

LIGHT-EMITTING ASSEMBLY AND OPTICAL MODULE

[0001] This application claims the priority of the Chinese patent application filed with the China Patent Office on December 28, 2023, with application number 202323621271.2 and invention name “light-emitting assembly and optical module”, the entire contents of which are incorporated by reference in this application.

TECHNICAL FIELD

[0002] The utility model relates to the technical field of semiconductor integration, in particular to a light-emitting assembly and a light module.

BACKGROUND ART

[0003] At present, the optical mode used by silicon photonic chips is mainly a TE mode. The width of the optical waveguide is generally about twice the thickness, and the TE mode light field distribution is horizontally flat. The main reason is that the top silicon thickness of the silicon photonic platform of most silicon photonic foundries is 220 nm or even lower. This thickness of silicon has poor light field confinement for the TM mode, which is not conducive to the performance of active and passive devices.

[0004] However, the TE mode also has certain disadvantages. For example, in the modulator, the overlap between the light field and the PN junction depletion layer is low, and the modulation efficiency is not high. In addition to being unfavorable to the modulator, the TE mode is also unfavorable to the loss of passive devices. The electric field vibration direction of the TE mode is horizontal, and it has a stronger effect on the left-side wall and the right-side wall of the waveguide. The left-side wall and the right-side wall of the waveguide are

formed by etching and have poor roughness, thereby resulting in large waveguide losses. The electric field vibration direction of the TM mode is vertical, and it has a stronger effect on the upper and lower edges of the waveguide. The upper and lower edges of the waveguide are polished and have good roughness, thereby resulting in lower waveguide losses.

UTILITY MODEL CONTENT

[0005] The utility model aims to provide a light-emitting assembly and an optical module, so as to reduce the transmission loss of light in an optical chip.

[0006] In order to achieve one of the above-mentioned purposes of the utility model, an embodiment of the utility model provides a light-emitting assembly, and the light-emitting assembly comprises a light output unit and an optical chip;

[0007] wherein the light output unit is configured for outputting a vertical polarized light;

[0008] the optical chip comprises a first coupling unit, an optical processing unit and a second coupling unit connected sequentially along the optical signal propagation direction via an optical transmission waveguide;

[0009] the first coupling unit is configured for receiving the vertical polarized light, coupling the vertical polarized light and then outputting a coupled vertical polarized light;

[0010] the optical processing unit is configured for receiving the coupled vertical polarized light, processing the coupled vertical polarized light and outputting a processed vertical polarized light;

[0011] the second coupling unit is configured for receiving the processed vertical polarized light, coupling the processed vertical polarized light and then outputting the coupled vertical polarized light outside the optical chip; and

[0012] a thickness of at least part of the optical transmission waveguide is greater than or equal to 250 nm.

[0013] As a further improvement of an embodiment of the utility model, the optical chip further comprises a beam-splitting unit, the beam-splitting unit is connected to an output end of the first coupling unit and is configured to split the coupled vertical polarized light into at least two transmission paths, and each transmission path is connected to the optical processing unit and the second coupling unit.

[0014] As a further improvement of an embodiment of the utility model, the optical chip further comprises a mode filtering unit, the mode filtering unit is connected to the first coupling unit and the optical processing unit, and an input end of the mode filtering unit is connected to the output end of the first coupling unit, and is configured to allow only the vertical polarized light to pass through.

[0015] As a further improvement of an embodiment of the utility model, the optical processing unit comprises an optical modulator, the optical modulator comprises a modulation electrode and a modulation waveguide, and the modulation waveguide is connected to the optical transmission waveguide; and

[0016] a thickness of the modulation waveguide is set to be greater than or equal to 250 nm.

[0017] As a further improvement of an embodiment of the utility model, the optical transmission waveguide is a silicon nitride waveguide and/or a silicon waveguide.

[0018] As a further improvement of an embodiment of the utility model, when the optical transmission waveguide is a silicon nitride waveguide, a thickness of the optical transmission waveguide is set to be greater than or equal to 250nm;

when the optical transmission waveguide is a silicon waveguide, the thickness of the optical transmission waveguide is set to be greater than or equal to 265nm.

[0019] As a further improvement of an embodiment of the utility model, when the optical transmission waveguide is a silicon nitride waveguide and a silicon waveguide, a waveguide conversion structure is provided at a connection between the silicon nitride waveguide and the silicon waveguide, and the waveguide conversion structure is configured for optical coupling between the silicon nitride waveguide and the silicon waveguide.

