

SPECIFICATION

TITLE OF INVENTION: OPTICAL MODULE

[0001] This application claims the priority benefit of China application serial no. 202323231753.7, filed on November 29, 2023, entitle “OPTICAL MODULE”. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

Technical Field

[0002] The present application relates to the technical field of optical communication equipment, and specifically relates to an optical module.

Description of Related Art

[0003] An optical module is an optical communication equipment that performs optical-electrical and electrical-optical conversion. In recent years, the market of global cloud computing data centers has continued to expand, and the construction of 5G telecommunication networks has been fully deployed, so the market demand for high-speed optical modules is also increasing day by day. Various series and types of products have been launched successively, so as to provide optimal optical module solutions for customers in fields such as cloud computing data centers, wireless access, and transmission.

[0004] At present, wavelength-tunable light source devices are used in coherent optical modules, and the outputted single-mode optical signals have narrow linewidths, enabling long-distance transmission. However, due to the large volume of the wavelength-tunable light source devices, there are difficulties in the layout design of the light source devices in coherent optical modules, and the heat dissipation effect of the light source devices is poor.

Summary of Utility Model

[0005] The present application provides an optical module, and by designing an assembling

method of a light source assembly and a housing of the optical module, more accommodating space is vacated in the housing, so that more devices can be assembled in the optical module, and the heat dissipation efficiency of the light-emitting device can be improved.

[0006] The present application provides an optical module including a housing including a first cover providing with a heat sink provided outside thereof and a second cover covering the first cover and an accommodating cavity being formed between the first cover and the second cover, and a light source assembly disposed in the accommodating cavity. The light source assembly includes a light-emitting device and a light source circuit board, the light-emitting device is electrically connected to the light source circuit board, and the light source circuit board is used to control the light-emitting device to output an optical signal. The light-emitting device is fixed to the light source circuit board, and the light source circuit board is directly fixed to the first cover, so that the light-emitting device is fixed at a position on the inner side of the first cover corresponding to the heat sink and is thermally connected to the first cover.

[0007] In an embodiment of the present application, the light-emitting device abuts against the inner side of the first cover and is in thermally connected to the first cover directly. Alternatively, a thermally-conductive flexible body is provided between the first cover and the light-emitting device, and the thermally-conductive flexible body directly contacts both the first cover and the light-emitting device to thermally connect to with the first cover and the light-emitting device.

[0008] In an embodiment of the present application, the thermally-conductive flexible body is thermally-conductive putty, a thermally-conductive pad, and/or thermally-conductive adhesive.

[0009] In an embodiment of the present application, the light source assembly further includes a supporting member connected to the light source circuit board and supporting the light-emitting device on a side away from the heat sink.

[0010] In an embodiment of the present application, the optical module has a first direction, a second direction, and a third direction that are mutually perpendicular, the first cover and the second cover overlap in the first direction, and the length of the optical module in the second

direction is less than the length of the optical module in the third direction. The light-emitting device is located on one side of the light source circuit board in the second direction, the light-emitting device has a target surface facing the light source circuit board in the second direction, and the supporting member is disposed close to the target surface.

5 **[0011]** In an embodiment of the present application, the housing is provided with an optical interface at one end in the third direction, and the optical interface is used to be optically connected to an optical fiber outside the optical module. The light-emitting device includes a hermetic box provided with a packaging cavity therein, a tunable laser module packaged in the packaging cavity, the tunable laser module used to generate a wavelength-tunable optical signal, and an output head
10 connected to a side of the hermetic box away from the optical interface in the third direction. The output head is used to output an optical signal generated by the tunable laser module. In the third direction, the supporting member is disposed close to the output head.

[0012] In an embodiment of the present application, the tunable laser module includes a thermoelectric cooler used to control the temperature of the packaging cavity, a semiconductor
15 gain chip, a collimating lens optically connected to the semiconductor gain chip, a tunable filter unit optically connected to the collimating lens, an isolator optically connected to the tunable filter unit, and a coupling lens optically connected to the isolator. The semiconductor gain chip, the collimating lens, the tunable filter unit, and the isolator are arranged on the thermoelectric cooler.

[0013] In an embodiment of the present application, the supporting member includes a
20 connection portion connected to a side of the light source circuit board away from the heat sink and a supporting portion connected to an end of the connection portion away from the light source circuit board. The supporting portion supports on a surface of the light-emitting device away from the heat sink.

