that it is accessible by a tray feeder and the positioning apparatus 308. The transport device 302 can be configured and arranged such that it is accessible by a robot and the positioning apparatus 308. The transport device 302 can be configured and arranged such that it is accessible by a pick-and-place robot and the positioning apparatus 308.

[0049] In an embodiment, the module comprises a rotary table 306 (Figs 3 to 7). The rotary table 306 can be arranged in a working chamber, particularly in a waveguide working chamber. The rotary table 306, the positioning apparatus 308 and the transport device 302 can be arranged and configured in coordination with each other. The rotary table 306 can be arranged and configured such that the rotary table 306 is accessible by the positioning apparatus 308. The rotary table 306 can be arranged and configured such that the rotary table 306 is accessible by the first manufacturing unit 310. The rotary table 306 can be arranged and configured such that the rotary table 306 is accessible by the second manufacturing unit 312. In an embodiment, the rotary table 306 is arranged and configured such that the rotary table 306 is accessible by the positioning apparatus 308 and the first manufacturing unit 310. In an embodiment, the rotary table 306 is arranged and configured such that the rotary table 306 is accessible by the positioning apparatus 308 and the second manufacturing unit 312. In an embodiment, the rotary table 306 is arranged and configured such that the rotary table 306 is accessible by the first manufacturing unit 310 and the second manufacturing unit 312. According to an embodiment, the rotary table 306 is arranged and configured such that the

rotary table 306 is accessible by the positioning apparatus 308, the first manufacturing unit 310 and the second manufacturing unit 312 (Figs 3 to 7).

[0050] The positioning apparatus 308 can be arranged or arrangeable beside the rotary table 306. The positioning apparatus 308 can be arranged or arrangeable between the transport device 302 and the rotary table 306. In an embodiment, the positioning apparatus 308, the transport device 302 and the rotary table 306 are arranged or arrangeable horizontally beside each other. The positioning apparatus 308 can be configured for horizontal movement. The positioning apparatus 308 can be configured for lateral movement. The positioning apparatus 308 can be configured for a back-and-forth movement.

[0051] According to an embodiment, the positioning apparatus 308 is arranged or arrangeable above the rotary table 306. According to an embodiment, the positioning apparatus 308 is arranged or arrangeable vertically above the rotary table 306. In an embodiment, the rotary table 306 is arranged below the positioning apparatus 308. In an embodiment, the transport device 302 is arranged above the positioning apparatus 308.

[0052] According to an embodiment, the transport device 302 is configured to pass over the rotary table 306. The transport device 302 can be configured such that an optical device arranged at the transport device 302 is accessible from below. In an embodiment, the positioning apparatus 308 is configured for up-and-down movement. In an embodiment, the positioning apparatus 308 comprises an ejection system. The positioning apparatus 308, particularly the ejection system, can be configured to supply the optical device to the rotary table 306. In an embodiment, the positioning apparatus 308 comprises a lifting system. The positioning apparatus 308, particularly the lifting system, can be configured to lift the optical device from the rotary table 306 to the transport device 302. The positioning apparatus 308, particularly the lifting system, can be configured to attract the optical device to the transport device 302, particularly to the conveyor.

[0053] The rotary table 306 can be rotatable with respect to a rotation axis 342 (Fig. 6). The rotary table 306 can be moved along a rotary movement direction 340. The rotary table 306 can have a circular shape.

[0054] The first manufacturing unit 310 and the second manufacturing unit 312 can be arranged around the rotary table 306. The first manufacturing unit 310 and the second manufacturing unit 312 can be arranged along a circumference of the rotary table 306 spaced apart from each other.

5 [0055] The first manufacturing unit 310 can be arranged at the rotary table 306. The first manufacturing unit 310 can be arranged such that the first manufacturing unit 310 faces towards the rotary table 306. Particularly, the first manufacturing unit 310 can be arranged such that the first manufacturing unit 310 can access the rotary table 306 (Figs 3 - 7). The first manufacturing unit 310 can comprise a first effective side 311 facing towards the rotary
10 table 306 (Fig. 6).

[0056] The second manufacturing unit 312 can be arranged at the rotary table 306. The second manufacturing unit 312 can be arranged such that the second manufacturing unit 312 faces towards the rotary table 306. Particularly, the second manufacturing unit 312 can be arranged such that the second manufacturing unit 312 can access the rotary table 306 (Figs
15 3 - 7). The second manufacturing unit 312 can comprise a second effective side 313 facing towards the rotary table 306 (Fig. 6).

[0057] The rotary table 306 can be configured and arranged such that it is accessible by the positioning apparatus 308 such that an optical device can be supplied to the rotary table 306 by the positioning apparatus 308. Particularly, the module 300 can be configured such
20 that when an optical device is provided at the intermediate position 324 the optical device can be taken from the transport device 302 by the positioning apparatus 308 and be supplied to the rotary table 306 by the positioning apparatus 308. The module 300 can be configured such that, when an optical device is provided at the intermediate position 324, the optical device can be taken from the transport device 302 by the positioning apparatus 308 and be
25 supplied to the rotary table 306 by the positioning apparatus 308 such that the optical device is accessible by the first manufacturing unit 310. The rotary table 306 can be configured to provide the optical device to the first manufacturing unit 310. The rotary table 306 can be configured to provide the optical device to the second manufacturing unit 312. The rotary table 306 can be configured to supply the optical device to the first manufacturing unit 310.
30 The rotary table 306 can be configured to supply the optical device to the second manufacturing unit 312.

[0058] In an embodiment, the rotary table 306 comprises a receptacle 338, 339 for receiving the optical device (Figs 5 and 6). The receptacle 338 can comprise or consist of a holder. The receptacle 338 can comprise a self-alignment device. The receptacle 338 can consist of a self-alignment device. The self-alignment device can be configured to hold the optical device. The self-alignment device can be configured to align the optical device. The self-alignment device can be configured to align the optical device with respect to the first manufacturing unit 310. The self-alignment device can be configured to align the optical device with respect to the second manufacturing unit 312. The rotary table 306 can comprise a plurality of receptacles 338, 339. A plurality of receptacles 338, 339 can be arranged at the rotary table 306. A plurality of receptacles 338, 339 can be arrangeable at the rotary table 306 (Fig. 6).

[0059] The rotary table 306 can be configured to arrange the receptacle 338, 339 in a first position 330. The rotary table 306 can be configured to arrange the receptacle 338, 339 in a second position 332. In an embodiment, the rotary table 306 is configured to arrange the receptacle 338, 339 in the first position 330 and in the second position 332 (Fig. 5). In an embodiment, the rotary table 306 is configured to move the receptacle 338, 339 from the first position 330 to the second position 332. In an embodiment, the rotary table 306 is configured to rotate such that the receptacle 338, 339 moves from the first position 330 to the second position 332.

[0060] In the first position 330, the receptacle 338, 339 can be accessible by the first manufacturing unit 310 (Fig. 5). The optical device received in the receptacle 338, 339 arranged in the first position 330, can be accessible by the first manufacturing unit 310. The first manufacturing unit 310 can act on the optical device received in the receptacle 338, 339 which is arranged in the first position 330.

[0061] In the second position 332, the receptacle 338, 339 can be accessible by the second manufacturing unit 312 (Fig. 5). The optical device received in the receptacle 338, 339 arranged in the second position 332 can be accessible by the second manufacturing unit 312. The second manufacturing unit 312 can act on the optical device received in the receptacle 338, 339 which is arranged in the second position 332.

[0062] In an embodiment, the first manufacturing unit 310 is configured to visually inspect the optical device. The pre-processed optical device can be the visually-inspected optical device. The first manufacturing unit 310 can be a camera. The first manufacturing unit 310 can be configured to detect a fiducial, particularly a plurality of fiducials, in the optical device. The pre-processed optical device can be the optical device with detected fiducial.
5 The first manufacturing unit 310 can be configured to determine the position and/or orientation of the optical device at the rotary table 306. The first manufacturing unit 310 can be configured to determine positional information and/or offset information. The first manufacturing unit 310 can be configured to determine positional information of the optical
10 device at the rotary table 306. The first manufacturing unit 310 can be configured to determine an offset information of the position and/or orientation of the optical device at the rotary table 306. The first manufacturing unit 310 can be configured to determine an offset information based on the positional information of the optical device at the rotary table 306. The offset information can be related to a reference target position.

15 [0063] The pre-processed optical device can be the optical device with determined position and/or orientation. The pre-processed optical device can be the optical device with determined offset of the position and/or orientation.