[0020] As a further improvement of an embodiment of the utility model, the light output unit comprises a laser-emitting unit and a spatial coupling unit, the laser-emitting unit is configured to output a horizontal polarized light, and the spatial coupling unit is arranged between the laser-emitting unit and the optical chip, and is configured to receive the horizontal polarized light, change a polarization state of the horizontal polarized light, and output the vertical polarized light.

[0021] As a further improvement of an embodiment of the utility model, the spatial coupling unit comprises a lens, an isolator and a wave plate, the lens is arranged adjacent to the laser-emitting unit, and the wave plate is arranged adjacent to the optical chip, and is configured to convert the horizontal polarized light into a vertical polarized light and then output the vertical polarized light; the isolator is arranged between the lens and the wave plate.

[0022] In order to achieve one of the above purposes of the utility model, the utility model further provides an optical module, and the optical module has the above-mentioned light-emitting assembly.

[0023] The beneficial effect of the utility model is that the optical chip in the light-emitting assembly receives vertical polarized light at one end that is optically coupled with the output light of the light output unit. Compared with the technical solution of the conventional technology in which the optical chip receives and outputs horizontal polarized light, the spot conversion unit, the optical processing unit and the waveguide for transmitting the optical signal in the optical chip can greatly reduce the nonlinear loss caused by optical transmission in the optical chip when the input optical power is large, by transmitting vertical polarized light rather than horizontal polarized light. In addition, by increasing the thickness of the optical transmission waveguide, the transmission loss of vertical polarized light can be further reduced, thereby improving the overall performance of the optical chip.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a schematic diagram of a light-emitting assembly in one embodiment of the present utility model; and

[0025] FIG. 2 is a schematic diagram of a light-emitting assembly in another embodiment of the present utility model.

DETAILED DESCRIPTION

[0026] In order to make the purpose, technical solutions and advantages of this application clearer, the technical solutions of this application will be clearly and completely described below in combination with the specific implementation methods of this application and the corresponding drawings. Obviously, the described implementation methods are only part of the implementation methods of this application, and not all of the implementation methods. Based on the implementation methods in this application, all other implementation methods

obtained by ordinary technicians in this field without making creative work are within the scope of protection of this application.

[0027] The embodiments of the present invention are described in detail below, and examples of the embodiments are shown in the accompanying drawings, in which the same or similar reference numerals throughout represent the same or similar elements or elements having the same or similar functions. The embodiments described below with reference to the accompanying drawings are exemplary and are only used to explain the present invention, and cannot be understood as limiting the present utility model.

[0028] The utility model provides a light-emitting assembly, which comprises a light output unit and an optical chip;

[0029] the light output unit is configured to output a vertical polarized light;

[0030] the optical chip comprises a first coupling unit, an optical processing unit and a second coupling unit connected sequentially along the optical signal propagation direction via an optical transmission waveguide;

[0031] the first coupling unit is configured for receiving the vertical polarized light, coupling the vertical polarized light and then outputting a coupled vertical polarized light;

[0032] the optical processing unit is configured for receiving the coupled vertical polarized light, processing the coupled vertical polarized light and outputting a processed vertical polarized light;

[0033] the second coupling unit is configured for receiving the processed vertical polarized light, coupling the processed vertical polarized light and then outputting the coupled vertical polarized light outside the optical chip; and

[0034] a thickness of at least part of the optical transmission waveguide is greater than or equal to 250 nm.

[0035] As shown in FIG. 1, an embodiment of the present utility model provides a light-emitting assembly, comprising a light output unit 1 and an optical chip 2.

[0036] The light output unit 1 is configured to output vertical polarized light.

[0037] The optical chip 2 is optically coupled with the light output unit 1 to receive the vertical polarized light output by the light output unit 1. Specifically, the optical chip 2 is sequentially connected to the first coupling unit 21, the optical processing unit 22 and the second coupling unit 23 through the optical transmission waveguide along the optical signal propagation direction.

[0038] The first coupling unit 21 is configured to receive the vertical polarized light output by the light output unit 1, couple the vertical polarized light and then output the coupled vertical polarized light. Since the electric field vibration direction of the vertical polarized light is the vertical direction, it has a stronger effect on the upper and lower edges of the optical transmission waveguide, and the upper and lower edges of the optical transmission waveguide are generally polished and have a good roughness, so that as compared with the horizontal polarized light, the vertical polarized light has a lower transmission loss when being transmitted in the optical chip.

