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Polarization rotators with overlapping waveguide cores

Abstract

Structures for a polarization rotator and methods of forming a structure for a polarization rotator. The structure comprises a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end. The first and second sections of the first waveguide core are arranged between the first terminating end and the second terminating end. The structure further comprises a second waveguide core including a first tapered section having a first overlapping arrangement with the first section of the first waveguide core and a second tapered section having a second overlapping arrangement with the second section of the first waveguide core. The first waveguide core comprises a first material, and the second waveguide core comprises a second material different from the first material.

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Background/Summary

BACKGROUND

(1) The disclosure relates to photonics chips and, more specifically, to structures for a polarization rotator and methods of forming a structure for a polarization rotator.

(2) Photonics chips are used in many applications and systems including, but not limited to, data communication systems and data computation systems. A photonics chip integrates optical components and electronic components into a unified platform. Among other factors, layout area, cost, and operational overhead may be reduced by the integration of both types of components on the same chip.
(3) Polarization rotators are a type of optical component commonly found in photonics chips. A polarization rotator may be configured to receive optical signals of a given polarization state (e.g., the fundamental transverse magnetic (TM0) polarization) as input and to output a different polarization state (e.g., the fundamental transverse electric (TE0) polarization). Conventional polarization rotators may suffer from a high conversion loss and significant polarization crosstalk that contribute to less than desirable performance.
(4) Improved structures for a polarization rotator and methods of forming a structure for a polarization rotator are needed.

SUMMARY

(5) In an embodiment of the invention, a structure for a polarization rotator is provided. The structure comprises a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end. The first and second sections of the first waveguide core are arranged between the first terminating end and the second terminating end. The structure further comprises a second waveguide core including a first tapered section and a second tapered section. The first tapered section of the second waveguide core has a first overlapping arrangement with the first section of the first waveguide core, and the second tapered section of the second waveguide core has a second overlapping arrangement with the second section of the first waveguide core. The first waveguide core comprises a first material, and the second waveguide core comprises a second material different from the first material.
(6) In an embodiment of the invention, a method of forming a structure for a polarization rotator is provided. The method comprises forming a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end. The first section and the second section of the first waveguide core are arranged between the first terminating end and the second terminating end. The method further comprises forming a second waveguide core including a first tapered section and a second tapered section. The first tapered section of the second waveguide core has a first overlapping arrangement with the first section of the first waveguide core, and the second tapered section of the second waveguide core has a second overlapping arrangement with the second section of the first waveguide core. The first waveguide core comprises a first material, and the second waveguide core comprises a second material different from the first material.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate various embodiments of the invention and, together with a general description of the invent ion given above and the detailed description of the embodiments given below, serve to explain the embodiments of the invention. In the drawings, like reference numerals refer to like features in the various views.
(2) FIG. **1** is a top view of a structure at an initial fabrication stage of a processing method in accordance with embodiments of the invention.
(3) FIG. **2** is a cross-sectional view of the structure taken generally along line **2-2** in FIG. **1**.
(4) FIG. **2**A is a cross-sectional view of the structure taken generally along line **2**A-**2**A in FIG. **1**.
(5) FIG. **2**B is a cross-sectional view of the structure taken generally along line **2**B-**2**B in FIG. **1**.

(6) FIG. **3** is a top view of the structure at a fabrication stage subsequent to FIG. **1**.
(7) FIG. **4** is a cross-sectional view of the structure taken generally along line **4-4** in FIG. **3**.
(8) FIG. **4**A is a cross-sectional view of the structure taken generally along line **4**A-**4**A in FIG. **3**.
(9) FIG. **4**B is a cross-sectional view of the structure taken generally along line **4**B-**4**B in FIG. **3**.
(10) FIGS. **5**, **5**A, **5**B are cross-sectional views of the structure at a fabrication stage subsequent to FIGS. **4**, **4**A, **4**B.
(11) FIG. **6** is a top view of a structure at an initial fabrication stage of a processing method in accordance with alternative embodiments of the invention.
(12) FIG. **7** is a top view of the structure at a fabrication stage subsequent to FIG. **6**.
(13) FIG. **8** is a top view of a structure in accordance with alternative embodiments of the invention.
(14) FIG. **9** is a top view of a structure in accordance with alternative embodiments of the invention.
(15) FIG. **10** is a cross-sectional view of the structure taken generally along line **10-10** in FIG. **9**.
(16) FIG. **10**A is a cross-sectional view of the structure taken generally along line **10**A-**10**A in FIG. **9**.
(17) FIG. **10**B is a cross-sectional view of the structure taken generally along line **10**B-**10**B in FIG. **9**.