[0064] Positional information can comprise a detected x-position, a detected y-position and/or a detected z-position. Positional information can comprise a detected x-position, a
20 detected y-position and/or a detected z-position of the optical device. Positional information can comprise a detected x-position, a detected y-position and/or a detected z-position of a fiducial of the optical device. The x-position and the y-position can be arranged in a plane extending parallel to a surface of the rotary table. The z-position can be arranged perpendicular to the plane extending parallel to a surface of the rotary table. The z-position
25 can be arranged perpendicular to the x-y-plane.

[0065] The offset information can comprise an offset x-position, an offset y-position, an offset z-position and/or a tilt angle θ . The offset of the position and/or orientation can be related to the optical device and/or of a fiducial of the optical device. The offset information can be determined with regard to a pre-defined reference target position with a reference x-
30 position, a reference y-position and/or a reference z-position. The offset information can consider the tilt angle θ . The tilt angle θ may indicate a rotational shift of the optical

device compared to the reference target position, particularly a rotational shift of the optical device in the x-y plane. The detected x-position, detected y-position and/or detected z-position can be compared to the respective reference x-position, reference y-position and/or reference z-position to determine the respective offset information, particularly the offset x-position, the offset y-position, the offset z-position and/or the tilt angle theta. In an embodiment, the offset x-position, the offset y-position, and the tilt angle theta are determined to determine the position and/or orientation of the optical device. The offset information can be determined based on the positional information and the reference target position. The module 300 can be configured to calculate the offset information.

10 [0066] The first manufacturing unit 310 can be configured to determine positional information. The first manufacturing unit 310 can be configured to determine the detected x-position of the optical device, particularly to determine the detected x-position of a fiducial of the optical device. The first manufacturing unit 310 can be configured to determine the detected y-position of the optical device, particularly to determine the detected y-position of a fiducial of the optical device. The first manufacturing unit 310 can be configured to determine the detected z-position of the optical device, particularly to determine the detected z-position of a fiducial of the optical device. The first manufacturing unit 310 can be configured to determine the detected x-position and the detected y-position of the optical device, particularly to determine the detected x-position and the detected y-position of a fiducial of the optical device. The first manufacturing unit 310 can be configured to determine the detected x-position, the detected y-position and the detected z-position of the optical device, particularly to determine the detected x-position, the detected y-position and the detected z-position of a fiducial of the optical device. The first manufacturing unit 310 can be configured to determine positional information of the optical device. The first manufacturing unit 310 can be configured to determine positional information of a fiducial of the optical device. In an embodiment, the first manufacturing unit 310 is configured to determine the respective x-position, y-position and/or z-position of a plurality of fiducials. In an embodiment, the first manufacturing unit 310 is configured to determine positional information of a plurality of fiducials. In an embodiment, the first manufacturing unit 310 is configured to determine offset information of a plurality of fiducials.

[0067] In an embodiment, the first manufacturing unit 310 is configured to determine the offset information based on the determined positional information.

[0068] In an embodiment, the first manufacturing unit 310 is configured to store positional information. In an embodiment, the first manufacturing unit 310 is configured to store the
5 detected x-position, the detected y-position and/or the detected z-position of a fiducial of the optical device. In an embodiment, the first manufacturing unit 310 is configured to store the offset information. In an embodiment, the first manufacturing unit 310 is configured to provide the positional information related to the optical device to the second manufacturing unit 312. In an embodiment, the first manufacturing unit 310 is configured to provide the
10 offset information to the second manufacturing unit 312. In an embodiment, the first manufacturing unit 310 is configured to instruct the second manufacturing unit 312 to align according to the positional information and/or according to the offset information. In an embodiment, the first manufacturing unit 310 is configured to instruct the second manufacturing unit 312 to align corresponding to the positional information and/or according
15 to the offset information.

[0069] In an embodiment, the module 300 comprises a controller 380 (Fig. 5). The controller 380 can be configured to receive information from the first manufacturing unit 310. The controller 380 can be configured to process information received from the first manufacturing unit 310. The controller 380 can be configured to provide information to the
20 second manufacturing unit 312. The controller 380 can be configured to store information. The controller 380 can be configured to determine the positional information and/or the offset information. The controller 380 can be configured to determine the positional information and/or the offset information, based on information of the first manufacturing unit 310. The controller 380 can be configured to provide the positional information and/or
25 the offset information to the second manufacturing unit 312.

[0070] In an embodiment, the second manufacturing unit 312 is configured to receive information from the first manufacturing unit 310. In an embodiment, the second manufacturing unit 312 is configured to receive positional information and/or offset information from the first manufacturing unit 310. In an embodiment, the second
30 manufacturing unit 312 is configured to receive information from the controller 380. In an embodiment, the second manufacturing unit 312 is configured to receive positional

information and/or offset information from the controller 380. In an embodiment, the second manufacturing unit 312 is configured to align corresponding to the received positional information. In an embodiment, the second manufacturing unit 312 is configured to align corresponding to the received offset information.

- 5 [0071] In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust its position with regard to the rotary table 306. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust its position with regard to the receptacles 338, 339. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust its position with regard to the optical device arranged at the rotary table
- 10 306. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust its position with regard to the optical device in response to the positional information received by the first manufacturing unit 310. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust its position with regard to the optical device in response to the positional information and/or offset information received by the controller
- 15 380. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust the position of the second effective side 313 with regard to the receptacle 338, 339. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust the position of the second effective side 313 with regard to the optical device. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust the position of the
- 20 second effective side 313 with regard to the optical device in response to the positional information and/or offset information received by the first manufacturing unit 310. In an embodiment, the second manufacturing unit 312 is arranged and configured to adjust the position of the second effective side 313 with regard to the optical device in response to the positional information and/or offset information received by the controller 380.
- 25 [0072] The first position 330 and the second position 332 may be arranged in sequence in a circumferential direction 344 of the rotary table 306. The first position 330 and the second position 332 may be arranged in sequence in the rotary movement direction 340 (Fig. 5). With respect to the rotary movement direction 340, the second position 332 can be arranged subsequently to the first position 330.
- 30 [0073] In an embodiment, the module 300 comprises a first receptacle 338 and a second receptacle 339. The rotary table 306, the first manufacturing unit 310 and the second

manufacturing unit 312 can be arranged and configured such that when the first receptacle 338 is in the first position 330, the second receptacle 339 is in the second position 332. The rotary table 306, the first manufacturing unit 310 and the second manufacturing unit 312 can be arranged and configured such that when the first receptacle 338 is accessible by the first manufacturing unit 310, the second receptacle 339 is accessible by the second manufacturing unit 312 (Fig. 6).

[0074] In an embodiment, the rotary table 306 is configured to move the receptacle 338, 339 between an exchange position 336 and the first position 330. In an embodiment, the rotary table 306 is configured to move the receptacle 338, 339 between the first position 330 and the second position 332 (Fig. 5). In an embodiment, the rotary table 306 is configured to move the receptacle 338, 339 between the exchange position 336, the first position 330 and the second position 332. The rotary table 306 can be configured to move the receptacle 338, 339 between the exchange position 336, the first position 330 and the second position 332 along the rotary movement direction 340. The rotary table 306 can be configured to move the receptacle 338, 339 from the exchange position 336, to the second position 332 via the first position 330. The rotary table 306 can be configured to move the receptacle 338, 339 from the first position 330 to the exchange position 336 via the second position 332. The rotary table 306 can be configured to move the receptacle 338, 339 from the second position 332 to the first position 330 via the exchange position 336. The rotary table 306 can rotate the receptacle 338, 339 between the exchange position 336, the first position 330 and the second position 332. The rotary table 306 can be configured to rotate the receptacle 338, 339 into a determined position.

[0075] According to an embodiment, the module 300 is arranged and configured such that when the receptacle 338, 339 is arranged in the first position 330, the receptacle 338, 339 is accessible by the positioning apparatus 308. When the receptacle 338, 339 is arranged in the first position 330, the optical device can be supplied to the receptacle 338, 339 by the positioning apparatus 308. The positioning apparatus 308 can be configured to supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330. The positioning apparatus 308 can deliver the optical device to the receptacle 338, 339. In an embodiment, the positioning apparatus 308 is configured to supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the

first position 330 and when the receptacle 338, 339 is unoccupied. According to an embodiment, the module 300 is arranged and configured such that when the receptacle 338, 339 is arranged in the exchange position 336, the receptacle 338, 339 is accessible by the positioning apparatus 308. When the receptacle 338, 339 is arranged in the exchange position 336, the optical device can be supplied to the receptacle 338, 339 by the positioning apparatus 308. The positioning apparatus 308 can be configured to supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336. The positioning apparatus 308 can deliver the optical device to the receptacle 338, 339. In an embodiment, the positioning apparatus 308 is configured to provide the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336 and when the receptacle 338, 339 is unoccupied. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is capable of receiving the optical device. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is unloaded. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is empty. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is free. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is unblocked. The wording that the receptacle 338, 339 is unoccupied can refer to a state in which the receptacle 338, 339 is not occupied by an optical device.