[0039] Specifically, the first coupling unit 21 is an edge coupler, such as a spot converter, which can be a spot converter having an inverse wedge structure, a spot converter having a sub-wavelength grating structure, or a spot converter having other structures. When the first coupling unit 21 is a spot converter, and when the light output unit 1 is optically coupled with the first coupling unit 21,

the first coupling unit 21 receives external input light and reduces the spot of the input light, so that the coupled light after the spot reduction can be transmitted between the optical transmission waveguide on the optical chip 2 and other optical units or optical devices.

[0040] The optical processing unit 22 is configured to receive the coupled vertical polarized light, process the coupled vertical polarized light, and output the processed vertical polarized light.

[0041] Specifically, the optical processing unit 22 at least comprises a light modulator, which modulates the coupled vertical polarized light and then outputs the modulated vertical polarized light.

[0042] Naturally, the optical processing unit 22 may also comprise functional devices such as a wavelength division multiplexer and a beam splitter. The utility model does not limit the type, quantity and setting position of the functional devices, and the design can be adjusted according to the actual design requirements and application scenarios of the optical chip.

[0043] The second coupling unit 23 is configured to receive the vertical polarized light processed by the optical processing unit 22, couple the processed vertical polarized light, and then output the coupled vertical polarized light to the outside of the optical chip 2.

[0044] Specifically, the second coupling unit 23 is an edge coupler, such as a spot converter, which can be a spot converter having an inverse wedge structure, a spot converter having a sub-wavelength grating structure, or a spot converter having other structures. When the second coupling unit 23 is a spot converter, the second coupling unit 23 receives the processed vertical polarized light,

performs spot amplification on the processed vertical polarized light, and then outputs the processed vertical polarized light to the outside of the optical chip 2.

[0045] Furthermore, the optical chip 2 in this embodiment further comprises a beam-splitting unit 24, the beam-splitting unit 24 is connected to the output end of the first coupling unit 21 and is configured to split the coupled vertical polarized light into at least two transmission paths, and each transmission path is connected to the optical processing unit 22 and the second coupling unit 23.

[0046] Specifically, the beam-splitting unit 24 is a 3dB coupler that splits the coupled vertical polarized light into two transmission paths, and each transmission path is connected to the optical processing unit 22 and the second coupling unit 23.

[0047] Naturally, the beam-splitting unit 24 can also be designed as a multi-channel beam splitter structure, and it is only necessary to ensure that the optical power of each transmission channel meets the transmission requirements of subsequent silicon-based optical devices.

[0048] Furthermore, as shown in FIG. 2, the optical chip 2 further comprises a first optical power monitoring unit 25 and a second optical power monitoring unit 26.

[0049] The first optical power monitoring unit 25 is connected to the output end of the first coupling unit 21, and is configured to monitor the optical power of the coupled vertical polarized light output by the first coupling unit 21.

[0050] The second optical power monitoring unit 26 is connected to the output end of the optical processing unit 22, and is configured to monitor the optical power of the processed vertical polarized light output by the optical processing unit 22.

[0051] Specifically, the first optical power monitoring unit 25 and the second optical power monitoring unit 26 are both optical detection devices.

[0052] In practical applications, it is difficult to ensure that the light coupled into the optical chip 2 by the first coupling unit 21 is all light in a vertical polarized state. Therefore, the optical chip 2 in this embodiment further comprises a mode filtering unit 27, which is connected to the first coupling unit 21 and the optical processing unit 22. Its input end is connected to the output end of the first coupling unit 21, and is configured to allow only numerically polarized light to pass through.

[0053] Specifically, the input end of the mode filtering unit 27 is connected to the output end of the first coupling unit 21, and the output end of the mode filtering unit 27 is connected to the input end of the beam-splitting unit 24.

[0054] More specifically, the mode filtering unit 27 is a polarization separator or a polarization rotation separator, and one end of the polarization separator or the polarization rotation separator outputting vertical polarized light is connected to the input end of the beam-splitting unit 24.

[0055] Naturally, a combiner may be designed after the output end of the optical processing unit 22 for combining the two optical transmission paths into one output, and the specific design may be based on actual needs.

