CLAIMS

1. A wavelength division multiplexer/demultiplexer, comprising:

a substrate;

a bus waveguide provided on the substrate; and

at least two wavelength division multiplexing/demultiplexing units provided on the bus waveguide,

wherein each of the at least two wavelength division multiplexing/demultiplexing units comprises a mode multiplexer and an asymmetric Bragg grating, and each of all the mode multiplexers of all the wavelength division multiplexing/demultiplexing units is configured to make all input light incident into the asymmetric Bragg grating in a mode with an TE1 mode as a lowest-order mode; the mode multiplexer comprises a first port, a second port, and a third port, the first port and the second port are configured to input or output optical signals, respectively, and the third port is connected to the asymmetric Bragg grating; the asymmetric Bragg gratings in different units of the at least two wavelength division multiplexing/demultiplexing units have different grating periods, respectively;

wherein the asymmetric Bragg grating comprises a grating structure that is gradually asymmetrical, wherein an etching depth of the grating is gradually increased from both ends toward middle of the grating, and a waveguide width in center of the grating gradually narrows from both ends toward the middle of the grating, so as to form a taper;

when the wavelength division multiplexer/demultiplexer serves as a demultiplexer and light with multiple wavelengths is input to one of the first port and the second port of the mode multiplexer for passing through the mode multiplexer, light in a TE(n+1) mode is output from the third port and is incident into the asymmetric Bragg grating, and the asymmetric Bragg grating reflects, of the light in the TE(n+1) mode, light with a resonance wavelength λi that satisfies a resonance condition with a grating period of the asymmetric Bragg grating while transmitting the rest of the light in the TE(n+1) mode, converts the reflected light with the resonance wavelength λi into light in a TE0 mode, and returns the light in the TE0 mode to the mode multiplexer for being output from the other of the first port and the second port, where n is an integer greater than or equal to zero.

2. The wavelength division multiplexer/demultiplexer according to claim 1, wherein the resonance condition is:

$$\frac{2\pi}{\Lambda} = \left(\frac{2\pi}{\lambda i}\right) n_{TE0} + \left(\frac{2\pi}{\lambda i}\right) n_{TE1} ,$$

where Λ represents the grating period of the asymmetric Bragg grating, λi represents a wavelength of a transmitted light, and n_{TE0} and n_{TE1} respectively represent effective refractive indices of light in the TE0 mode and light in the TE1 mode when being transmitted in the asymmetric Bragg grating.

3. The wavelength division multiplexer/demultiplexer according to claim 1, wherein the wavelength division multiplexer/demultiplexer is a four-channel

wavelength division multiplexer/demultiplexer that comprises a first wavelength division multiplexing/demultiplexing unit, a second wavelength division multiplexing/demultiplexing unit, and a third wavelength division multiplexing/demultiplexing unit that are sequentially cascaded;

the asymmetric Bragg grating of the first wavelength division multiplexing/demultiplexing unit is configured to reflect light with a wavelength λ1 and transmit light with wavelengths λ2, λ3, and λ4, the asymmetric Bragg grating of the second wavelength division multiplexing/demultiplexing unit is configured to reflect light with the wavelength λ2 and transmit light with the wavelengths λ3 and λ4, and the asymmetric Bragg grating of the third wavelength division multiplexing/demultiplexing unit is configured to reflect light with the wavelength λ3 and transmit light with the wavelength λ4, where the wavelengths λ1, λ2, λ3, and λ4 represent four-channel wavelengths that are unequal to each other.

4. The wavelength division multiplexer/demultiplexer according to claim 3, wherein the mode multiplexer comprises a straight-through waveguide and a cross waveguide, two ends of the straight-through waveguide are respectively the first port and the third port, an end of the cross waveguide that is adjacent to the first port is the second port, and the cross waveguide is mode-coupled to the straight-through waveguide.