[0076] In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can supply the optical device to the receptacle 338, 339 when the receptacle 338, 339 is arranged in the first position 330. In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can supply the optical device to the receptacle 338, 339 when the receptacle 338, 339 is arranged in the exchange position 336. In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can take the optical device from the transport device 302 and arrange the optical device in the receptacle 338, 339 when the receptacle 338, 339 is in the exchange position 336. In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can take the optical device from the transport device 302 and arrange the optical device in the receptacle 338, 339 when the receptacle 338, 339 is in the first position 330.

[0077] In an embodiment, the positioning apparatus 308 is configured to remove the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336 and the optical device is arranged in the receptacle 338, 339. In an embodiment, the positioning apparatus 308 is configured to take off the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336 and the optical device is arranged in the receptacle 338, 339. The positioning apparatus 308 can be configured to unload the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336 and the optical device is arranged in the receptacle 338, 339. The state in which the optical device is arranged in the receptacle 338, 339 can be referred to as occupied state. The state in which the optical device is arranged in the receptacle 338, 339 can be referred to as loaded state. In an embodiment, the positioning apparatus 308 is configured to remove the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330 and the optical device is arranged in the receptacle 338, 339. In an embodiment, the positioning apparatus 308 is configured to take off the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330 and the optical device is arranged in the receptacle 338, 339. The positioning apparatus 308 can be configured to unload the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330 and the optical device is arranged in the receptacle 338, 339. The state in which the optical device is arranged in the receptacle 338, 339 can be referred to as occupied state. The state in which the optical device is arranged in the receptacle 338, 339 can be referred to as loaded state.

[0078] In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can take the optical device from the receptacle 338, 339 when the receptacle 338, 339 is in the exchange position 336 and arrange the optical device at the transport device 302, particularly at the intermediate position 324. In an embodiment, the module 300 is arranged and configured such that the positioning apparatus 308 can take the optical device from the receptacle 338, 339 when the receptacle 338, 339 is in the first position 330 and arrange the optical device at the transport device 302, particularly at the intermediate position 324. In an embodiment, the positioning apparatus 308 is configured to move back and forth between the transport device 302 and the rotary table 306. In an embodiment, the positioning apparatus 308 is configured to move back and forth between the intermediate position 324 of the transport device 302 and the exchange position 336 of

the rotary table 306. In an embodiment, the positioning apparatus 308 is configured to move back and forth between the intermediate position 324 of the transport device 302 and the first position 330 of the rotary table 306.

[0079] In an embodiment, the positioning apparatus 308 is configured to provide the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336, and to take off the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336. In an embodiment, the positioning apparatus 308 is configured to supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336, and to remove the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336. In an embodiment, the positioning apparatus 308 is configured to remove optical device from the transport device 302, when the optical device is in the intermediate position 324, and supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336, and the positioning apparatus 308 is configured to take the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336, and supply the optical device to the transport device 302, particularly at the intermediate position 324. The positioning apparatus 308 can be configured to load and unload the receptacle 338, 339, when the receptacle 338, 339 is arranged in the exchange position 336. The positioning apparatus 308 can be configured to exchange the optical device arranged in the receptacle 338, 339 at the exchange position 336. In an embodiment, the positioning apparatus 308 is configured to supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330, and to remove the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330. In an embodiment, the positioning apparatus 308 is configured to remove the optical device from the transport device 302, when the optical device is in the intermediate position 324, and supply the optical device to the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330, and the positioning apparatus 308 is configured to remove the optical device from the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330, and supply the optical device to the transport device 302, particularly at the intermediate position 324. The positioning apparatus 308 can be configured to load and unload the receptacle 338, 339, when the receptacle 338, 339 is arranged in the first position 330. The positioning apparatus

308 can be configured to exchange the optical device arranged in the receptacle 338, 339 at the first position 330.

[0080] An advantage can be that the processing of a plurality of optical devices can be accelerated. For instance, a reference for the state of the art is a productivity of about 20 waveguides per hour. It can be assumed that the productivity of a “back end of line” (BEOL) line is primarily bottlenecked by the most critical process step. The most critical step can be a limiting step. In an embodiment of the invention, the invention allows to split the most critical step in a plurality of small sub-steps aiming at a productivity of about 200 waveguides per hour or more. A smaller sub-step can be a sub-step that can be executed in a shorter time.

[0081] In an embodiment, the rotary table 306 is arranged and configured to move the receptacle 338, 339 in a third position 334 (Fig. 5). In the third position 334, the receptacle 338, 339 can be accessible by a third manufacturing unit 314 (Fig. 5).

[0082] The rotary table 306 can be configured to move the receptacle 338, 339 from the second position 332 to the first position 330 via the third position 334. The rotary table 306 can be configured to move the receptacle 338, 339 from the first position 330 to the third position 334 via the second position 332. The rotary table 306 can be configured to move the receptacle 338, 339 between the first position 330, the second position 332 and the third position 334 along the rotary movement direction 340. The rotary table 306 can be configured to cycle the receptacle 338, 339 to the first position 330, the second position 332 and the third position 334 in sequence along the rotary movement direction 340.

[0083] The rotary table 306 can be configured to move the receptacle 338, 339 from the second position 332 to the exchange position 336 via the third position 334. The rotary table 306 can be configured to move the receptacle 338, 339 from the first position 330 to the exchange position 336 via the second position 332 and the third position 334. The rotary table 306 can be configured to move the receptacle 338, 339 between the exchange position 336, the first position 330, the second position 332 and the third position 334 along the rotary movement direction 340. The rotary table 306 can be configured to cycle the receptacle 338, 339 to the exchange position 336, the first position 330, the second position 332 and the third position 334 in sequence along the rotary movement direction 340.

[0084] The third manufacturing unit 314 can be arranged at the rotary table 306. The third manufacturing unit 314 can be arranged such that the third manufacturing unit 314 faces towards the rotary table 306. In particular, the third manufacturing unit 314 can be arranged such that the third manufacturing unit 314 has access to the rotary table 306 (Fig. 5). The
5 third manufacturing unit 314 can comprise a third effective side facing towards the rotary table 306.

[0085] In an embodiment, the first manufacturing unit 310 and/or the controller 380 is configured to provide positional information and/or offset information of a fiducial of the optical device to the third manufacturing unit 314. In an embodiment, the first manufacturing
10 unit 310 is configured to instruct the third manufacturing unit 314 to align corresponding to the positional information and/or offset information. In an embodiment, the first manufacturing unit 310 is configured to instruct the third manufacturing unit 314 to align corresponding to the determined positional information of a fiducial of the optical device and/or corresponding to the offset information of a fiducial of the optical device. In an
15 embodiment, the controller 380 is configured to instruct the third manufacturing unit 314 to align corresponding to the positional information and/or offset information with regard to the fiducial of the optical device. In an embodiment, the first manufacturing unit 310 and/or the controller 380 is configured to instruct the third manufacturing unit 314 to align corresponding to the positional information and/or the offset information of the optical
20 device.

[0086] In an embodiment, the third manufacturing unit 314 is configured to receive information from the first manufacturing unit 310 and/or the controller 380. In an embodiment, the third manufacturing unit 314 is configured to receive positional information from the first manufacturing unit 310 and/or the controller 380. In an
25 embodiment, the third manufacturing unit 314 is configured to receive the offset information from the first manufacturing unit 310 and/or the controller 380. In an embodiment, the third manufacturing unit 314 is configured to align corresponding to the received positional information and/or the offset information.

[0087] In an embodiment, the third manufacturing unit 314 is arranged and configured to
30 adjust its position with regard to the rotary table 306. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust its position with regard to the

receptacle 338, 339. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust its position with regard to the optical device arranged at the rotary table 306. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust its position with regard to the optical device in response to the positional information
5 received by the first manufacturing unit 310 and/or by the controller 380. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust its position with regard to the optical device in response to the offset information received by the first manufacturing unit 310 and/or by the controller 380. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust the position of the third effective side with regard to the
10 receptacle 338, 339. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust the position of the third effective side with regard to the optical device. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust the position of the third effective side with regard to the optical device in response to the positional information and/or offset information received by the first manufacturing unit
15 310. In an embodiment, the third manufacturing unit 314 is arranged and configured to adjust the position of the third effective side with regard to the optical device in response to the positional information and/or offset information received by the controller 380.

[0088] The module 300 can comprise a plurality of manufacturing units 310, 312, 314. The invention is not limited to three manufacturing units 310, 312, 314. The module may
20 comprise more than three manufacturing units.