[0014] In an embodiment of the present application, the connection portion includes a
25 connection column, the supporting portion includes a supporting plate, one end of the connection column is fixedly connected to the light source circuit board, the other end is fixedly connected to

the supporting plate, and the supporting plate supports on a surface of the light-emitting device away from the heat sink.

[0015] In an embodiment of the present application, the optical module has a first direction, a second direction, and a third direction that are mutually perpendicular, the first cover and the second cover overlap in the first direction, and the length of the optical module in the second direction is less than the length of the optical module in the third direction. The accommodating cavity is divided into a first sub-cavity and a second sub-cavity communicating with each other in the third direction. An inner wall of the first cover facing the first sub-cavity in the first direction and/or an inner wall of the second cover facing the first sub-cavity in the first direction is formed with a groove, such that a maximum length of the first sub-cavity in the first direction is greater than a maximum length of the second sub-cavity in the first direction. The light source assembly is accommodated in the first sub-cavity.

[0016] In an embodiment of the present application, the light source assembly further includes an electrical connector. The light-emitting device is electrically connected to the light source circuit board through the electrical connector, and the electrical connector is connected to a side of the light source circuit board away from the heat sink.

[0017] In an embodiment of the present application, the housing is provided with an optical interface and an electrical interface at opposite ends. The optical interface is used to be optically connected to an optical fiber outside the optical module. The optical module further includes a main circuit board electrically connected to the light source assembly, and one end of the main circuit board is electrically connected to equipment outside the optical module via the electrical interface. The light source assembly and the heat sink are disposed close to the optical interface.

[0018] In an embodiment of the present application, the light source circuit board is a rigid circuit board.

[0019] The beneficial effects of the present application are that, different from the related art, the present application provides an optical module. The optical module includes a housing and

a light source assembly. a light-emitting device of the light source assembly is fixed to a light source circuit board, and the light source circuit board is directly fixed to a first cover, so that the light-emitting device is fixed to a position of an inner side of the first cover corresponding to a heat sink and is in thermally conductive connection with the first cover. That is, in this embodiment, by changing the fixing structure and the fixing position of the light source assembly, a heat dissipation metal plate of a light source device in the related art is omitted. Further, the light source assembly is fixed to the first cover, so that the light-emitting device is closer to the first cover to conduct heat dissipation through the first cover and the heat sink thereon, and a manner of conducting heat of the light-emitting device to the heat sink through the heat dissipation metal plate for heat dissipation is thus avoided. In this way, the heat dissipation efficiency of the light-emitting device is improved, and more accommodating space is vacated in the housing, so that more devices can be assembled in the optical module, and performance of the optical module is improved while ensuring that the size of the optical module satisfies requirements of protocols such as MSA (multi-source agreement).

Description of the Drawings

[0020] To make the technical solutions provided in the embodiments of the present application more clearly illustrated, several accompanying drawings required by the embodiments for description are briefly introduced as follows. Obviously, the drawings in the following description are merely some embodiments of the disclosure, and for a person having ordinary skill in the art, other drawings can be obtained based on these drawings without an inventive effort.

[0021] FIG. 1 is a schematic structural side view of a coherent optical module of the related art.

[0022] FIG. 2 is a schematic structural view of an optical module in an embodiment of the present application.

[0023] FIG. 3 is a schematic structural cross-sectional view of the optical module shown in FIG.

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[0024] FIG. 4 is a schematic structural view of a light source assembly and a first cover in an assembled state in an embodiment of the present application.

[0025] FIG. 5 is a schematic structural view of the light source assembly in an embodiment of the present application.

5 **[0026]** FIG. 6 is a schematic structural top view of the light source assembly shown in FIG. 5.

[0027] FIG. 7 is a schematic structural view of a light-emitting device in an embodiment of the present application.

[0028] Description of Reference Numerals:

[0029] 10: optical module, 11: housing, 111: accommodating cavity, 1111: first sub-cavity, 1112: second sub-cavity, 112: first housing portion, 113: second housing portion, 114: first cover, 115: second cover, 116: optical interface, 117: electrical interface, 118: groove, 12: main circuit board, 13: pull ring, 131: force application portion, 132: sliding arm, 14: heat sink, 20: light source assembly, 21: light-emitting device, 211: hermetic box, 2111: packaging cavity, 212: output head, 213: target surface, 214: thermoelectric cooler, 215: semiconductor gain chip, 2151: first cavity surface, 216: collimating lens, 217: tunable filter unit, 218: isolator, 2181: second cavity surface, 219: coupling lens, 22: light source circuit board, 23: supporting member, 231: supporting portion, 232: connection portion, 24: electrical connector, 30: optical amplification assembly.

