CLAIMS

1. An integrated device comprising:

a grating disposed on a substrate and arranged to couple radiation incident on the grating into a plurality of optical waveguides disposed on the substrate;

~~a first inlet to a first receiving region of the plurality of optical waveguides; and~~

a first receiving region of a first waveguide of the plurality of optical waveguides;

a first inlet via which the incident radiation is coupled into the first receiving region; and

~~a second inlet to a second receiving region of the plurality of optical waveguides,~~

a second receiving region of a second waveguide of the plurality of optical waveguides;

a second inlet via which the incident radiation is coupled into the second receiving region,

wherein the second inlet is offset a first amount with respect to the first inlet in a first direction approximately perpendicular to lines of the grating such that signals from the first and second waveguides can disambiguate motion of an optical beam on the grating in a direction toward or away from the inlets.

2. The integrated device of claim 1, further comprising:

~~a third inlet to~~ a third receiving region of a third waveguide of the plurality of optical waveguides; and

a third inlet via which the incident radiation is coupled into the second receiving region,

wherein the third inlet is offset a second amount with respect to the first inlet in a second direction approximately perpendicular to lines of the grating, the second direction opposite the first direction.

3. The integrated device of claim 1 or 2, wherein a first portion of the grating located adjacent to the first inlet has a first periodicity that is different than a second periodicity of a second portion of the grating located adjacent to a fourth inlet to a fourth receiving region of the plurality of optical waveguides.

4. The integrated device of any one of claims 1 through 3, further comprising:

a first optical sensor arranged to receive radiation coupled into the first waveguide; and

a second optical sensor arranged to receive radiation coupled into the second waveguide.

~~5. The integrated device of any one of claims 1 through 4, wherein the first inlet is at a first position angle to the first receiving region and the second inlet is at a second position angle to the second receiving region.~~

~~6~~5. The integrated device of any one of claims 1 through ~~5~~ 4, wherein the first inlet has a different width than the second inlet.

~~7. The integrated device of any one of claims 1 through 6, wherein the first amount of the offset is any value between 1 micron and 20 microns.~~

~~8. The integrated device of any one of claims 1 through 7, wherein the grating comprises a plurality of separated grating portions.~~

~~9~~6. The integrated device of any one of claims 1 through ~~8~~5, wherein lines of the grating comprise a first dielectric material embedded within a second dielectric material having a lower index of refraction than the first dielectric material.

~~10. The integrated device of any one of claims 1 through 9, wherein lines of the grating comprise a metal.~~

~~11. The integrated device of claim 10, wherein the first dielectric material is a same material and layer that is used to form the plurality of optical waveguides.~~

~~12~~7. The integrated device of any one of claims 1 through ~~11~~6, wherein each waveguide of the plurality of optical waveguides comprises a first dielectric material embedded within a second dielectric material having a lower index of refraction than the first dielectric material.

~~13~~8. The integrated device of claim ~~12~~7, wherein the first dielectric material is silicon nitride.

~~14~~9. The integrated device of any one of claims 1 through ~~14~~8, wherein the second receiving region has a tapered width.

~~15~~10. The integrated device of claim ~~14~~9, wherein a width of the first inlet is different from a width of the second inlet.

~~16~~11. The integrated device of any one of claims 1 through ~~15~~10, further comprising a plurality of pixels formed on the substrate, each including a reaction chamber and an optical sensor, wherein at least one waveguide is configured to provide excitation radiation to a plurality of the reaction chambers~~.~~

~~17. The integrated device of claim 16~~, optionally wherein each reaction chamber is configured to receive a sample for genetic sequencing, protein sequencing or another biological assay.