[0089] In an embodiment, the module is configured such that each manufacturing unit 310, 312, 314 is allocated to one related position 330, 332, 334. In an embodiment, the exchange position 336 is allocated to the positioning apparatus 308 and all other positions 330, 332, 334 are each allocated to one manufacturing unit 310, 312, 314. The positions 330, 332, 334
25 allocated to manufacturing units 310, 312, 314 can be referred to as manufacturing positions.

[0090] On the rotary table 306, the manufacturing positions 330, 332, 334 (corresponding to the respective manufacturing units 310, 312, 314) can be regularly arranged along the circumferential direction 344. Related to the circumferential direction 344, the manufacturing positions 330, 332, 334 can be arranged equally spaced. On the rotary table
30 306, the exchange position 336 and the manufacturing positions 330, 332, 334 can be regularly arranged along the circumferential direction 344. Related to the circumferential

direction 344, the exchange position 336 and the manufacturing positions 330, 332, 334 can be arranged equally spaced (Fig. 5).

[0091] In an embodiment, the first manufacturing unit 310 is an optical inspection device. In an embodiment, the second manufacturing unit 312 is an optical inspection device. In an embodiment, the third manufacturing unit 314 is an optical inspection device. The optical inspection device can be configured for the optical inspection of the optical device. The optical inspection device can be a camera. The optical inspection device can be configured for the optical inspection. In an embodiment, the optical inspection device is configured for quality control. The optical inspection device can be configured for quality control of the optical device. In an embodiment, the optical inspection device is configured to inspect the processed optical device. In an embodiment, the optical inspection device is configured to inspect the processed optical device and to determine a key performance indicator. In an embodiment, the optical inspection device is configured to inspect the processed optical device, and stops the module if the process key performance indicators move out of tolerance. A key performance indicator (KPI) can refer to the geometry of an optical device, such as its shape, contour, continuity, or uniformity.

[0092] In an embodiment, the first manufacturing unit 310 is an optical alignment device. In an embodiment, the second manufacturing unit 312 is an optical alignment device. In an embodiment, the third manufacturing unit 314 is an optical alignment device. The optical alignment device can be configured to determine a position of the optical device. The optical alignment device can be configured to determine an orientation of the optical device. The optical alignment device can be configured to determine the position and the orientation of the optical device. The optical alignment device can be configured to detect a contour of the optical device. The optical alignment device can be configured to detect a shape of the optical device. The optical alignment device can be configured to detect an outline of the optical device. The optical alignment device can be configured to detect a fiducial. The optical alignment device can be configured to detect a plurality of fiducials. The optical alignment device can be configured to detect a fiducial mark and/or a plurality of fiducial marks. A fiducial can be a marking in the optical device. The fiducial can be used as a reference point. The fiducial can be used to align a manufacturing unit in regard to the position and/or orientation of the optical device. The optical alignment device can be configured to

determine the positional information of the optical device. The optical alignment device can be configured to determine the offset information of the optical device. The optical alignment device can be configured to determine the positional information of the fiducial of the optical device. The optical alignment device can be configured to determine the offset information of the fiducial of the optical device. The optical alignment device can comprise the controller. The optical alignment device can be in communication with the controller.

[0093] In an embodiment, the optical alignment device comprises or consists of a camera, particularly a CCD camera. The CCD camera can be configured to detect the x-position, the y-position and the tilt angle θ . An advantage can be that the positional information and/or the offset information can be easily determined.

[0094] In an embodiment, the optical alignment device comprises an optical z-position system and/or a mechanical z-position system for the determination of the z-position. The optical z-position system can comprise a laser.

[0095] The optical alignment device can be configured to provide the positional information to a further manufacturing unit, particularly a downstream manufacturing unit. The optical alignment device can be configured to provide the offset information to a further manufacturing unit, particularly a downstream manufacturing unit. The optical alignment device can be configured to supply the positional information to a further manufacturing unit, particularly a downstream manufacturing unit. The optical alignment device can be configured to supply the offset information to a further manufacturing unit, particularly a downstream manufacturing unit. In an embodiment, the first manufacturing unit 310 is the optical alignment device, wherein the first manufacturing unit 310 is configured to provide the positional information and/or the offset information to the second manufacturing unit 312. In an embodiment, the first manufacturing unit 310 is the optical alignment device, wherein the first manufacturing unit 310 is configured to provide positional information and/or offset information to the third manufacturing unit 314. In an embodiment, the first manufacturing unit 310 is the optical alignment device, wherein the first manufacturing unit 310 is configured to provide positional information and/or offset information to the second manufacturing unit 312 and to the third manufacturing unit 314. In an embodiment, the optical alignment device is configured to take optical information and provide the optical information to the controller 380. In an embodiment, the optical alignment device is

configured to acquire optical information and provide the acquired optical information to the controller 380. The controller 380 can be configured to determine the positional information and/or offset information based on the received optical information.

[0096] In an embodiment, the first manufacturing unit 310 is a processing device. In an embodiment, the second manufacturing unit 312 is a processing device. In an embodiment, the third manufacturing unit 314 is a processing device. The processing device can be configured for processing the optical device.

[0097] In an embodiment, the first manufacturing unit 310 is a binning device. In an embodiment, the second manufacturing unit 312 is a binning device. In an embodiment, the third manufacturing unit 314 is a binning device. The binning device can be configured for classifying the optical device. In an embodiment, the binning device is configured for classifying the optical device according to the optical inspection of the optical inspection device. In an embodiment, the binning device is configured for classifying the optical device according to the quality control of the optical inspection device. In an embodiment, the binning device is configured for classifying the optical device according to the optical inspection and the quality control.

[0098] In an embodiment, the first manufacturing unit 310 is a stacking device. In an embodiment, the second manufacturing unit 312 is a stacking device. In an embodiment, the third manufacturing unit 314 is a stacking device. The stacking device can be configured for generating a stack of the waveguide and a further waveguide. The stacking device can be configured for generating a stack of the waveguide and a cover glass. The stacking device can be configured for generating a waveguide stack, e.g. a waveguide stack 200 (see Fig. 2).

[0099] In an embodiment, the first manufacturing unit 310 is an edge-blackening device. In an embodiment, the second manufacturing unit 312 is an edge-blackening device. In an embodiment, the third manufacturing unit 314 is an edge-blackening device. The edge-blackening device can be configured for blackening an edge of the waveguide. The edge-blackening device can be configured for blackening an edge of the optical device. The edge-blackening device can be configured for blackening the edge of the waveguide and the edge of the optical device.

[00100] In an embodiment, the first manufacturing unit 310 is a UV-activation device. In an embodiment, the second manufacturing unit 312 is a UV-activation device. In an embodiment, the third manufacturing unit 314 is a UV-activation device.

5 [00101] In an embodiment, the first manufacturing unit 310 is a framing device. In an embodiment, the second manufacturing unit 312 is a framing device. In an embodiment, the third manufacturing unit 314 is a framing device. The framing device can be configured for assembling the waveguide and a frame. In an embodiment, the framing device is configured for assembling a waveguide stack and the frame.

10 [00102] In an embodiment, the first manufacturing unit 310 is a frame-gluing device. In an embodiment, the second manufacturing unit 312 is a frame-gluing device. In an embodiment, the third manufacturing unit 314 is a frame-gluing device. The frame-gluing device can be configured for bonding the waveguide and a frame together. In an embodiment, the frame-gluing device is configured for bonding the waveguide stack and a frame together.

15 [00103] In an embodiment, the first manufacturing unit 310 is a pre-curing device. In an embodiment, the second manufacturing unit 312 is a pre-curing device. In an embodiment, the third manufacturing unit 314 is a pre-curing device. The pre-curing device can be configured for hardening the stack of the waveguide and the further waveguide. The pre-curing device can be configured for hardening the waveguide stack. The pre-curing device
20 can be configured for hardening the stack of the waveguide and the cover glass.

[00104] In an embodiment, the first manufacturing unit 310 is a curing device. In an embodiment, the second manufacturing unit 312 is a curing device. In an embodiment, the third manufacturing unit 314 is a curing device. The curing device can be configured for hardening the optical device.

25 [00105] In an embodiment, the first manufacturing unit 310 is an optical alignment device, the second manufacturing unit 312 is a processing device and the third manufacturing unit 314 is an optical inspection device. In an embodiment, the first manufacturing unit 310 is an optical alignment device for detecting the position and/or the offset of the optical device and instructing accordingly the positional adjustments of the subsequent manufacturing units;

the second manufacturing unit 312 is the processing device configured for performing a process on the optical device; and the third manufacturing unit 314 is the optical inspection device, configured to inspect the processed optical device and stop the machine if the process key performance indicators move out of tolerance.