DETAILED DESCRIPTION

(18) With reference to FIGS. **1**, **2**, **2**A, **2**B and in accordance with embodiments of the invention, a structure **10** for a polarization rotator includes a waveguide core **12** that is positioned over a dielectric layer **14** and a substrate **16**. In an embodiment, the dielectric layer **14** may be comprised of a dielectric material, such as silicon dioxide, and the substrate **16** may be comprised of a semiconductor material, such as single-crystal silicon. In an embodiment, the dielectric layer **14** may be a buried oxide layer of a silicon-on-insulator substrate, and the dielectric layer **14** may separate the waveguide core **12** from the substrate **16**. In an alternative embodiment, one or more additional dielectric layers comprised of, for example, silicon dioxide may separate the waveguide core **12** from the dielectric layer **14**.

(19) In an embodiment, the waveguide core **12** may be comprised of a material having a refractive index that is greater than the refractive index of silicon dioxide. In an embodiment, the waveguide core **12** may be comprised of a semiconductor material, such as single-crystal silicon or polysilicon. In an alternative embodiment, the waveguide core **12** may be comprised of a dielectric material, such as silicon nitride, silicon oxynitride, or aluminum nitride. In alternative embodiments, other materials, such as a polymer or a III-V compound semiconductor, may be used to form the waveguide core **12**.

(20) In an embodiment, the waveguide core **12** may be formed by patterning a layer comprised of a material with lithography and etching processes. In an embodiment, an etch mask may be formed by a lithography process over the layer, and unmasked sections of the deposited layer may be etched and removed with an etching process. The shape of the etch mask determines the patterned shape of the waveguide core **12**. In an embodiment, the waveguide core **12** may be formed by patterning the semiconductor material (e.g., single-crystal silicon) of a device layer of a silicon-on-insulator substrate. In an embodiment, the waveguide core **12** may be formed by patterning a deposited layer comprised of the material (e.g., polysilicon).

(21) The waveguide core **12** includes a section **18**, a section **20** adjoined to the section **18**, a section **22** adjoined to the section **20**, and a section **24** adjoined to the section **22**. The section **20** is longitudinally arranged between the section **18** and the section **22**, and the section **20** may connect the section **18** to the section **22**. The waveguide core **12** has a finite length extending between a terminating end **26** and a terminating end **28** opposite to the terminating end **26**. The section **18** is aligned along a longitudinal axis **17**, the section **20** is aligned along a longitudinal axis **19**, and the section **22** is aligned along a longitudinal axis **21**. The longitudinal axis **17** of the section **18** is

slanted (i.e., angled) relative to the longitudinal axis **19** of the section **20** to provide a directional change at the junction between the section **18** and the section **20**. The longitudinal axis **19** of the section **20** is slanted (i.e., angled) relative to the longitudinal axis **21** of the section **22** to provide a directional change at the junction between the section **20** and the section **22**. The directional change at the junction transitioning from the section **20** to the section **22** defines a shallow corner at which the angular orientation between the longitudinal axis **19** and longitudinal axis **21** changes. In an embodiment, the section **24** may be a bend that curves away from the longitudinal axis **21** of the section **22**.