~~18. A method of coupling radiation into a plurality of optical waveguides formed on a substrate, the method comprising:~~

~~receiving one or more beams of radiation on a grating formed on the substrate;~~

~~coupling the radiation from the one or more beams into a plurality of receiving regions connected to the plurality of optical waveguides;~~

~~monitoring a first amount of radiation received from a first waveguide of the plurality of optical waveguides; and~~

~~determining whether the one or more beams move toward or away from an inlet of the first waveguide in a direction approximately perpendicular to lines of the grating based, at least in part, upon the monitored amount of radiation.~~

~~19. The method of claim 18, further comprising:~~

~~monitoring a second amount of radiation received from a second waveguide of the plurality of optical waveguides;~~

~~differencing in the first and second amounts of radiation received by the first and second waveguides;~~

~~if the difference increases, determining that motion of the one or more beams is in a first direction approximately perpendicular to lines of the grating; and~~

~~if the difference decreases, determining that the motion of the one or more beams is in a second direction opposite to the first direction.~~

~~20. The method of claim 19, further comprising:~~

~~performing an initial alignment of the one or more beams on the grating by maximizing an amount of radiation coupled into a third waveguide of the plurality of waveguides;~~

~~moving the beam across the grating in the first and second directions approximately perpendicular to lines of the grating; and~~

~~recording reference values for differences in the first and second amounts of radiation~~

~~received from the first and second waveguides as a function of the beam's location in the direction approximately perpendicular to lines of the grating.~~

~~21. The method of claim 20, wherein an inlet is at a position angle to the third waveguide, different from another position angle of another inlet to another waveguide.~~

~~22. The method of any one of claims 18 through 21, wherein the monitoring comprises detecting the first and second amounts of radiation with sensors integrated on the substrate.~~

~~23. The method of claim 22, further comprising:~~

~~averaging signals from the sensors over a plurality of data frames, wherein the sensors are located in a plurality of pixels formed on the substrate and the data frames comprise outputs from the sensors.~~

~~24. The method of any one of claims 18 through 23, wherein the coupling comprises coupling a same amount of the radiation to within 25 % into two or more waveguides of the plurality of waveguides.~~

~~25. The method of claim 24, wherein two or more waveguides of the plurality of waveguides each have an inlet and tapered receiving region adjacent to the inlet, and wherein a first width of a first tapered receiving region at an inlet to a first of the two or more waveguides is different from a second width of a second tapered receiving region at an inlet to a second of the two or more waveguides.~~

~~26. The method of any one of claims 18 through 25, further comprising delivering radiation from one or more of the plurality of optical waveguides to a plurality of reaction chambers formed on the substrate.~~

~~27. The method of claim 26, further comprising performing steps of genetic sequencing or protein sequencing or another biological assay at two or more of the reaction chambers.~~

~~28. The method of any one of claims 18 through 25, further comprising delivering radiation from one or more of the plurality of optical waveguides to a plurality of sensors formed on the substrate.~~

~~29. The method of any one of claims 18 through 28, further comprising outputting at least one signal from a sensor integrated on the substrate to cause automated realignment of the one or more beams on the grating in response to determining that the one or more beams have moved toward or away from inlets of the first and second waveguides.~~

~~30~~12. A method of making an integrated device comprising:

forming a plurality of waveguides on a substrate;

forming a grating on the substrate that spans inlets to the plurality of waveguides;

locating a first inlet to a first waveguide of the plurality of waveguides along a reference line for the grating; and

offsetting a second inlet to a second waveguide of the plurality of waveguides by a first distance from the reference line, wherein the first distance is in a first direction approximately perpendicular to lines of the grating, and wherein the first distance is provided such that signals from the first and second waveguides can disambiguate motion of an optical beam on the grating in a direction toward or away from the inlets;

forming a first receiving region adjacent to the first inlet of the first waveguide of the plurality of waveguides; and

forming a second receiving region adjacent to the second inlet of the second waveguide of the plurality of waveguides.

~~31. The method of claim 30, wherein the first distance is a value between 0.1 micron and 20 microns.~~

~~32~~13. The method of claim ~~30 or 31~~12, wherein an inlet is at a position angle to a waveguide, different from another position angle of another inlet to another waveguide.

~~33~~14. The method of ~~any one of~~ claim~~s 30 through 32~~ 12 or 13, ~~further comprising:~~wherein the first receiving region and the second receiving region are ~~forming a first~~ tapered ~~receiving region adjacent to the first inlet of the first waveguide of the plurality of waveguides; and~~

~~forming a second tapered receiving region adjacent to the second inlet of the second waveguide of the plurality of waveguides~~.