5. The wavelength division multiplexer/demultiplexer according to claim 4,

wherein the asymmetric Bragg grating of a wavelength division multiplexing/demultiplexing unit of the cascaded wavelength division multiplexing/demultiplexing units at each stage is connected to the first port of the mode multiplexer of a wavelength division multiplexing/demultiplexing unit of the cascaded wavelength division multiplexing/demultiplexing units at a next stage;

when the wavelength division multiplexer/demultiplexer serves as the demultiplexer, the first port of the mode multiplexer of the first wavelength division multiplexing/demultiplexing unit is configured to receive composite light in the TE(n+1) mode, and the second port of the mode multiplexer of each of the cascaded wavelength division multiplexing/demultiplexing units and the asymmetric Bragg grating of the third wavelength division multiplexing/demultiplexing unit are configured to output demultiplexed light of each channel.

6. The wavelength division multiplexer/demultiplexer according to claim 5, wherein each of the wavelength division multiplexing/demultiplexing units further comprises a first mode converter connected to the second port of the mode multiplexer; when the wavelength division multiplexer/demultiplexer serves as the demultiplexer, the first mode converter is configured to convert light output from the second port of the mode multiplexer from the TE(n+1) mode to the TE0 mode.

7. The wavelength division multiplexer/demultiplexer according to claim 4,

wherein a second mode converter is further provided between every two adjacent ones of the wavelength division multiplexing/demultiplexing units, the second mode converter comprises two ports respectively connected to the asymmetric Bragg grating on one side of the second mode converter and the second port of the mode multiplexer on the other side of the second mode converter;

when the wavelength division multiplexer/demultiplexer serves as the demultiplexer, the second port of the mode multiplexer of the first wavelength division multiplexing/demultiplexing unit is configured to receive composite light in the TE0 mode, the second mode converter is configured to convert light transmitted through the asymmetric Bragg grating from the TE(n+1) mode to the TE0 mode and transmit the converted light to the second port of the mode multiplexer of the wavelength division multiplexing/demultiplexing unit at a next stage, and the first port of the mode multiplexer of each of the cascaded wavelength division multiplexing/demultiplexing units and the asymmetric Bragg grating of the third wavelength division multiplexing/demultiplexing unit are configured to output demultiplexed light of each channel.

8. The wavelength division multiplexer/demultiplexer according to claim 3, wherein the first port of the mode multiplexer is configured to transmit light in the TE(n+1) mode, and the second port is configured to transmit light in the TE0 mode;

the asymmetric Bragg grating of a wavelength division

multiplexing/demultiplexing unit of the cascaded wavelength division multiplexing/demultiplexing units at each stage is connected to the first port of the mode multiplexer of a wavelength division multiplexing/demultiplexing unit of the cascaded wavelength division multiplexing/demultiplexing units at a next stage;

when the wavelength division multiplexer/demultiplexer serves as the demultiplexer, the first port of the mode multiplexer of the first wavelength division multiplexing/demultiplexing unit is configured to receive composite light in the TE(n+1) mode, and the second port of the mode multiplexer of each of the cascaded wavelength division multiplexing/demultiplexing units and the asymmetric Bragg grating of the third wavelength division multiplexing/demultiplexing unit are configured to output demultiplexed light of each channel.

9. The wavelength division multiplexer/demultiplexer according to any one of claims 3-8, wherein the four-channel wavelength division multiplexer/demultiplexer further comprises a fourth wavelength division multiplexing/demultiplexing unit that is cascaded with the third wavelength division multiplexing/demultiplexing unit;

the fourth wavelength division multiplexing/demultiplexing unit comprises the mode multiplexer and the asymmetric Bragg grating that is configured to reflect the light with the wavelength λ4.

10. The wavelength division multiplexer/demultiplexer according to any one of

claims 1-8, wherein the bus waveguide is a strip waveguide or a ridge waveguide;

the substrate is a silicon substrate, an indium phosphide substrate, a gallium nitride substrate, or a lithium niobate substrate; the bus waveguide is a silicon waveguide, a silicon nitride waveguide, a silicon oxynitride waveguide, a silicon oxide waveguide, an indium phosphide waveguide, a gallium nitride waveguide, or a lithium niobate waveguide.

11. A photonic integrated chip, characterized in that the wavelength division multiplexer/demultiplexer according to any one of claims 1-10 is disposed in the photonic integrated chip.

12. An optical module, comprising the wavelength division multiplexer/demultiplexer according to any one of claims 1-10.