(22) The waveguide core **12** may have a width dimension W**1** that varies over its length. In an embodiment, each of the sections **18**, **20**, and **22** of the waveguide core **12** may be tapered. In an embodiment, the width dimension W**1** of the section **18** of the waveguide core **12** may increase with increasing distance from the terminating end **26**. In an embodiment, the width dimension W**1** of the section **20** and the section **22** of the waveguide core **12** may decrease with increasing distance from the terminating end **26**. The section **20** and the section **22** may taper in an opposite direction from the tapering of the section **18**. In an embodiment, the section **18**, the section **20**, and the section **22** may linearly taper and have uniform taper angles. In an embodiment, the taper angle (i.e., width change) of the section **20** may be significantly less than the taper angle of the section **22**. In an alternative embodiment, the width dimension W**1** of the section **20** of the waveguide core **12** may be constant.

(23) With reference to FIGS. **3**, **4**, **4**A, **4**B in which like reference numerals refer to like features in FIGS. **1**, **2**, **2**A, **2**B and at a subsequent fabrication stage, a dielectric layer **30** is formed over the waveguide core **12**. The dielectric layer **30** may be comprised of a dielectric material, such as silicon dioxide, having a refractive index that is less than the refractive index of the material constituting the waveguide core **12**. The waveguide core **12** is embedded in the dielectric layer **30**, which may be deposited and planarized after deposition, because the dielectric layer **30** is thicker than the height of the waveguide core **12**.

(24) The structure **10** further includes a waveguide core **32** that is positioned on the dielectric layer **30**. The waveguide core **32** may be formed by depositing a layer on the dielectric layer **30** and patterning the deposited layer with lithography and etching processes. In an embodiment, an etch mask may be formed by a lithography process over the deposited layer, and unmasked sections of the deposited layer may be etched and removed with an etching process. The shape of the etch mask determines the patterned shape of the waveguide core **32**.

(25) In an embodiment, the waveguide core **32** may be comprised of a material having a refractive index that is greater than the refractive index of silicon dioxide. In an embodiment, the waveguide core **32** may be comprised of a different material than the waveguide core **12**. In an embodiment, the waveguide core **32** may be comprised of a dielectric material, such as silicon nitride, aluminum nitride, or silicon oxynitride. In an alternative embodiment, the waveguide core **32** may be comprised of a semiconductor material, such as polysilicon or amorphous silicon. In alternative embodiments, other materials, such as a polymer or a III-V compound semiconductor, may be used to form the waveguide core **32**.

(26) The waveguide core **32** includes a section **34**, a section **36** adjoined to the section **34**, a section **38** adjoined to the section **36**, and a section **40** adjoined to the section **38**. The section **36** and the section **38** are longitudinally arranged between the section **34** and the section **40**. The waveguide core **32** is generally aligned along a longitudinal axis **31** has a sidewall **42** and a sidewall **44** opposite to the sidewall **42**. The section **34** may define a light input of the polarization rotator, and the section **40** may define a light output of the polarization rotator.

(27) The waveguide core **32** may have a width dimension W**2** that varies over its length. In an embodiment, the section **34**, the section **36**, and the section **38** of the waveguide core **32** may taper. In an embodiment, the width dimension W**2** of the section **34** of the waveguide core **32** may decrease with decreasing distance from the junction transitioning from the section **34** to the section

36. In an embodiment, the width dimension W**2** of the section **36** may increase with increasing distance from the junction transitioning from the section **36** to the section **34**. In an embodiment, the width dimension W**2** of the section **38** of the waveguide core **32** may increase with increasing distance from the junction transitioning from the section **38** to the section **36**. The section **38** tapers in the same direction as the section **36** but with a larger taper angle to provide a compound taper. The section **36** and the section **38** each taper in an opposite direction from the section **34**. The sections **34**, **36** and **38** of the waveguide core **32** define consecutive tapered sections. In an embodiment, the width dimension W**2** of the section **40** of the waveguide core **32** may be constant.

(28) The waveguide core **12** is positioned in a vertical direction between the waveguide core **32** and the substrate **16**. The section **34** of the waveguide core **32** has an overlapping arrangement with a portion of the waveguide core **12**, the section **36** of the waveguide core **32** has an overlapping arrangement with a different portion of the waveguide core **12**, and the section **38** of the waveguide core **32** has an overlapping arrangement with yet a different portion of the waveguide core **12**.