[0056] In this embodiment, the thickness of at least part of the optical transmission waveguide used to connect various devices in the optical chip 2 is greater than or equal to 250 nm. Since the electric field vibration direction of vertical polarized light transmitted in the optical transmission waveguide is vertical, the interaction with the upper and lower edges of the optical

transmission waveguide is stronger, and the thicker the optical transmission waveguide is, the smaller the transmission loss of the vertical polarized light is.

[0057] Naturally, when the optical processing unit 22 comprises an optical modulator, the optical modulator comprises a modulation electrode and a modulation waveguide, the modulation waveguide is connected to the optical transmission waveguide, and the thickness of the modulation waveguide is set to be greater than or equal to 250 nm.

[0058] Specifically, the light transmission waveguide is a silicon nitride waveguide and/or a silicon waveguide.

[0059] When the light transmission waveguide is a silicon nitride waveguide, the thickness of the light transmission waveguide is set to be greater than or equal to 250 nm.

[0060] When the light transmission waveguide is a silicon waveguide, the thickness of the light transmission waveguide is set to be greater than or equal to 265 nm.

[0061] Naturally, the present utility model does not limit the specific value of the thickness of the optical transmission waveguide, and it can be adjusted according to the manufacturing process of the optical chip and actual design requirements.

[0062] Specifically, when the optical transmission waveguide is a silicon nitride waveguide and a silicon waveguide, a waveguide conversion structure is provided at the connection between the silicon nitride waveguide and the silicon waveguide, and the waveguide conversion structure is configured for optical coupling between the silicon nitride waveguide and the silicon waveguide. In other words, if a section of the optical transmission waveguide on the optical

transmission path is the silicon nitride waveguide and the silicon waveguide connected to each other, the waveguide conversion structure can couple the light transmitted by the silicon nitride waveguide into the silicon waveguide.

[0063] In this embodiment, the light output unit 1 comprises a laser-emitting unit 11 and a spatial coupling unit 12.

[0064] The laser-emitting unit 11 is configured to output the horizontal polarized light.

[0065] The spatial coupling unit 12 is disposed between the laser-emitting unit 11 and the optical chip 2, and is configured to receive the horizontal polarized light, change the polarization state of the horizontal polarized light, and output the vertical polarized light.

[0066] Specifically, the laser-emitting unit 11 outputs the horizontal polarized light having high power. In this embodiment, the laser-emitting unit 11 uses a 1310 nm DFB laser.

[0067] The spatial coupling unit 12 is configured to receive the horizontal polarized light output by the laser-emitting unit 11, expand the mode field diameter of the horizontal polarized light output by the laser-emitting unit 11, and change and convert the polarization state of the horizontal polarized light output by the laser-emitting unit 11 into the vertical polarized light.

[0068] Naturally, in other embodiments of the present utility model, the laser-emitting unit 11 may also use other types of lasers that can output high-power lasers, and the output lasers may be horizontal polarized light or mixed polarized light. When the laser-emitting unit 11 outputs the mixed polarized light, the spatial coupling unit 12 may filter out or convert the horizontal polarized light in the mixed polarized light into the vertical polarized light.

[0069] Specifically, the spatial coupling unit 12 comprises a lens 121, an isolator 122 and a wave plate 123.

[0070] The lens 121 is disposed adjacent to the laser-emitting unit 11, and is configured to expand the mode field diameter of the horizontal polarized light output by the laser-emitting unit 11. Here, the lens 121 is a spherical glass lens.

[0071] The wave plate 123 is disposed adjacent to the optical chip 2, and relevant parameters can be set by the wave plate 123 to convert the horizontal polarized light output by the laser-emitting unit 11 into vertical polarized light output.

[0072] The isolator 122 is disposed between the lens 121 and the wave plate 123.

[0073] The utility model further provides an optical module, and the optical module has the light-emitting assembly as described in any one of the above embodiments.

[0074] In summary, the optical chip in the coupled optical path proposed by the utility model receives vertical polarized light at one end that is optically coupled with the output light of the laser source. Compared with the technical solution of the commonly used technology in which the optical chip receives and outputs horizontal polarized light, the spot conversion unit, the optical processing unit and the waveguide for transmitting the optical signal in the optical chip transmit vertical polarized light rather than horizontal polarized light when the input optical power is large, which can greatly reduce the nonlinear loss caused by optical transmission in the optical chip. In addition, increasing the thickness of the optical transmission waveguide can further reduce the

transmission loss of the vertical polarized light and improve the overall performance of the optical chip.

