CLAIMS

1. An optical coupling device for coupling light between optical components, the optical coupling device comprising:

   a substrate; and a grating arrangement comprising a plurality of grating elements, the plurality of grating elements being defined on one surface of the substrate; and

   a plurality of input/output ports optically coupled to the grating arrangement, wherein the grating arrangement is arranged at an intersection of the plurality of input/output ports,

   a detector on the substrate;

   a plurality of waveguides, a first waveguide of the plurality of waveguides connecting the detector to a first port of the plurality of input/output ports and a second waveguide of the plurality of waveguides connecting the detector to a second port of the plurality of input/output ports;

   wherein the plurality of grating elements are arranged uniformly to have a first period along a first direction, and arranged uniformly to have a second period along a second direction orthogonal to the first direction, the first period being different from the second period,

   wherein the first waveguide is along the first direction and the second waveguide is along the second direction; and

   wherein two input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the first direction, and two other input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the second direction.

2. The optical coupling device as claimed in claim 1, wherein the first period is between about 100 nm and about 10 μm.

3. The optical coupling device as claimed in claim 2, wherein the second period is between about 100 nm and about 10 μm.

4. The optical coupling device as claimed in claim 1, wherein the plurality of grating elements are arranged in a grid-like pattern.

5. The optical coupling device as claimed in claim 1, wherein each grating element of the plurality of grating elements comprises a groove, a channel, a projection, a recess, or a cavity.

6. The optical coupling device as claimed in claim 1, wherein the grating arrangement is configured to optically couple light of a first wavelength towards one side of the grating arrangement and optically couple light of a second wavelength towards one other side of the grating arrangement.

7. The optical coupling device as claimed in claim 1, wherein the grating arrangement is configured to receive light having orthogonal polarization modes and further configured to provide output light of a polarization mode determined from the orthogonal polarization modes towards different sides of the grating arrangement.

8. The optical coupling device as claimed in claim 1, wherein the substrate comprises silicon.

9. The optical coupling device as claimed in claim 6, wherein the one side and the other side of the grating arrangement are opposite sides of the grating arrangement along the first direction.

10. The optical coupling device as claimed in claim 9, wherein the grating arrangement is further configured to optically couple light of a third wavelength towards opposite sides of the grating arrangement along the second direction.

11. A photonic integrated circuit comprising:

an optical element; and
an optical coupling device optically coupled to the optical element and comprising:
a substrate; and

a grating arrangement comprising a plurality of grating elements, the plurality of grating elements being defined on one surface of the substrate; and

a plurality of input/output ports optically coupled to the grating arrangement, wherein the grating arrangement is arranged at an intersection of the plurality of input/output ports,

a detector on the substrate;

a plurality of waveguides, a first waveguide of the plurality of waveguides connecting the detector to a first port of the plurality of input/output ports and a second waveguide of the plurality of waveguides connecting the detector to a second port of the plurality of input/output ports;

wherein the plurality of grating elements are arranged uniformly to have a first period along a first direction, and arranged uniformly to have a second period along a second direction orthogonal to the first direction, the first period being different from the second period, wherein the first waveguide is along the first direction and the second waveguide is along the second direction; and

wherein two input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the first direction, and two other input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the second direction.

12. The photonic integrated circuit as claimed in claim 11, wherein the optical element is optically coupled to the grating arrangement, wherein the grating arrangement is adapted to couple light between the optical element and at least some of the plurality of input/output ports.

13. The photonic integrated circuit as claimed in claim 12, wherein the optical element is arranged tilted relative to the surface of the substrate.

14. The photonic integrated circuit as claimed in claim 11, further comprising a light source optically coupled to an input/output port of the plurality of input/output ports.

15. The photonic integrated circuit as claimed in claim 11, wherein the photonic integrated circuit is an optical transceiver.

16. The photonic integrated circuit as claimed in claim 13,

wherein the optical element comprises an end surface facing the grating arrangement, wherein, for a first cross-sectional plane of the optical element wherein the first cross-sectional plane is defined along the first direction and a third direction that is orthogonal to the first direction and the second direction, the end surface is arranged non-parallel to an axis defined along the first direction, and

wherein, for a second cross-sectional plane of the optical element wherein the second cross-sectional plane is defined along the second direction and the third direction, the end surface is arranged at least substantially parallel to an axis defined along the second direction.

17. A method of forming an optical coupling device, the method comprising:

providing a substrate;

forming a grating arrangement comprising a plurality of grating elements, the plurality of grating elements being formed on one surface of the substrate; and

forming a plurality of input/output ports optically coupled to the grating arrangement, wherein the grating arrangement is arranged at an intersection of the plurality of input/output ports,

forming a detector on the substrate;

forming a plurality of waveguides, a first waveguide of the plurality of waveguides connecting the detector to a first port of the plurality of input/output ports and a second waveguide of the plurality of waveguides connecting the detector to a second port of the plurality of input/output ports;

wherein the plurality of grating elements are arranged uniformly to have a first period along a first direction, and arranged uniformly to have a second period along a second direction orthogonal to the first direction, the first period being different from the second period, wherein the first waveguide is along the first direction and the second waveguide is along the second direction; and

wherein two input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the first direction, and two other

input/output ports of the plurality of input/output ports are arranged on opposite sides of the grating arrangement along the second direction.