(29) In an embodiment, the section **34** of waveguide core **32** is positioned to overlap with the section **18** of the waveguide core **12**. In an embodiment, the section **34** of waveguide core **32** may fully overlap with the section **18** of the waveguide core **12**. The section **34** of the waveguide core **32** and the section **18** of the waveguide core **12** taper in opposite directions.

(30) In an embodiment, the section **36** of waveguide core **32** is positioned to overlap with the section **20** of the waveguide core **12**. The degree of overlap in the overlapping arrangement between the section **20** of the waveguide core **12** and the section **36** of waveguide core **32** decreases with increasing distance from the terminating end **26** of the waveguide core **12** (FIG. **1**) as the lateral offset of the section **20** relative to the section **36** increases. In an embodiment, the section **36** may fully overlap with the section **20** adjacent to the terminating end **26**, and the section **36** may partially overlap with the section **20** at the junction between the section **20** and the section **22**. The increase in the lateral offset between the section **36** and the section **20** is primarily due to the slant of the longitudinal axis **19** of the section **20**.

(31) In an embodiment, the section **38** of waveguide core **32** is positioned to overlap with the section **22** of the waveguide core **12**. The degree of overlap in the overlapping arrangement between the section **22** of the waveguide core **12** and the section **38** of waveguide core **32** increases with decreasing distance from the terminating end **28** of the waveguide core **12** (FIG. **1**) as the lateral offset of the section **22** relative to the section **38** decreases. In an embodiment, the section **38** may partially overlap with the section **22** at the junction between the section **22** and the section **20**, and the section **38** may fully overlap with the section **22** adjacent to the terminating end **28**. The increase in the lateral offset between the section **38** and the section **22** is primarily due to the slant of the longitudinal axis **21** of the section **22**, which differs from the slant of the longitudinal axis **19** of the section **20**.

(32) With reference to FIGS. **5**, **5**A, **5**B in which like reference numerals refer to like features in FIGS. **4**, **4**A, **4**B and at a subsequent fabrication stage, a dielectric layer **46** is formed over the waveguide core **32**. The dielectric layer **46** may be comprised of a dielectric material, such as silicon dioxide, having a refractive index that is less than the refractive index of the material constituting the waveguide core **32**. The waveguide core **32** is embedded in the dielectric layer **46**, which may be deposited and planarized after deposition, because the dielectric layer **46** is thicker than the height of the waveguide core **32**.

(33) A back-end-of-line stack **48** may be formed over the dielectric layer **46**. The back-end-of-line stack **48** may include stacked dielectric layers that are each comprised of a dielectric material, such as silicon dioxide, silicon nitride, tetraethylorthosilicate silicon dioxide, or fluorinated-tetraethylorthosilicate silicon dioxide.

(34) In use, optical signals propagating with a transverse magnetic (TM) mode may be guided on a photonics chip by the waveguide core **32** for input to the structure **10**. The waveguide cores **12**, **32** cooperate to rotate the polarization mode of the light embodied in the optical signals from the TM

mode to the transverse electric (TE) mode, which is output from the structure **10** to the waveguide core **32** for routing on the photonics chip to other optical components.

(35) The waveguide core **12** of the polarization rotator assists with the rotation of the light polarization by the waveguide core **32** of the polarization rotator. The stacked waveguide cores **12**, **32** mimic a twisted waveguide to achieve low conversion loss, suppress polarization crosstalk, improve the power handling capability of the polarization rotator, and may be seamlessly integrated with photonic integrated circuits that are based on the material (e.g., silicon nitride or polysilicon) of the waveguide core **32**.