5 [00106] In an embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the processing device. In an embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the binning device. In an
10 embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the stacking device. In an embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the edge-blackening device. In an embodiment, the first
15 manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the UV-activation device. In an embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the framing device. In an embodiment, the first manufacturing
20 unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the frame-gluing device. In an embodiment, the first manufacturing unit 310 is the optical alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the pre-curing device. In an embodiment, the first manufacturing unit 310 is the optical
25 alignment device, the third manufacturing unit 314 is the optical inspection device and the second manufacturing unit 312 is the curing device.

[00107] In an embodiment, the module 300 further comprises a fourth manufacturing unit. In an embodiment, the first manufacturing unit is the optical alignment device, the second manufacturing unit is a processing device, the third manufacturing unit is a further
30 processing device, and the fourth manufacturing unit is the optical inspection device. In an embodiment, the first manufacturing unit is the optical alignment device, the fourth

manufacturing unit is the optical inspection device, the second manufacturing unit is one of: the processing device, the binning device, the stacking device, the edge-blackening device, the UV-activation device, the framing device, the frame-gluing device, the pre-curing device, and the curing device, and the third manufacturing unit is one of: the processing device, the binning device, the stacking device, the edge-blackening device, the UV-activation device, the framing device, the frame-gluing device, the pre-curing device, and the curing device.

[00108] In an embodiment, the first manufacturing unit is the optical alignment device, the second manufacturing unit is the edge-blackening device, the third manufacturing unit is the pre-curing device and the fourth manufacturing unit is the optical inspection device. In an embodiment, the first manufacturing unit is the optical alignment device, the second manufacturing unit is the edge-blackening device, the third manufacturing unit is the optical inspection device, and the fourth manufacturing unit is the pre-curing device. In an embodiment, the first manufacturing unit is the optical alignment device, the second manufacturing unit is the UV-activation device, the third manufacturing unit is the stacking device, and the fourth manufacturing unit is the optical inspection device. In an embodiment, the third manufacturing unit is configured to execute a process on the optical device which is downstream of the process performed by the second manufacturing unit.

[00109] In an embodiment, the module 300 comprises five manufacturing units. In an embodiment, the first manufacturing unit is the optical alignment device, the third manufacturing unit is the optical inspection device, the fifth manufacturing unit is an additional optical inspection device, the second manufacturing unit is one of: the processing device, the binning device, the stacking device, the edge-blackening device, the UV-activation device, the framing device, the frame-gluing device, the pre-curing device, and the curing device, and the fourth manufacturing unit is one of: the processing device, the binning device, the stacking device, the edge-blackening device, the UV-activation device, the framing device, the frame-gluing device, the pre-curing device, and the curing device. In an embodiment, the second manufacturing unit is configured to execute a preparing process on the optical device and the fourth manufacturing unit is configured to perform a subsequent process on the optical device. In an embodiment, the fourth manufacturing unit is configured

to execute a process on the optical device which is downstream of the process performed by the second manufacturing unit.

[00110] In an embodiment, the module 300 is configured for simultaneous processing of the optical device by the first manufacturing unit 310 and of a further optical device by the second manufacturing unit 312, when the optical device is arranged in the first receptacle 338 and the further optical device is arranged in a second receptacle 339 of the rotary table 306 (Fig. 6). In an embodiment, the module 300 is configured for simultaneous processing of the optical device by the first manufacturing unit 310 and of a further optical device by the second manufacturing unit 312, when the optical device is arranged in the first position 330 and the further optical device is arranged in the second position 332. In an embodiment, the module 300 is configured for simultaneous processing of the optical device by the first manufacturing unit 310 and of a further optical device by the second manufacturing unit 312, when the optical device is arranged in the first receptacle 338 and the further optical device is arranged in the second receptacle 339, when the first receptacle 338 is arranged in the first position 330 and the second receptacle 339 is arranged in the second position 332 (Fig. 6).

[00111] In an embodiment, the module 300 is configured for parallel processing of the optical device by the first manufacturing unit 310 and of a further optical device by the second manufacturing unit 312, when the optical device is arranged in the first receptacle 338 and the further optical device is arranged in a second receptacle 339 of the rotary table 306. In an embodiment, the module 300 is configured such that the further optical device arranged in the second receptacle 339 at the second manufacturing unit 312 can be processed by the second manufacturing unit 312 while the optical device arranged in the first receptacle 338 at the first manufacturing unit 310 is processed by the first manufacturing unit 310. In an embodiment, the module 300 is configured such that the further optical device arranged in the second position 332 at the second manufacturing unit 312 can be processed by the second manufacturing unit 312 while the optical device arranged in the first position 330 at the first manufacturing unit 310 is processed by the first manufacturing unit 310.

[00112] The first manufacturing unit 310 and the second manufacturing unit 312 can be configured and arranged such that the first manufacturing unit 310 and the second manufacturing unit 312 can both have simultaneous access to the rotary table 306.

[00113] In an embodiment, the duration of the process of the first manufacturing unit is equal to the duration of the process of the second manufacturing unit. Advantageously, waiting times can be reduced.

[00114] In an embodiment, the module 300 is configured such that after the process of the first manufacturing unit 310 is finished, the respective receptacle 338, 339 is moved from the first position 330 to the second position 332. In an embodiment, the module 300 is configured such that after the process of the first manufacturing unit 310 is finished and after the process of the second manufacturing unit 312 is finished, the receptacle 338, 339 is moved from the first position 330 to the second position 332.

[00115] The module 300 can be configured for simultaneous processing of a plurality of optical devices. The module 300 can be configured for parallel processing of a plurality of optical devices. The module 300 can be configured for parallel processing of a plurality of optical devices arranged at the rotary table 306 at different receptacles 338, 339. An advantage can be that the production time can be reduced.

[00116] According to an embodiment, the module 300 comprises a further optical inspection device 350 (Fig. 6). The further optical inspection device 350 can be arranged at the transport device 302. The further optical inspection device 350 can be arranged between the intermediate position 324 and the terminal end 322. The further optical inspection device 350 can be arranged downstream of the rotary table 306. The further optical inspection device 350 can be arranged downstream of the intermediate position 324 of the transport device 302. The further optical inspection device 350 can be arranged downstream of the first manufacturing unit 310. The further optical inspection device 350 can be arranged downstream of the second manufacturing unit 312 (Fig. 6). In an embodiment, the further optical inspection device 350 is configured for optical inspection of the optical device. In an embodiment, the further optical inspection device 350 is configured for quality control of the optical device. In an embodiment, the further optical inspection device 350 is configured for optical inspection and quality control of the optical device. In an embodiment, the further optical inspection device 350 is configured for optical inspection and/or quality control of the optical device downstream of a processing of the optical device by the first manufacturing unit 310 and/or the second manufacturing unit 312. The further optical

inspection device 350 can be configured for in-line process control. The further optical inspection device 350 can be configured for final classification of the optical device.

[00117] In an embodiment, the positioning apparatus 308 is a handling robot. The positioning apparatus 308 can comprise a gripper. In an embodiment, the gripper travels
5 back and forth between the exchange position 336 on the rotary table 306 and the tray where the waveguide are arranged. In an embodiment, the gripper travels back and forth between the exchange position 336 on the rotary table 306 and the intermediate position 324 of the transport device 302.

[00118] In an embodiment, the positioning apparatus 308 comprises an ejection system.
10 In an embodiment, the positioning apparatus 308 comprises a lifting system. In an embodiment, the positioning apparatus 308 comprises an ejection system and a lifting system. The ejection system can be configured to lay the optical device in the receptacle 338, 339. The lifting system can be configured to attract the optical device to the conveyor.

[00119] According to an embodiment, the module 300 comprises a further rotary table 360
15 (Fig. 7). In an embodiment, the further rotary table 360 is arranged and configured such that the further rotary table 360 is accessible by the positioning apparatus 308. In an embodiment, the further rotary table 360 comprises a further receptacle 370. The further rotary table 360 can be configured to move the further receptacle 370 into a further exchange position 366. The further rotary table 360 can be configured to move the further receptacle 370 into a
20 further first position 366. The positioning apparatus 308 can be arranged and configured to serve the rotary table 306 and the further rotary table 360 (Fig. 7).

[00120] The further rotary table 360 can be rotatable with respect to a further rotation axis 368 (Fig. 7). The further rotary table 360 can have a circular shape.

[00121] The further rotary table 360 can be accessible by a further first manufacturing unit
25 362. The further rotary table 360 can be accessible by a further second manufacturing unit 364 (Fig. 7).

[00122] The positioning apparatus 308 can be arranged and configured to take an optical device arranged at the rotary table 306 and supply the taken optical device to the further rotary table 360 (Fig. 7). The positioning apparatus 308 can be arranged and configured to

take an optical device arranged in the exchange position 336 of the rotary table 306 and supply the taken optical device to the further exchange position 366 of the further rotary table 360 (Fig. 7). The positioning apparatus 308 can be arranged and configured to take the optical device from the further exchange position 366 of the further rotary table 360 and supply the optical device to the transport device 302, particularly to the intermediate position 324.