Specific Embodiments

20 **[0030]** The technical solutions in the embodiments of the present application will be clearly and completely described below together with the drawings in the embodiments of the present application. Obviously, the described embodiments are only part of the embodiments of the present application, not all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by a person having ordinary skill in the art without
25 creative labor are within the scope of protection of the present application. In addition, it should be understood that the specific embodiments described herein serve to illustrate and explain the

present application merely and are not used to limit the present application. In the present application, unless otherwise specified, the directional terms used such as "upper", "lower", "left", and "right" usually refer to the upper, lower, left, and right directions when the device is in actual use or working state, specifically referring to the drawing directions in the accompanying drawings.

5 **[0031]** In the present application, unless otherwise clearly specified and defined, terms such as "connected", "connection", "stacked" and the like should be understood in a broad sense. For instance, it may be a fixed connection, or a detachable connection, or integrated; it may be directly connected, or indirectly connected through an intermediate medium, or it may be the internal communication between two elements or the interaction relationship between two elements. For
10 a person having ordinary skill in the art, the specific meanings of the above terms in the present application may be understood according to specific circumstances.

[0032] The present application provides an optical module, which will be described in detail below. It should be noted that the description order of the following embodiments is not intended to limit the preferred order of the embodiments of the present application. Moreover, in the
15 following embodiments, the description of each embodiment has its own emphasis, and for parts not described in detail in a certain embodiment, reference may be made to the relevant description of other embodiments.

[0033] In QSFP-DD (quad small form factor pluggable-double density) packaged coherent optical modules, silicon photonic modulation schemes are adopted, and their output power is
20 limited by silicon photonic technology. For scenarios of 100G transmission, the output power of conventional coherent optical modules can only reach around -6.5dBm. For scenarios of 400G transmission, the output power of conventional coherent optical modules can only reach around -9dBm. Further, conventional coherent optical modules have already sacrificed certain OSNR (optical signal noise ratio) performance in order to ensure the output power of -6.5dBm to -9dBm.
25 The above factors lead to limited application of conventional coherent optical modules in point-to-point transmission scenarios without repeaters.

[0034] Coherent optical modules may improve the output power through integration of EDFAs (erbium doped fiber amplifiers), enabling the output power of coherent optical modules to reach +5dBm. In transmission scenarios of IP over DWDM and point-to-point transmission scenarios, coherent optical modules with integration of EDFAs may optimize network structure and reduce deployment costs. Further, coherent optical modules with integration of EDFAs may also be compatible with the emerging ROADM (reconfigurable optical add-drop multiplexer) line systems, playing a significant role in metro/regional ROADM networks.

[0035] However, the length and width size of conventional EDFA packaging is 35 mm*20 mm. The length and width size of QSFP-DD conventional coherent optical modules specified by MSA protocol is 127.86 mm*18.35 mm. It can be seen that the width of an EDFA is greater than the width of a coherent optical module, which results in the EDFA being unable to be packaged in the QSFP-DD coherent optical module or smaller coherent optical modules. Further, the four sizes of the coherent optical module as shown in FIG. 1 (i.e., A1, A2, A3, and A4) as well as the total length of the optical module including the pull ring need to satisfy MSA protocol requirements. Therefore, how to package EDFAs in coherent optical modules while ensuring that the size of coherent optical modules satisfies MSA protocol requirements is an urgent problem to be solved.

[0036] In view of the above, the embodiments of the present application provide an optical module with high output power, and the size of the optical module in the embodiments of the present application may satisfy the protocol requirements as well. Detailed elaboration is provided in the following paragraphs.

[0037] Referring to FIG. 2 to FIG. 4, FIG. 2 is a schematic structural view of an optical module in an embodiment of the present application, FIG. 3 is a schematic structural cross-sectional view of the optical module shown in FIG. 2, and FIG. 4 is a schematic structural view of a light source assembly and a first cover in an assembled state in an embodiment of the present application.