(36) With reference to FIG. **6** and in accordance with alternative embodiments of the invention, the structure **10** may include a waveguide core **50** that is positioned adjacent to the waveguide core **12** to define a slotted waveguide core over a portion of the length of the waveguide core **12**. The waveguide core **50** is separated from the waveguide core **12** by a slot S**1**. The waveguide core **50** includes sections **52**, **54**, **56** that are similar in construction to the sections **20**, **22**, **24** of the waveguide core **12**. In an embodiment, the changes in direction at the transitions between the different sections **52**, **54**, **56** of the waveguide core **50** may parallel the changes in direction of the sections **20**, **22**, **24** of the waveguide core **12** such that the slot S**1** has a constant or substantially constant width dimension over the length of the waveguide core **12**. In an embodiment, the waveguide core **50** may be comprised of the same material as the waveguide core **12** and may be concurrently formed with the waveguide core **12**. The waveguide core **50** may lack a section analogous to the section **18** of the waveguide core **12** in order to avoid interference with the overlap between the section **18** of the waveguide core **12** and the section **34** of the waveguide core **32**. In an alternative embodiment, the slotted waveguide core may include one or more additional waveguide cores positioned adjacent to the waveguide core **50** such that the slotted waveguide core includes multiple slots.

(37) With reference to FIG. **7** in which like reference numerals refer to like features in FIG. **6** and at a subsequent fabrication stage, the dielectric layer **30** and the waveguide core **32** may be formed over the slotted waveguide core including the waveguide core **12** and the waveguide core **50**. In an embodiment, the waveguide core **50** may be laterally offset from the waveguide core **12** such that the waveguide core **32** has a non-overlapping arrangement with the waveguide core **50**. In an embodiment, the waveguide core **50** may be laterally offset from the waveguide core **12** such that the waveguide core **32** has a non-overlapping arrangement with the waveguide core **50** and with the slot S**1** between the waveguide cores **12**, **50**.

(38) With reference to FIG. **8** and in accordance with alternative embodiments of the invention, the structure **10** may include a waveguide core **60** that is positioned adjacent to the waveguide core **32** to define a slotted waveguide core over a portion of the length of the waveguide core **32**. The waveguide core **60** is separated from the waveguide core **32** by a slot S**2**. The waveguide core **32** has a non-overlapping arrangement with the waveguide core **12**. In an embodiment, the changes in direction at the transitions between the different sections of the waveguide core **60** may parallel the changes in direction of the sections **36**, **38**, **40** of the waveguide core **32** such that the slot S**2** has a constant or substantially constant width dimension over the length of the waveguide core **60**. In an embodiment, the waveguide core **60** may be comprised of the same material as the waveguide core **32** and may be concurrently formed with the waveguide core **32**. The waveguide core **60** may lack a section analogous to the section **34** of the waveguide core **32** in order to avoid interference with the overlap between the section **18** of the waveguide core **12** and the section **34** of the waveguide core **32**.

(39) With reference to FIGS. **9**, **10**, **10**A, **10**B and in accordance with alternative embodiments of the invention, the structure **10** may include a waveguide core **62** that is positioned in the back-end-of-line stack **48**. The waveguide core **62** is positioned over the waveguide core **32** such that the waveguide core **32** is positioned in a vertical direction between the waveguide core **62** and the substrate **16**. The waveguide core **62** has a finite length extending between a terminating end **76**

and a terminating end **78**. The waveguide core **62** includes sections **68**, **70**, **72**, and **74** that are identical or substantially identical to the sections **18**, **20**, **22**, and **24** of the waveguide core **12**, and the sections **68**, **70**, and **72** of the waveguide core **62** have respective overlapping arrangements with the sections **34**, **36**, and **38** of the waveguide core **32**, as described hereinabove in connection with the waveguide core **12** and the waveguide core **32**.

(40) The waveguide core **62** may be comprised of a dielectric material, such as silicon-carbon nitride or hydrogenated silicon-carbon nitride, having a refractive index greater than the refractive index of silicon dioxide. In an alternative embodiment, the waveguide core **62** may be comprised of a dielectric material, such as silicon nitride, silicon oxynitride, or aluminum nitride. In an embodiment, the waveguide core **62** may be formed by depositing a layer of its constituent material on the dielectric layer **46** and patterning the deposited layer by lithography and etching processes.