[00123] The positioning apparatus 308 can be arranged and configured to take an optical device arranged in the first position 330 of the rotary table 306 and supply the taken optical device to the further first position of the further rotary table 360. The positioning apparatus 308 can be arranged and configured to take the optical device from the further first position of the further rotary table 360 and supply the optical device to the transport device 302, particularly to the intermediate position 324.

[00124] In an embodiment, the module 300 is configured such that the positioning apparatus 308 can supply the optical device to the first position 330 of the rotary table 306. The positioning apparatus 308 can be arranged and configured to take the optical device from a second position of the rotary table 306 and supply the optical device to the further first position of the further rotary table 360.

[00125] An advantage can be that an optical device which cannot be returned to the tray after the process assigned to the rotary table 306 can be further processed by a subsequent processing that can be performed in relation to the further rotary table 360. In an embodiment, edge blackening can be executed on the optical device at the rotary table 306 and the subsequent thermal curing process can be executed at the further rotary table 360.

[00126] A module 300 can operate as a stand-alone device. The module 300 can be configured for in-line connection. The modularity can provide a means of splitting complex processes into a plurality of sub-steps with shorter cycle times. Advantageously, the in-line capability can allow the creation of clusters of in-series tools where a complete process may be carried out with a shorter cycle time. A process can be divided into two or more sub-steps. A module 300 can perform one or more operations of a given sub-step. The cycle time can be the time during which the optical device is arranged at the rotary table 306. The cycle time can be the time during which the optical device is arranged in a receptacle 338, 339.

The cycle time can be the time during which the optical device is processed by the manufacturing units 310, 312, 314 related to the rotary table 306.

[00127] A plurality of modules 300 can be combined to form a system 500. The system 500 can be modular. A system 500 can comprise a first module 300' and a second module 300'' (Figs 8 and 9). A module 300', 300'' can be configured as described above with respect to the embodiments of the module 300. Each module 300', 300'' can be configured as described above with respect to the embodiments of the model 300. A plurality of modules 300, 300', 300'' can be arranged in communication to form a system 500. A system 500 can be a cluster of a plurality of modules 300, 300', 300''.

[00128] In an embodiment, the system comprises a first module 300' and a second module 300''. The first module 300' can comprise a transport device 302' of the first module 300', wherein the transport device 302' of the first module 300' extends along a transportation direction 304' of the first module 300' from a front end 320' of the first module 300' to an opposing terminal end 322' of the first module 300'. The transport device 302' of the first module 300' can be configured to move the optical device along the transportation direction 304' of the first module 300' from the front end 320' of the first module 300' to the terminal end 322' of the first module 300' via an intermediate position 324' of the first module 300'. The first module 300' can comprise a first manufacturing unit 310' of the first module 300' configured to act on the optical device. The first module 300' can comprise a second manufacturing unit 312' of the first module 300' configured to act on the optical device. The first module 300' can comprise a positioning apparatus 308' of the first module 300'. The positioning apparatus 308' of the first module 300' can be arranged and configured to take the optical device from the transport device 302' of the first module 300', when the optical device is at the intermediate position 324' of the first module 300', and to supply the optical device to the first manufacturing unit 310' of the first module 300'.

[00129] The second module 300'' can comprise a transport device 302'' of the second module 300'', wherein the transport device 302'' of the second module 300'' extends along a transportation direction 304'' of the second module 300'' from a front end 320'' of the second module 300'' to an opposing terminal end 322'' of the second module 300''. The transport device 302'' of the second module 300'' can be configured to move the optical device along the transportation direction 304'' of the second module 300'' from the front

end 320'' of the second module 300'' to the terminal end 322'' of the second module 300'' via an intermediate position 324'' of the second module 300''. The second module 300'' can comprise a first manufacturing unit 310'' of the second module 300'' configured to act on the optical device. The second module 300'' can comprise a second manufacturing unit 312'' of the second module 300'' configured to act on the optical device. The second module 300'' can comprise a positioning apparatus 308'' of the second module 300''. The positioning apparatus 308'' of the second module 300'' can be arranged and configured to take the optical device from the transport device 302'' of the second module 300'', when the optical device is at the intermediate position 324'' of the second module 300'', and to supply the optical device to the first manufacturing unit 310'' of the second module 300''.

[00130] The first module 300' can comprise a rotary table 306'. The second module 300'' can comprise a rotary table 306''.

[00131] An advantage can be that the system 500 can be flexible. An advantage can be that the system 500 can be easily adapted to specific requirements of the user. An advantage can be that the system 500 can be easily adapted to specific requirements of a particular production process. An advantage can be that the system 500 can be easily scalable. An advantage can be that the system 500 can be scalable to high volume. An advantage can be that the system 500 can be both flexible and easily scalable.

[00132] The system 500 can be based on a modular tool architecture. The system 500 can be based on a modular manufacturing unit architecture.

[00133] The first module 300' and the second module 300'' can be arranged in sequence. The first module 300' and the second module 300'' can be arranged in-line. The second module 300'' can be arranged downstream of the first module 300'. The second module 300'' can be arranged subsequent to the first module 300'. An advantage can be that the first module 300' and the second module 300'' can be easily connected in series. An advantage can be that the demand of tray feeders can be reduced. Advantageously, the number of tray feeders can be reduced while maintaining the production flexibility. Clusters of modules can be connected via tray feeders. The production flexibility can be advantageously maintained. In an embodiment, tray feeders can feed upstream product lines. In an embodiment, tray feeders can feed downstream of a centralised inspection. In an embodiment, tray feeders can

move the optical devices between a module and a centralised inspection. In an embodiment, tray feeders can move the optical devices between a system and a centralised inspection. The centralised inspection can comprise a central sorter. The centralised inspection can be configured for quality control. The centralised inspection can be configured for final
5 classification.

[00134] An advantage can be that a manufacturing process, particularly a back end of line process, can be split into smaller steps, particularly steps having shorter cycle times. A process step may be split into multiple in-series sub-step operations. It can be advantageous to split a manufacturing process into smaller steps of uniform cycle times. In an embodiment,
10 the cycle time related to the first module is equal to the cycle time of the second module. Waiting times can advantageously be reduced. Advantageously, cycle times can be reduced. The productivity can be advantageously improved.

[00135] In an embodiment, the terminal end 322' of the first module 300' is connected with the front end 320'' of the second module 300'' (Figs 8, 9). The terminal end 322' of
15 the first module 300' can be connected with the front end 320'' of the second module 300'', such that the system 500 is arranged and configured to move the optical device from the front end 320' of the first module 300' to the terminal end 322'' of the second module 300'' via the intermediate position 324' of the first module 300' and the intermediate position 324'' of the second module 300''. The system 500 can be arranged and configured to move
20 the optical device from the front end 320' of the first module 300' to the terminal end 322'' of the second module 300'' along an overall transportation direction 305. The overall transportation direction 305 can be composed of the transportation direction 304' of the first module 300' and the transportation direction 304'' of the second module 300''.

[00136] The overall transportation direction 305 can be straight (Figs 8, 9). In an embodiment, the overall transportation direction 305 is curved. In an embodiment, the overall transportation direction 305 comprises a curved section and a straight section. In an embodiment, the transport device of the first module 300' is a straight conveyor. In an embodiment, the transport device of the second module 300'' is a straight conveyor. Advantageously, the straight conveyor of the first module 300' and the straight conveyor of
30 the second module 300'' can be easily connected.

[00137] In an embodiment, the second manufacturing unit 312' of the first module 300' is configured to perform a first processing process and the second manufacturing unit 312'' of the second module 300'' is configured to perform a second processing process differing from the first processing process. In an embodiment, the second processing process is downstream of the first processing process.

[00138] In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the framing device and the edge-blackening device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the framing device and the pre-curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the framing device and the curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the framing device and the frame-gluing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the frame-gluing device and the edge-blackening device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the frame-gluing device and the pre-curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the frame-gluing device and the curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the edge-blackening device and the pre-curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the edge-blackening device and the curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the UV-activation device and the stacking device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the pre-curing device and the curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the stacking device and the edge-

blackening device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the edge-blackening device and the stacking device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the stacking device and the pre-curing device. In an embodiment, the second manufacturing unit 312' of the first module 300' and the second manufacturing unit 312'' of the second module 300'' are the stacking device and the curing device.

[00139] In an embodiment, a processing step can be divided into a plurality of sub-steps. In an embodiment, a processing step may be split into multiple in-series sub-step operations. The system 500 can be configured such that each sub-step is performed by a different module 300, 300', 300''. An advantage can be that a cycle time of a module can be reduced compared with a production in that the processing is not divided into sub-steps. In an embodiment, the processing of an optical device can be divided into a plurality of sub-steps of the same duration of time.