[0038] In an embodiment, an optical module 10 includes a housing 11, and the housing 11 acts as a basic carrier of the optical module 10 for packaging and protecting the remaining components

of the optical module 10. Specifically, the housing 11 has an accommodating cavity 111 therein, and the accommodating cavity 111 is used to accommodate the remaining components of the optical module 10. The housing 11 further includes a first cover 114 and a second cover 115. The optical module 10 has a first direction (as shown by arrow Z in FIG. 3, the same below), a second direction (as shown by arrow X in FIG. 2, the same below), and a third direction (as shown by arrow Y in FIG. 2 and FIG. 3, the same below) that are mutually perpendicular. The first cover 114 and the second cover 115 cover each other in the first direction to form the accommodating cavity 111, that is, the accommodating cavity 111 is located between the first cover 114 and the second cover 115. The length of the optical module 10 in the second direction is less than the length of the optical module 10 in the third direction. The first direction is a height direction of the optical module 10, the second direction is a width direction of the optical module 10, and the third direction is a length direction of the optical module 10.

[0039] The optical module 10 further includes a light source assembly 20, a main circuit board 12, and an optical amplification assembly 30, and the light source assembly 20, the main circuit board 12, and the optical amplification assembly 30 are all accommodated in the accommodating cavity 111. The optical amplification assembly 30 is optically connected to the light source assembly 20, the light source assembly 20 and the optical amplification assembly 30 are both electrically connected to the main circuit board 12, and the optical amplification assembly 30 is used to amplify an optical signal outputted by the light source assembly 20, so that the optical module 10 of this embodiment has improved output power. The output power of the optical module 10 in the embodiments of the present application may reach +5dBm.

[0040] In an embodiment, the main circuit board 12 is integrated with a signal circuit and a power supply circuit, and the main circuit board 12 connects the electronic devices in the optical module 10 according to circuit design through circuit traces, so that electrical functions such as power supply, electrical signal transmission, and grounding can be implemented. The housing 11 has an optical interface 116 and an electrical interface 117 at opposite ends in the third direction,

the optical interface 116 is used to be optically connected to an optical fiber outside the optical module 10, and one end of the main circuit board 12 is electrically connected to an equipment outside the optical module 10 through the electrical interface 117. The end of the main circuit board 12 is designed with golden fingers, and the golden fingers are used to be connected to an electrical connector of an optical cage on customer equipment through the electrical interface 117. The main circuit board 12 is also integrated with an electrical chip (not shown), which is used to control and/or process electrical signals, such as a DSP (digital signal processor), etc.

[0041] In an embodiment of the present application, the devices of the optical amplification assembly 30 are connected through optical fibers, a packaging housing of the optical amplification assembly 30 is omitted, and the devices of the optical amplification assembly 30 are directly arranged in the accommodating cavity 111 of the housing 11 of the optical module 10. In this embodiment, the main circuit board 12, the light source assembly 20, and the devices of the optical amplification assembly 30 are stacked within the housing 11. In this way, with reasonable arrangement of the light source assembly 20 and the optical amplification assembly 30 in this embodiment, the stacked structure composed of the light source assembly 20 and the optical amplification assembly 30 is relatively compact, so that the utilization of an internal space of the optical module 10 is improved, the size of the optical module 10 may both satisfy the MSA protocol requirements and accommodate the added optical amplification assembly 30, thereby achieving high output power for the optical module 10.

[0042] In an embodiment, a heat sink 14 is provided outside the housing 11 for heat dissipation of the optical module 10. In this embodiment, the housing 11 is divided into a first housing portion 112 and a second housing portion 113 in the third direction, and the first housing portion 112 and the second housing portion 113 are connected to each other. An end of the second housing portion 113 is provided with the electrical interface 117 used to be matched with an interface of external equipment. An end portion of the first housing portion 112 is provided with the optical interface 116, and the first housing portion 112 is provided with the above-mentioned