~~34~~15. The method of any one of claims ~~30~~12 through ~~33~~14, further comprising forming a first portion of the grating located adjacent to the first inlet to have a different periodicity than a

second portion of the grating located adjacent to a third inlet to a third waveguide of the plurality of waveguides.

~~35. The method of any one of claims 30 through 34, further comprising forming the grating, at least in part, from a same material and in a same layer that is used to form the plurality of waveguides.~~

~~36. An integrated device comprising:~~

~~a grating disposed on a substrate and arranged to couple radiation incident on the grating into a plurality of optical waveguides disposed on the substrate;~~

~~a first inlet to a first waveguide of the plurality of optical waveguides; and~~

~~a second inlet to a second waveguide of the plurality of optical waveguides, wherein a first portion of the grating located adjacent to the first inlet has a different periodicity than a second portion of the grating located adjacent to the second inlet.~~

~~37. The integrated device of claim 36, further comprising:~~

~~a first optical sensor arranged to receive radiation coupled into the first waveguide; and~~

~~a second optical sensor arranged to receive radiation coupled into the second waveguide.~~

~~38. The integrated device of claim 36 or 37, wherein the first inlet is at a first position angle to the first receiving region and the second inlet is at a second position angle to the second receiving region.~~

~~39. The integrated device of any one of claims 36 through 38, wherein the first inlet has a different width than the second inlet.~~

~~40. The integrated device of any one of claims 36 through 39, wherein a difference in periodicity of the first portion and second portion of the grating is any value between 0.5 nm and 4 nm.~~

~~41. The integrated device of any one of claims 36 through 40, wherein the grating comprises a plurality of separated grating portions.~~

42. The integrated device of any one of claims 36 through 41, wherein lines of the grating comprise a first dielectric material embedded within a second dielectric material having a lower index of refraction than the first dielectric material.

43. The integrated device of claim 42, wherein the first dielectric material is a same material and layer that is used to form the plurality of optical waveguides.

44. The integrated device of any one of claims 36 through 43, wherein lines of the grating comprise a metal.

45. The integrated device of any one of claims 36 through 44, wherein each waveguide of the plurality of optical waveguides comprises a third dielectric material embedded within a second dielectric material having a lower index of refraction than the third dielectric material.

46. The integrated device of claim 45, wherein the third dielectric material is silicon nitride.

47. The integrated device of any one of claims 36 through 46, wherein the second receiving region has a tapered width.

48. The integrated device of claim 47, wherein a width of the first inlet is different from a width of the second inlet.

49. The integrated device of any one of claims 36 through 46, further comprising a plurality of pixels formed on the substrate, each including a reaction chamber and an optical sensor, wherein at least one waveguide is configured to provide excitation radiation to a plurality of the reaction chambers.

50. The integrated device of claim 49, wherein two or more of the reaction chambers are adapted to receive a sample for genetic sequencing, protein sequencing or another biological assay.

51. A method of coupling radiation into a plurality of optical waveguides formed on a substrate, the method comprising:

receiving one or more beams of radiation on a grating;

coupling radiation from the one or more beams into a plurality of optical waveguides;

monitoring a first amount of radiation received from a first waveguide of the plurality of optical waveguides; and

determining whether an incident pitch angle of the one or more beams on the grating changes in a direction approximately perpendicular to lines of the grating based, at least in part, upon the first amount of radiation monitored from the first waveguide.

52. The method of claim 51, further comprising:

monitoring a second amount of radiation received from a second waveguide of the plurality of optical waveguides;

differencing in the first and second amounts of radiation received by the first and second waveguides;

if the difference increases, determining that change in pitch angle of the one or more beams is in a first direction approximately perpendicular to lines of the grating; and

if the difference decreases, determining that the pitch angle of the one or more beams is in a second direction opposite to the first direction.

53. The method of claim 51 or 52, further comprising:

performing an initial alignment of the one or more beams on the grating by maximizing an amount of radiation coupled into a third waveguide of the plurality of waveguides;

changing an incident pitch angle of the beam on the grating in the first and second directions; and

recording reference values for differences in the first and second amounts of radiation received from the first and second waveguides as a function of the beam's pitch angle on the grating.

54. The method of any one of claims 51 through 53, wherein the monitoring comprises detecting the first and second amounts of radiation with sensors integrated on the substrate.