[00140] In an embodiment, the first module 300' is configured to execute a first sub-step, and the second module 300'' is configured to execute a subsequent second sub-step.

[00141] In an embodiment, the system 500 comprises a first module 300' and a second module 300'' in series connected in-line, wherein the first module 300' is configured for edge blackening and wherein the second module 300'' is configured for curing. The first module 300' can be an edge-blackening deposition module. The second module 300'' can be a cure oven module. In an embodiment, edge-blackening productivity can be increased by a factor of eight. In an embodiment, edge-blackening productivity can be greater than 100 waveguides per hour, edge-blackening productivity can be greater than 150 waveguides per hour, particularly greater than 200 waveguides per hour. In an embodiment, edge-blackening productivity can be 240 waveguides per hour.

[00142] A module 300, 300', 300'' can be removed from the system 500 and replaced by a new module 300, 300', 300''. An advantage might be that the system 500 can be easily adapted to specific requirements of the user. An advantage might be that the system 500 can be easily adapted to specific requirements of a particular production process.

[00143] The system 500 can comprise a plurality of modules 300, 300', 300''. The terminal end 322' of a previous module can be coupled to the front end 320'' of a subsequent module. The system 500 can comprise a sequence of such combined modules 300, 300', 300''. Tray feeders can be used to load/unload the system 500. Advantageously, the need for tray feeders can be reduced because the optical device can be moved via the combined modules 300, 300', 300'' towards different manufacturing units.

[00144] In an embodiment, the system 500 comprises a sorter unit 372 (Fig. 9). The sorter unit 372 can be configured to sort the optical devices according to the optical inspection of the optical inspection device of the first module 300'. The sorter unit 372 can be configured to sort the optical devices according to the optical inspection of the optical inspection device of the second module 300''. The sorter unit 372 can be configured to sort the optical devices according to the optical inspection of the further optical inspection device of the first module 300'. The sorter unit 372 can be configured to sort the optical devices according to the optical inspection of the further optical inspection device of the second module 300''. The sorter unit 372 can be configured for handling a wide range of logic bins. The sorter unit 372 can be configured for handling 72 to 96 logic bins depending on customer form factor.

[00145] In an embodiment of the module, the process complexity can be concentrated in one module. The workflow of the optical devices among different modules can be provided by tray feeders. In an embodiment, the productivity can be greater than 15 waveguides per hour, particularly greater than 20 waveguides per hour, particularly greater than 25 waveguides per hour. In an embodiment, the productivity can be 30 waveguides per hour.

[00146] In an embodiment of the module, the process complexity can be split into a plurality of stand-alone modules. In an embodiment of the module, the process complexity can be distributed over a plurality of stand-alone modules. The workflow of the optical devices among different modules can be provided by tray feeders. In an embodiment, the productivity can be greater than 50 waveguides per hour, particularly greater than 75 waveguides per hour, particularly greater than 90 waveguides per hour. In an embodiment, the productivity can be 100 waveguides per hour.

[00147] In an embodiment of the system, the process complexity can be split into a plurality of in-line modules. In an embodiment of the system, the process complexity can be

distributed over a plurality of in-line modules. The workflow of the optical devices among different systems can be provided by tray feeders. In an embodiment, the productivity can be greater than 100 waveguides per hour, particularly greater than 150 waveguides per hour, particularly greater than 200 waveguides per hour. In an embodiment, the productivity can be 240 waveguides per hour.

[00148] A method for processing of an optical device can be performed. The method can be performed using a module 300, 300', 300'' according to the invention. The method can be performed using a system 500 according to the invention.

[00149] The method can comprise providing the optical device to a front end 320, 320', 320'' of a transport device 302, 302', 302'' and moving the optical device along a transportation direction 304, 304', 304'' from the front end 320, 320', 320'' to an intermediate position 324, 324', 324'' by a transport device 302, 302', 302''. The method can comprise taking the optical device from the transport device 302, 302', 302'' using a positioning apparatus 308, 308', 308'' and supplying the optical device to a first manufacturing unit 310, 310', 310''. The method can comprise processing the optical device using the first manufacturing unit 310, 310', 310'', generating a pre-processed optical device. The method can comprise processing the pre-processed optical device using the second manufacturing unit 312, 312', 312'', generating a processed optical device. The method can comprise moving the processed optical device from the second manufacturing unit 312, 312', 312'' to the transport device 302, 302', 302'' using the positioning apparatus 308, 308', 308''. The method can comprise moving the processed optical device along the transportation direction 304, 304', 304'' from the intermediate position 324, 324', 324'' to a terminal end 322, 322', 322'' using the transport device 302, 302', 302''.

[00150] The method can comprise

- providing the optical device to a front end 320 of a transport device 302 and moving the optical device along a transportation direction 304 from the front end 320 to an intermediate position 324 using a transport device 320,
- taking the optical device from the transport device 302 using a positioning apparatus 308 and providing the optical device to the receptacle 338, 339 arranged in the first position 330,

- processing the optical device by the first manufacturing unit 310, generating a pre-processed optical device,
- rotating the rotary table 306 such that the receptacle 338, 339 moves from the first position 330 to the second position 332,
- 5 - processing the pre-processed optical device using the second manufacturing unit 312, generating a processed optical device,
- moving the processed optical device from the second manufacturing unit 312 to the transport device 302 using the positioning apparatus 308,
- moving the processed optical device along the transportation direction 304 from the
10 intermediate position 324 to a terminal end 322 using the transport device 302.

[00151] The method can comprise

- providing the optical device to a front end 320 of a transport device 302 and moving the optical device along a transportation direction 304 from the front end 320 to an intermediate position 324 using a transport device 302,
- 15 - taking the optical device from the transport device 302 using a positioning apparatus 308 and supplying the optical device to the receptacle 338, 339 arranged in the exchange position 336,
- rotating the rotary table 306 such that the receptacle 338, 339 moves from the exchange position 336 to the first position 330,
- 20 - processing the optical device using the first manufacturing unit 310, generating a pre-processed optical device,
- rotating the rotary table 306 such that the receptacle 338, 339 moves from the first position 330 to the second position 332,
- processing the pre-processed optical device using the second manufacturing unit 312,
25 generating a processed optical device,

- moving the processed optical device from the second manufacturing unit 312 to the transport device 302 using the positioning apparatus 308,
- moving the processed optical device along the transportation direction 304 from the intermediate position 324 to a terminal end 322 using the transport device 302.

5 [00152] The method can further comprise moving the processed optical device from the terminal end 322' (of a first module 300') to the front end 320'' of a transport device 302'' of a subsequent module (second module 300''), and performing the steps on the processed optical device using the subsequent (second) module 300'' to generate a further-processed optical device.

10 [00153] In an embodiment, the method comprises

- supplying the optical device to a front end 320' of a transport device 302' of a first module 300',

15 - moving the optical device along a transportation direction 304' of the first module 300' from the front end 320' of the first module 300' to an intermediate position 324' of the first module 300' using a transport device 302' of the first module 300',

- taking the optical device from the transport device 302' of the first module 300' using a positioning apparatus 308' of the first module 300' and supplying the optical device to a first manufacturing unit 310' of the first module 300',

20 - processing the optical device using the first manufacturing unit 310' of the first module 300', generating a pre-processed optical device,

- processing the pre-processed optical device using the second manufacturing unit 312' of the first module 300', generating a processed optical device,

25 - moving the processed optical device from the second manufacturing unit 312' of the first module 300' to the transport device 302' of the first module 300' using the positioning apparatus 308' of the first module 300',

- moving the processed optical device along the transportation direction 304' of the first module 300' from the intermediate position 324' of the first module 300' to a terminal end 322' of the first module 300' using the transport device 302' of the first module 300',
- moving the processed optical device from the terminal end 322' of the first module 300' to
5 the front end 320'' of a transport device 302'' of a second module 300'',
- moving the processed optical device along a transportation direction 304'' of the second module 300'' from the front 320'' end of the second module 300'' of the transport device 302'' of the second module 300'' to an intermediate position 324'' of the transport device 302'' of the second module 300'' using the transport device 302'' of the second module
10 300'',
- taking the processed optical device from the transport device 302'' of the second module 300'' using a positioning apparatus 308'' of the second module 300'' and providing the processed optical device to a first manufacturing unit 310'' of the second module 300'',
- further processing the processed optical device using the first manufacturing unit 310'' of
15 the second module 300'', generating an additionally-processed optical device,
- further processing the additionally-processed optical device using the second manufacturing unit 312'' of the second module 300'', generating a further-processed optical device,
- moving the further-processed optical device from the second manufacturing unit 312'' of
20 the second module 300'' to the transport device 302'' of the second module 300'' using the positioning apparatus 308'' of the second module 300'', and
- moving the further-processed optical device along the transportation direction 304'' of the second module 300'' from the intermediate position 324'' of the second module 300'' to a terminal end 322'' of the second module 300'' using the transport device 302'' of the second
25 module 300''.