heat sink 14 on an outer side of the first cover 114. That is, the above-mentioned heat sink 14 is disposed on the outside the first cover 114, at a position of the first housing portion 112. The accommodating cavity 111 is divided into a first sub-cavity 1111 and a second sub-cavity 1112 in the third direction, and the first sub-cavity 1111 and the second sub-cavity 1112 communicate with each other. The first sub-cavity 1111 is located in the first housing portion 112, and the second sub-cavity 1112 is located in the second housing portion 113. It is considered in this embodiment that the first housing portion 112 has a larger space and is provided with the heat sink 14, so a maximum length H1 of the first sub-cavity 1111 in the first direction may be set to be greater than a maximum length H2 of the second sub-cavity 1112 in the first direction, so that the first sub-cavity 1111 in the first housing portion 112 has sufficient space to accommodate the light source assembly 20 and the optical amplification assembly 30. Therefore, the light source assembly 20 and the optical amplification assembly 30 are accommodated in the first sub-cavity 1111, which is beneficial for arranging the light source assembly 20 and the optical amplification assembly 30 together within the optical module 10. In addition, the light source assembly 20 and the optical amplification assembly 30 are arranged in the first housing portion 112 in this embodiment, so that the light source assembly 20 and the optical amplification assembly 30 are close to the heat sink 14, particularly making the light source assembly 20 close to the side of the first cover 114, to facilitate heat dissipation of the light source assembly 20 through the first cover 114 and the heat sink 14 thereon, so that the heat dissipation effect of the light source assembly 20 and the optical amplification assembly 30 is thereby improved.

[0043] Further, an inner wall of the first housing portion 112 in the first direction is formed with a groove 118. That is, the inner wall of the first cover 114 facing the first sub-cavity 1111 in the first direction and/or the inner wall of the second cover 115 facing the first sub-cavity 1111 in the first direction is formed with the groove 118, and the groove 118 is recessed in a direction away from the first sub-cavity 1111 in the first direction, so that the maximum length H1 of the first sub-cavity 1111 in the first direction is greater than the maximum length H2 of the second sub-cavity

1112 in the first direction. FIG. 3 exemplarily shows that both a lower surface of the first cover 114 in the first direction and an upper surface of the second cover 115 in the first direction are formed with grooves 118.

[0044] It should be noted that the second housing portion 113 is used to cooperate with an interface of an external equipment, the length (i.e., thickness) of the second housing portion 113 in the first direction is limited by standards, while the first housing portion 112 does not need to be inserted into the interface of the external equipment. Therefore, the length of the first housing portion 112 in the first direction may be greater than the length of the second housing portion 113 in the first direction, so that the inner wall of the first housing portion 112 in the first direction may be formed with the groove 118.

[0045] In an embodiment, the heat sink 14 includes a plurality of heat dissipation columns arranged in an array, so that a heat dissipation area of the optical module 10 is increased through the plurality of heat dissipation columns, and that heat dissipation efficiency of the optical module 10 is improved. Certainly, in other embodiments of the present application, the heat sink 14 may also include heat dissipation structures such as heat dissipation fins, which is not limited herein.

[0046] Referring to FIG. 4, FIG. 5, and FIG. 6 together, FIG. 5 is a schematic structural view of the light source assembly in an embodiment of the present application, and FIG. 6 is a schematic structural top view of the light source assembly shown in FIG. 5. The light source assembly 20 in the embodiments of the present application is elaborated in the following paragraphs.

[0047] In an embodiment, the light source assembly 20 includes a light-emitting device 21 and a light source circuit board 22, and the light-emitting device 21 is electrically connected to the light source circuit board 22. The light source circuit board 22 is a rigid circuit board, the light source circuit board 22 is integrated with a logic control circuit for controlling the light-emitting device 21 to output an optical signal, and the light source circuit board 22 may be electrically connected to the main circuit board 12 through a flexible circuit board or a plug-in electrical connector. For the above example where the heat sink 14 is arranged on a top of the first cover

114, the light-emitting device 21 is fixed to the light source circuit board 22, and the light source circuit board 22 is directly fixed to the first cover 114, so that the light-emitting device 21 is fixed at a position on the inner side of the first cover 114 corresponding to the heat sink 14 and is thermally connected to the first cover 114. That is, in this embodiment, a fixing structure and a fixing position of the light source assembly 20 are changed, so that a heat dissipation metal plate of a light source device in the related art is omitted. Further, the light source assembly 20 is fixed to the first cover 114, so that the light-emitting device 21 is closer to the first cover 114 to conduct heat dissipation through the first cover 114 and the heat sink 14 thereon, and a manner of conducting heat of the light-emitting device 21 to the heat sink 14 through the heat dissipation metal plate for heat dissipation is thus avoided. In this way, the heat dissipation efficiency of the light-emitting device 21 is improved, and a volume of the light source assembly 20 is also decreased, so more accommodating space is vacated in the housing 11, more devices can be assembled in the optical module 10, and performance of the optical module 10 is improved while ensuring that the size of the optical module 10 satisfies the protocol requirements.