(41) In an embodiment, the waveguide core **62** may replace the waveguide core **12** in the structure **10**. In an alternative embodiment, the structure **10** may include the waveguide core **62** and the waveguide core **12** such that the sections **34**, **36**, and **38** of the waveguide core **32** have respective overlapping arrangements with the sections **18**, **20**, **22** of the waveguide core **12** and the sections **68**, **70**, **72** of the waveguide core **62** have respective overlapping arrangements with the sections **34**, **36**, and **38** of the waveguide core **32**. The combination of the waveguide core **12** and the waveguide core **62** in the structure **10** may further reduce the conversion loss, suppress polarization crosstalk, and improve the power handling capability of the polarization rotator.

(42) The methods as described above are used in the fabrication of integrated circuit chips. The resulting integrated circuit chips can be distributed by the fabricator in raw wafer form (e.g., as a single wafer that has multiple unpackaged chips), as a bare die, or in a packaged form. The chip may be integrated with other chips, discrete circuit elements, and/or other signal processing devices as part of either an intermediate product or an end product. The end product can be any product that includes integrated circuit chips, such as computer products having a central processor or smartphones.

(43) References herein to terms modified by language of approximation, such as “about”, “approximately”, and “substantially”, are not to be limited to the precise value specified. The language of approximation may correspond to the precision of an instrument used to measure the value and, unless otherwise dependent on the precision of the instrument, may indicate a range of +/−10% of the stated value(s).

(44) References herein to terms such as “vertical”, “horizontal”, etc. are made by way of example, and not by way of limitation, to establish a frame of reference. The term “horizontal” as used herein is defined as a plane parallel to a conventional plane of a semiconductor substrate, regardless of its actual three-dimensional spatial orientation. The terms “vertical” and “normal” refer to a direction in the frame of reference perpendicular to the horizontal, as just defined. The term “lateral” refers to a direction in the frame of reference within the horizontal plane.

(45) A feature “connected” or “coupled” to or with another feature may be directly connected or coupled to or with the other feature or, instead, one or more intervening features may be present. A feature may be “directly connected” or “directly coupled” to or with another feature if intervening features are absent. A feature may be “indirectly connected” or “indirectly coupled” to or with another feature if at least one intervening feature is present. A feature “on” or “contacting” another feature may be directly on or in direct contact with the other feature or, instead, one or more intervening features may be present. A feature may be “directly on” or in “direct contact” with another feature if intervening features are absent. A feature may be “indirectly on” or in “indirect contact” with another feature if at least one intervening feature is present. Different features may “overlap” if a feature extends over, and covers a part of, another feature with either direct contact or indirect contact.

(46) The descriptions of the various embodiments of the present invention have been presented for purposes of illustration but are not intended to be exhaustive or limited to the embodiments

disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments. The terminology used herein was chosen to best explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

Claims

1. A structure for a polarization rotator, the structure comprising: a substrate; a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end, the first section and the second section arranged between the first terminating end and the second terminating end, and the first waveguide core comprising a first material; and a second waveguide core including a first tapered section, a second tapered section, a third tapered section adjoined to the first tapered section, and a non-tapered section adjoined to the second tapered section, the third tapered section configured as a light input of the polarization rotator to receive light of a first polarization, the non-tapered section configured as a light output to output light of a second polarization from the polarization rotator, the first tapered section of the second waveguide core having a first overlapping arrangement with the first section of the first waveguide core, the second tapered section of the second waveguide core having a second overlapping arrangement with the second section of the first waveguide core, and the second waveguide core comprising a second material different from the first material, wherein the first waveguide core is positioned between the second waveguide core and the substrate, and the first tapered section and the second tapered section are longitudinally arranged between the third tapered section and the non-tapered section.
2. The structure of claim 1 wherein the first material comprises single-crystal silicon, and the second material comprises silicon nitride or polysilicon.
3. The structure of claim 1 further comprising: a third waveguide core positioned adjacent to the first waveguide core, the third waveguide core separated from the first waveguide core by a slot.
4. The structure of claim 3 wherein the second waveguide core has a non-overlapping arrangement with the third waveguide core.
5. The structure of claim 4 wherein the second waveguide core has a non-overlapping arrangement with the slot.
6. The structure of claim 1 further comprising: a dielectric layer positioned between the first waveguide core and the second waveguide core, the dielectric layer comprising a dielectric material.
7. The structure of claim 1 further comprising: a dielectric layer positioned between the first waveguide core and the second waveguide core, the dielectric layer comprising a dielectric material.
8. The structure of claim 1 further comprising: a back-end-of-line stack on the substrate, wherein the second waveguide core is positioned in the back-end-of-line stack.
9. The structure of claim 8 wherein the second material is silicon-carbon nitride or hydrogenated silicon-carbon nitride.
10. The structure of claim 1 wherein the first section of the first waveguide core and the second section of the first waveguide core adjoin at a junction.
11. The structure of claim 10 wherein the first tapered section of the second waveguide core fully overlaps with the first section of the first waveguide core adjacent to the first terminating end, and the first tapered section of the second waveguide core partially overlaps with the first section of the first waveguide core adjacent to the junction.
12. The structure of claim 11 wherein the second tapered section of the second waveguide core fully overlaps with the second section of the first waveguide core adjacent to the junction, and the