55. The method of claim 54, further comprising:

averaging signals from the sensors over a plurality of data frames, wherein the sensors are located in a plurality of pixels formed on the substrate and the data frames comprise outputs from the sensors.

~~56. The method of any one of claims 51 through 55, further comprising delivering radiation from one or more of the plurality of optical waveguides to a plurality of reaction chambers formed on the substrate.~~

~~57. The method of claim 56, further comprising performing steps of genetic sequencing or protein sequencing or another biological assay at two or more of the reaction chambers.~~

~~58. The method of any one of claims 51 through 57, further comprising delivering radiation from one or more of the plurality of optical waveguides to a plurality of sensors formed on the substrate.~~

~~59. The method of any one of claims 51 through 58, further comprising outputting at least one signal from a sensor integrated on the substrate to cause automated realignment of the one or more beams on the grating in response to determining that the one or more beams have changed their pitch angle from an aligned orientation.~~

~~60. A method of making an integrated device comprising:~~

~~forming a plurality of waveguides on a substrate, each waveguide having an inlet adjacent to a grating; and~~

~~forming the grating on the substrate to span the inlets to the plurality of waveguides, wherein a first portion of the grating located adjacent to a first inlet to a first waveguide of the plurality of waveguides has a different periodicity than a second portion of the grating located adjacent to a second inlet to a second waveguide of the plurality of waveguides.~~

~~61. The method of claim 60, wherein a difference in the periodicity between the first portion and second portion is between 0.5 nm and 4 nm.~~

~~62. The method of any one of claim 60 or 61, further comprising:~~

~~forming a first tapered receiving region adjacent to the first inlet of the first waveguide of the plurality of waveguides; and~~

~~forming a second tapered receiving region adjacent to the second inlet of the second waveguide of the plurality of waveguides.~~

~~63. The method of any one of claims 60 through 62, further comprising forming the first inlet of the first waveguide to lie on a reference line and forming a third inlet of a third waveguide to be offset from the reference line.~~

~~64. The method of any one of claims 60 through 63, further comprising forming the grating, at least in part, from a same material and in a same layer that is used to form the plurality of waveguides.~~

~~65. An integrated device comprising:~~

~~a grating disposed on a substrate and arranged to couple radiation incident on the grating into a plurality of optical waveguides disposed on the substrate;~~

~~a first inlet to a first receiving region of the plurality of optical waveguides;~~

~~a second inlet to a second receiving region of the plurality of optical waveguides, wherein the second inlet is offset a first amount with respect to the first inlet in a first direction approximately perpendicular to lines of the grating; and~~

~~a third inlet to a third receiving region of the plurality of optical waveguides, wherein a first portion of the grating located adjacent to the first inlet has a different periodicity than a second portion of the grating located adjacent to the third inlet.~~

~~66. The integrated device of claim 65, further comprising:~~

~~a first optical sensor arranged to receive radiation coupled into the first waveguide; and~~

~~a second optical sensor arranged to receive radiation coupled into the second waveguide.~~

~~67. The integrated device of claim 65 or 66, wherein the grating comprises a plurality of separated grating portions.~~

~~68. The integrated device of any one of claims 65 through 67, wherein lines of the grating comprise a first dielectric material embedded within a second dielectric material having a lower index of refraction than the first dielectric material.~~

~~69. The integrated device of claim 68, wherein the first dielectric material is a same material and layer that is used to form the plurality of optical waveguides.~~

~~70. The integrated device of any one of claims 65 through 69, wherein each waveguide of the plurality of optical waveguides comprises a first dielectric material embedded within a second dielectric material having a lower index of refraction than the first dielectric material.~~

~~71. The integrated device of claim 70, wherein the first dielectric material is a nitrogen-rich silicon nitride.~~

~~72. The integrated device of any one of claims 65 through 71, further comprising a plurality of pixels formed on the substrate, each including a reaction chamber and an optical sensor, wherein at least one waveguide is configured to provide excitation radiation to a plurality of the reaction chambers.~~

~~73. The integrated device of claim 72, wherein each reaction chamber is configured to hold a sample for genetic sequencing or protein sequencing.~~