15 **[0048]** It should be noted that the light source circuit board 22 being directly fixed to the first cover 114 in this embodiment should be understood as the light source circuit board 22 is not fixed to the first cover 114 through a heat dissipation metal plate, but the light source circuit board 22 itself is directly fixed to the first cover 114 through fasteners such as screws or gluing. The light source assembly 20 may be an ITLA (integrable tunable laser assembly) or the like, which is not limited herein. Further, the light source assembly 20 is arranged close to the optical interface 116. In this way, the utilization of the internal space of the optical module 10 may be improved in this embodiment by reasonably designing the arrangement position of the light source assembly 20, and further ensure that the size of the optical module 10 satisfies protocol requirements.

25 **[0049]** Further, the light-emitting device 21 abuts against an inner side of the first cover 114 and is thermally connected to the first cover 114; alternatively, the light source assembly 20 further includes a thermally-conductive flexible (not shown). The thermally-conductive flexible body is

disposed between the first cover 114 and the light-emitting device 21, and the thermally-conductive flexible body directly contacts the first cover 114 and the light-emitting device 21, so as to thermally connect the first cover 114 and the light-emitting device 21. The thermally-conductive flexible is preferably thermally-conductive adhesive, a thermally-conductive pad, or thermally-conductive putty, disposed between the light-emitting device 21 and the first cover 114, and may fill a gap between the light-emitting device 21 and the first cover 114. On one hand, the thermally-conductive flexible body reduces thermal resistance of thermal conduction between the light-emitting device 21 and the first cover 114 and improves thermal conduction efficiency between the two, so heat dissipation efficiency of the light-emitting device 21 is improved. If in the related art, heat generated by the light-emitting device 21 is first conducted through a heat dissipation metal plate and then through the thermally-conductive flexible body to the heat sink 14, this inevitably lengthens the thermal conduction path, resulting in reduced heat dissipation efficiency of the light-emitting device 21. On the other hand, the thermally-conductive flexible body may compensate for assembly errors between the light source assembly 20 and the first cover 114, and requirements for assembly precision of the two are thus reduced.

[0050] Referring to FIG. 7 together, FIG. 7 is a schematic structural view of a light-emitting device in an embodiment of the present application.

[0051] In an embodiment, the light-emitting device 21 includes a hermetic box 211, and the hermetic box 211 has a packaging cavity 2111 inside. The light-emitting device 21 further includes a tunable laser module, the tunable laser module is packaged in the packaging cavity 2111, and the tunable laser module is used to generate a wavelength-tunable optical signal. In this embodiment, the tunable laser module adopts a semiconductor gain chip combined with a tunable external cavity, so as to generate wavelength-tunable laser with a narrow line width. The light-emitting device 21 further includes an output head 212, the output head 212 is connected to a side of the hermetic box 211 away from the optical interface 116 in the third direction, and the output head 212 is used to output the optical signal generated by the tunable laser module. In this

embodiment, a bottom portion of the hermetic box 211 used to carry the tunable laser module is relatively close to the first cover 114, so heat generated by the tunable laser module is conducted to the first cover 114 through the bottom portion of the hermetic box 211 and then dissipated from the heat sink 14 on an outer side of the first cover 114.

5 **[0052]** The tunable laser module includes a thermoelectric cooler 214, and the thermoelectric cooler 214 is used to control a temperature of the packaging cavity 2111. The tunable laser module further includes a semiconductor gain chip 215, a collimating lens 216, a tunable filter unit 217, and an isolator 218. The semiconductor gain chip 215, the collimating lens 216, the tunable filter unit 217, and the isolator 218 are arranged on the thermoelectric cooler 214. Herein, the
10 semiconductor gain chip 215 is used to emit excitation light containing multiple wavelengths. The collimating lens 216 is optically connected to the semiconductor gain chip 215, and the collimating lens 216 is used to collimate light beams emitted by the semiconductor gain chip 215. The tunable filter unit 217 is optically connected to the collimating lens 216. In this embodiment, the tunable filter unit 217 filters light beams emitted by the semiconductor gain chip 215 based on
15 vernier effect, allowing only light of specific wavelengths to pass through. The isolator 218 is optically connected to the tunable filter unit 217 and is used to isolate return light that may be reflected from rear optical end faces, so that the return light is prevented from returning to a resonant cavity and affecting laser stability. In this embodiment, an end surface of the semiconductor gain chip 215 on a side away from the collimating lens 216 is a first cavity surface
20 2151, and a side wall of the isolator 218 away from the output head 212 is a second cavity surface 2181. The first cavity surface 2151 and the second cavity surface 2181 constitute a laser resonant cavity, and an optical distance between the first cavity surface 2151 and the second cavity surface 2181 is the cavity length. Light emitted by the semiconductor gain chip 215 resonates between the two cavity surfaces, and only light whose wavelength satisfies the resonance conditions with
25 the cavity length can form laser output. The tunable filter unit 217 filters these lasers, to select only laser of specific wavelengths among them to pass through. Only the light of this specific