[00154] While the foregoing is directed to embodiments of the disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

CLAIMS

1. A module (300) for processing an optical device, wherein the optical device comprises or consists of a waveguide (10), wherein the module (300) comprises:
- 5 a transport device (302), wherein the transport device (302) extends along a transportation direction (304) from a front end (320) to an opposing terminal end (322), wherein the transport device (302) is configured to move the optical device along the transportation direction (304) from the front end (320) to the terminal end (322) via an intermediate position (324),
- a first manufacturing unit (310) configured to act on the optical device,
- 10 a second manufacturing unit (312) configured to act on the optical device, and
- a positioning apparatus (302) arranged and configured to take the optical device from the transport device (302), when the optical device is at the intermediate position (324), and to supply the optical device to the first manufacturing unit (310).
- 15 2. The module (300) according to claim 1, wherein the transport device (302) comprises a linear section and/or a curved section, wherein the linear section and/or the curved section are arranged and configured such that the front end (320) and the terminal end (322) are arranged spaced apart from each other.
- 20 3. The module (300) according to one of the claims 1 or 2, wherein the transport device (302) comprises at least one of: a conveyor, a rail system, a shuttle system, a linear actuator, and a rotary actuator.
4. The module (300) according to one of the claims 1 to 3, wherein the module (300)
- 25 comprises a rotary table (306), wherein the rotary table (306) is arranged and configured such that the rotary table (306) is accessible by the positioning apparatus (308), the first manufacturing unit (310) and/or the second manufacturing unit (312).

5. The module (300) according to claim 4, wherein the rotary table (306) comprises a receptacle (338, 339) for receiving the optical device, wherein the rotary table (306) is configured to arrange the receptacle (338, 339) in a first position (330) and in a second position (332), wherein in the first position (330), the receptacle (338, 339) is accessible by
5 the first manufacturing unit (310), and wherein in the second position (332), the receptacle (338, 339) is accessible by the second manufacturing unit (312).

6. The module (300) according to claim 5, wherein the rotary table (306) is configured to move the receptacle (338, 339) between an exchange position (336), the first position (330)
10 and the second position (332).

7. The module (300) according to one of the claims 5 or 6, wherein the module (300) is configured such that in the exchange position (336), the receptacle (338, 339) is accessible by the positioning apparatus (308) to supply the optical device to the receptacle (338, 339),
15 and/or to remove the optical device from the receptacle (338, 339),

and/or wherein the module (300) is configured such that in the first position (330), the receptacle (338, 339) is accessible by the positioning apparatus (308) to supply the optical device to the receptacle (338, 339), and/or to remove the optical device from the receptacle (338, 339).
20

8. The module (300) according to one of the claims 4 to 7, wherein the rotary table (306) is arranged and configured to move the receptacle (338, 339) into a third position (334), wherein in the third position (334), the receptacle (338, 339) is accessible by a third manufacturing unit (314).
25

9. The module (300) according to one of the claims 1 to 8, wherein the first manufacturing unit (310), the second manufacturing unit (312) and/or the third manufacturing unit (314) is one of:

- an optical inspection device, particularly a camera, configured for the optical inspection of the optical device and/or for quality control, particularly configured for optical inspection,
- an optical alignment device configured to determine a position of the optical device and/or an orientation of the optical device,
- 5 - a processing device configured for processing the optical device,
- a binning device configured for classification of the optical device, particularly according to the optical inspection and/or quality control,
- a stacking device configured for generating a stack (200) of the waveguide (10) and a further waveguide (10) and/or a stack (200) of the waveguide (10) and a cover glass (202a, 10 202b),
- an edge-blackening device configured for blackening an edge of the waveguide (10) and/or an edge of the optical device,
- a UV-activation device,
- a framing device configured for assembling the waveguide (10) and a frame,
- 15 - a frame-gluing device configured for bonding the waveguide (10) and a frame together,
- a pre-curing device configured for hardening the stack (200) of the waveguide (10) and the further waveguide (10) and/or the stack (200) of the waveguide (10) and the cover glass (200), and
- a curing device configured for hardening the optical device.

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10. The module (300) according to claim 9, wherein the first manufacturing unit (310) is the optical alignment device, wherein the third manufacturing unit (314) is the optical inspection device, and wherein the second manufacturing unit (312) is one of: the processing device, the binning device, the stacking device, the edge-blackening device, the UV-activation device, the framing device, the frame-gluing device, the pre-curing device, and the curing device.
- 25

11. The module (300) according to one of the claims 4 to 10, wherein the module (300) is configured for the simultaneous processing of the optical device by the first manufacturing unit (310) and of a further optical device by the second manufacturing unit (312), when the optical device is arranged in the first receptacle (338) and the further optical device is
5 arranged in a second receptacle (339) of the rotary table (306).

12. The module (300) according to one of the claims 1 to 11, wherein the positioning device (308) is a handling robot.

10 13. The module (300) according to one of the claims 1 to 12, wherein the module (300) comprises a further optical inspection device (350), wherein the further optical inspection device (350) is arranged at the transport device (302) between the intermediate position (324) and the terminal end (322), particularly wherein the further optical device (350) is configured for the optical inspection of the optical device and/or quality control of the optical device,
15 particularly configured for the optical inspection.

14. The module (300) according to one of the claims 1 to 13, wherein the module (300) comprises a further rotary table (360), particularly wherein the further rotary table (360) is arranged and configured such that the further rotary table (360) is accessible by the
20 positioning apparatus (308).

15. A system (500) for processing of an optical device, wherein the optical device comprises or consists of a waveguide (10), wherein the system (500) comprises a first module (300') according to one of the claims 1 to 14, and a second module (300'') according to one of the
25 claims 1 to 14,

wherein the first module (300') and the second module (300'') are arranged in sequence, wherein the terminal end (322') of the first module (300') is connected with the front end (320'') of the second module (300''), such that the system (500) is arranged and configured to move the optical device from the front end (320') of the first module (300') to the terminal

end (322'') of the second module (300'') via the intermediate position (324') of the first module (300') and the intermediate position (324'') of the second module (300'').

16. The system (500) according to claim 15, wherein the second manufacturing unit (312') of the first module (300') is configured to perform a first processing process and the second manufacturing unit (312'') of the second module (300'') is configured to perform a second processing process differing from the first processing process.

17. The system (500) according to one of the claims 15 or 16, wherein the second manufacturing unit (312') of the first module (300') and the second manufacturing unit (312'') of the second module (300'') is one of the combinations:

- the framing device and the edge-blackening device,
- the framing device and the pre-curing device,
- the framing device and the curing device,
- 15 - the framing device and the frame-gluing device,
- the frame-gluing device and the edge-blackening device,
- the frame-gluing device and the pre-curing device,
- the frame-gluing device and the curing device,
- the edge-blackening device and the pre-curing device,
- 20 - the edge-blackening device and the curing device,
- the UV-activation device and the stacking device,
- the pre-curing device and the curing device,
- the stacking device and the edge-blackening device,
- the edge-blackening device and the stacking device,
- 25 - the stacking device and the pre-curing device, and
- the stacking device and the curing device.

18. The system (500) according to one of the claims 15 to 17, wherein the system (500) comprises a sorter unit (372), wherein the sorter unit (372) is configured to sort the optical devices according to the optical inspection of the optical inspection device of the first module (300'), of the optical inspection device of the second module (300''), of the further optical inspection device of the first module (300') and/or of the further optical inspection device of the second module (300'').

19. A method for processing of an optical device, wherein the optical device comprises or consists of a waveguide (10), the method comprising:

- providing the optical device to a front end of a transport device (302),
- moving the optical device along a transportation direction (304) from the front end (320) to an intermediate position (324) by a transport device (302),
- taking the optical device from the transport device (302) using a positioning apparatus (308) and supplying the optical device to a first manufacturing unit (310),
- processing the optical device by the first manufacturing unit (310), generating a pre-processed optical device,
- processing the pre-processed optical device by the second manufacturing unit (312), generating a processed optical device,
- moving the processed optical device from the second manufacturing unit (312) to the transport device (302) using the positioning apparatus (308), and
- moving the processed optical device along the transportation direction (304) from the intermediate position (324) to a terminal end (322) using the transport device (302).

20. The method according to claim 19, wherein the method further comprises:

- moving the processed optical device from the terminal end to the front end of a transport device of a subsequent module and

- performing the steps of the method according to claim 19 on the processed optical device using the subsequent module to generate a further-processed optical device.