[0075] It should be understood that, although this specification is described according to implementation modes, not every implementation mode contains only one independent technical solution. This description of the specification is only for the sake of clarity. Those skilled in the art should regard the specification as a whole. The technical solutions in each implementation mode may also be appropriately combined to form other implementation modes that can be understood by those skilled in the art.

[0076] The series of detailed descriptions listed above are only specific descriptions of feasible implementation methods of the utility model. They are not intended to limit the protection scope of the utility model. Any equivalent implementation methods or changes that do not deviate from the technical spirit of the utility model should be included in the protection scope of the utility model.

CLAIMS

- [Claim 1] A light-emitting assembly, wherein, the light-emitting assembly comprises a light output unit and an optical chip;
wherein the light output unit is configured for outputting a vertical polarized light;
the optical chip comprises a first coupling unit, an optical processing unit and a second coupling unit connected sequentially along the optical signal propagation direction via an optical transmission waveguide;
the first coupling unit is configured for receiving the vertical polarized light, coupling the vertical polarized light and then outputting a coupled vertical polarized light;
the optical processing unit is configured for receiving the coupled vertical polarized light, processing the coupled vertical polarized light and outputting a processed vertical polarized light;
the second coupling unit is configured for receiving the processed vertical polarized light, coupling the processed vertical polarized light and then outputting the coupled vertical polarized light outside the optical chip; and
a thickness of at least part of the optical transmission waveguide is greater than or equal to 250 nm.
- [Claim 2] The light-emitting assembly according to claim 1, wherein, the optical chip further comprises a beam-splitting unit, the beam-splitting unit is connected to an output end of the first coupling unit and is configured to split the coupled vertical polarized light into at

least two transmission paths, and each transmission path is connected to the optical processing unit and the second coupling unit.

[Claim 3] The light-emitting assembly according to claim 1, wherein, the optical chip further comprises a mode filtering unit, the mode filtering unit is connected to the first coupling unit and the optical processing unit, and an input end of the mode filtering unit is connected to the output end of the first coupling unit, and is configured to allow only the vertical polarized light to pass through.

[Claim 4] The light-emitting assembly according to claim 1, wherein, the optical processing unit comprises an optical modulator, the optical modulator comprises a modulation electrode and a modulation waveguide, and the modulation waveguide is connected to the optical transmission waveguide; and
a thickness of the modulation waveguide is set to be greater than or equal to 250 nm.

[Claim 5] The light-emitting assembly according to any one of claims 1 to 4, wherein, the optical transmission waveguide is a silicon nitride waveguide and/or a silicon waveguide.

[Claim 6] The light-emitting assembly according to claim 5, wherein, when the optical transmission waveguide is a silicon nitride waveguide, a thickness of the optical transmission waveguide is set to be greater than or equal to 250 nm; when the optical transmission waveguide is a silicon waveguide, the thickness of the optical transmission

waveguide is set to be greater than or equal to 265 nm.

[Claim 7] The light-emitting assembly according to claim 5, wherein, when the optical transmission waveguide is a silicon nitride waveguide and a silicon waveguide, a waveguide conversion structure is provided at a connection between the silicon nitride waveguide and the silicon waveguide, and the waveguide conversion structure is configured for optical coupling between the silicon nitride waveguide and the silicon waveguide.

[Claim 8] The light-emitting assembly according to claim 1, wherein, the light output unit comprises a laser-emitting unit and a spatial coupling unit, the laser-emitting unit is configured to output a horizontal polarized light, and the spatial coupling unit is arranged between the laser-emitting unit and the optical chip, and is configured to receive the horizontal polarized light, change a polarization state of the horizontal polarized light, and output the vertical polarized light.

[Claim 9] The light-emitting assembly according to claim 8, wherein, the spatial coupling unit comprises a lens, an isolator and a wave plate, the lens is arranged adjacent to the laser-emitting unit, and the wave plate is arranged adjacent to the optical chip, and is configured to convert the horizontal polarized light into a vertical polarized light and then output the vertical polarized light; the isolator is arranged between the lens and the wave plate.

[Claim 10] An optical module, wherein, the optical module has the light-emitting assembly as claimed in any one of claims 1-9.