wavelength can resonate between the first cavity surface 2151 and the second cavity surface 2181 to form laser output, and lastly, the narrow line width laser with only one center wavelength is outputted. The tunable laser module further includes a coupling lens 219, and the coupling lens 219 is optically connected to the isolator 218 and is used to couple the outputted laser into the optical fiber of the output head 212 to output laser from the output head 212.

[0053] In one embodiment, the light source assembly 20 further includes a supporting member 23, and the supporting member 23 is connected to the light source circuit board 22 and supports the light-emitting device 21 on a side away from the heat sink 14, so as to cooperate with the light source circuit board 22 to reliably fix the light-emitting device 21 inside the first cover 144 together.

In this embodiment, the supporting member 23 includes a connection portion 232 and a supporting portion 231. The connection portion 232 is connected to a side of the light source circuit board 22 away from the heat sink 14, the supporting portion 231 is connected to an end portion of the connection portion 232 away from the light source circuit board 22, and the supporting portion 231 supports on a surface of the light-emitting device 21 away from the heat sink 14. When the light source assembly 20 is fixed to the first cover 114, the supporting member 23 cooperates with the first cover 114 to clamp the light-emitting device 21 between the supporting member 23 and the first cover 114, so as to stably fix the light-emitting device 21 inside the first cover 114. The connection portion 232 includes a connection column, the supporting portion 231 includes a supporting plate, one end of the connection column is fixedly connected to the light source circuit board 22, the other end is fixedly connected to the supporting plate, and the supporting plate supports on the surface of the light-emitting device 21 away from the heat sink 14.

[0054] In this embodiment, the supporting member 23 is only provided on one side of the light-emitting device 21 and cooperates with the light source circuit board 22 and the first cover 114 to fix the light-emitting device 21. Compared to the related art, one clamping plate is omitted, the structure is simple, and the only a small space is occupied, so that more space is vacated in the housing 11 of the optical module 10, which is beneficial for packaging other devices inside the

optical module 10.

[0055] In an embodiment, the light-emitting device 21 is located on one side of the light source circuit board 22 in the second direction, the light-emitting device 21 has a target surface 213 facing the light source circuit board 22 in the second direction, and the supporting member 23 is arranged close to the target surface 213, and specifically the supporting portion 231 of the supporting member 23 is arranged close to the target surface 213. Since a photodetector 36 of the optical amplification assembly 30 is arranged on a side of the light-emitting device 21 away from the heat sink 14, in this embodiment, the supporting member 23 is arranged on an inner side of the light-emitting device 21 in the second direction, while the photodetector 36 of the optical amplification assembly 30 is closer to an outer side of the light-emitting device 21, so that the supporting member 23 may avoid the photodetector 36, making the stacking structure of electronic devices inside the optical module 10 more compact. Which is beneficial to reducing the size of the optical module 10 in the first direction, and it is further ensured that the size of the optical module 10 satisfies protocol requirements.

[0056] Further, in the third direction, the supporting member 23 is arranged close to the output head 212 of the light-emitting device 21, and specifically the supporting portion 231 of the supporting member 23 is arranged close to the output head 212. In this embodiment, the supporting member 23 is not only arranged on the inner side of the light-emitting device 21 in the second direction, but also close to the output head 212 of the light-emitting device 21 in the third direction, so that the supporting member 23 may also avoid the fiber coiling of the optical amplification assembly 30. As such, the size of the stacking structure formed by the light source assembly 20 and the optical amplification assembly 30 in the first direction may be reduced, making the stacking structure of electronic devices inside the optical module 10 more compact, and further ensuring that the size of the optical module 10 satisfies protocol requirements.