second tapered section of the second waveguide core partially overlaps with the second section of the first waveguide core adjacent to the second terminating end.

13. The structure of claim 10 wherein the second tapered section of the second waveguide core fully overlaps with the second section of the first waveguide core adjacent to the junction, and the second tapered section of the second waveguide core partially overlaps with the second section of the first waveguide core adjacent to the second terminating end.

14. The structure of claim 1 wherein the first tapered section of the second waveguide core is adjoined to the second tapered section of the second waveguide core at a junction.

15. The structure of claim 14 wherein the first tapered section of the second waveguide core increases in width dimension with decreasing distance from the junction, and the second tapered section of the second waveguide core increases in width dimension with increasing distance from the junction.

16. The structure of claim 1 wherein the second tapered section tapers in a same direction as the first tapered section, and the second tapered section has a larger taper angle than the first tapered section.

17. The structure of claim 16 wherein the first tapered section and the second tapered section each taper in an opposite direction from the third tapered section.

18. A structure for a polarization rotator, the structure comprising: a substrate; a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end, the first section and the second section arranged between the first terminating end and the second terminating end, and the first waveguide core comprising a first material; and a second waveguide core including a first tapered section, a second tapered section, and a third tapered section adjoined to the first tapered section, the third tapered section configured as a light input of the polarization rotator to receive light of a first polarization, the first tapered section of the second waveguide core having a first overlapping arrangement with the first section of the first waveguide core, the second tapered section of the second waveguide core having a second overlapping arrangement with the second section of the first waveguide core, and the second waveguide core comprising a second material different from the first material, wherein the first waveguide core is positioned between the second waveguide core and the substrate, the first section of the first waveguide core and the second section of the first waveguide core adjoin at a junction, the first section of the first waveguide core is aligned along a first longitudinal axis, the second section of the first waveguide core is aligned along a second longitudinal axis, and the first longitudinal axis is angled relative to the second longitudinal axis at the junction.

19. A method of forming a structure for a polarization rotator, the method comprising: forming a first waveguide core having a first section, a second section, a first terminating end, and a second terminating end opposite to the first terminating end, wherein the first section and the second section are arranged between the first terminating end and the second terminating end, and the first waveguide core comprises a first material; and forming a second waveguide core including a first tapered section, a second tapered section, a third tapered section adjoined to the first tapered section, and a non-tapered section adjoined to the second tapered section, wherein the third tapered section is configured as a light input of the polarization rotator to receive light of a first polarization, the non-tapered section is configured as a light output to output light of a second polarization from the polarization rotator, the first tapered section of the second waveguide core has a first overlapping arrangement with the first section of the first waveguide core, the second tapered section of the second waveguide core has a second overlapping arrangement with the second section of the first waveguide core, the second waveguide core comprises a second material different from the first material, the first waveguide core is positioned between the second waveguide core and a substrate, and the first tapered section and the second tapered section are longitudinally arranged between the third tapered section and the non-tapered section.