[0057] In an embodiment, the light source assembly 20 further includes an electrical connector 24, and the light-emitting device 21 is electrically connected to the light source circuit board 22

through the electrical connector 24 and is fixed to the light source circuit board 22 through the electrical connector 24. The electrical connector 24 is connected to a side of the light source circuit board 22 away from the heat sink 14. Compared to the case where the electrical connector 24 is connected to a side of the light source circuit board 22 facing the heat sink 14, in this embodiment, the light source circuit board 22 is closer to the first cover 114, so that more space may be vacated below the light source circuit board 22 to allow accommodation of more devices. Further, the size of the stacking structure formed by the light source assembly 20, the optical amplification assembly 30, and the main circuit board 12 stacked with one another in the first direction may be reduced, making the stacking structure of the electronic devices inside the optical module 10 more compact, and further ensuring that the size of the optical module 10 satisfies protocol requirements. In addition, since the size of the stacking structure formed by the light source assembly 20 and the optical amplification assembly 30 in the first direction is reduced, sufficient space may also be reserved for heat dissipation fins or heat dissipation teeth of the heat sink 14, and the heat dissipation performance of the optical module 10 is thus improved.

[0058] Referring to FIG. 2 again, in an embodiment, in order to arrange the light source assembly 20 and optical amplification assembly 30 inside the optical module 10, while ensuring that an overall length of the optical module 10 remains unchanged and satisfies the specific size requirements of protocol standards, a length of a portion with the heat sink 14 of the housing 11 of the optical module 10 is extended. Therefore, in this embodiment, a length L1 of the housing 11 in the third direction is 96.5 mm to 106.5 mm, for example, 96.5 mm, 96.12 mm, 97.35 mm, 98.16 mm, 99.68 mm, 101.66 mm, 102.41 mm, 103.72 mm, 104.69 mm, 106.5 mm, etc. In this way, the accommodating cavity 111 inside the housing 11 has sufficient space, so that a length of the main circuit board 12 in the third direction may also be appropriately extended to accommodate the light source assembly 20 and the optical amplification assembly 30, ensuring that the optical module 10 has high output power.

[0059] In an embodiment, the optical module 10 further includes a pull ring 13, and the pull ring

13 is connected to the housing 11. The pull ring 13 is used to release locking between the optical module 10 and the optical cage. Specifically, when the optical module 10 is inserted in the optical cage, the pull ring 13 can be pulled from outside to release the locking between the optical module 10 and the optical cage, thereby allowing the optical module 10 to be pulled out from the optical cage. Specifically, the pull ring 13 includes a force application portion 131 and at least two sliding arms 132. The force application portion 131 is connected to the housing 11 through each sliding arm 132. An external force is applied to the force application portion 131 to drive the pull ring 13 to move to release the locking between the optical module 10 and the optical cage. The force application portion 131 and the housing 11 are spaced apart from each other in the third direction, and the user applies a force to the force application portion 131 through a gap between the force application portion 131 and the housing 11.

[0060] Considering that the length of the housing 11 of the optical module 10 is extended, in order to ensure that the overall length of the optical module 10 and a length L2 of the gap between the force application portion 131 on the pull ring 13 and the housing 11 satisfy the requirements, a length L3 of the force application portion 131 in the third direction is reduced in this embodiment. Specifically, the length L3 of the force application portion 131 in the third direction is 3 mm to 6 mm, for example, 3 mm, 3.5 mm, 4 mm, 4.5 mm, 5 mm, 5.5 mm, 6 mm, etc., so that there is a sufficiently large gap between the force application portion 131 and the housing 11, which may facilitate the pluggable connection between an external optical fiber and the optical interface 116 of the optical module 10. Meanwhile, the length L3 of the force application portion 131 in the third direction in this embodiment is not excessively small, which may ensure that the force application portion 131 has sufficient structural strength and sufficient space for marking.

[0061] The optical module provided by the present application has been described in detail above. Specific examples have been applied in this document to illustrate the principles and implementation methods of the present application. The description of the above embodiments is only used to help understand the method and core idea of the present application. Meanwhile,

for a person having ordinary skill in the art, based on the idea of the present application, there will be changes in specific implementation methods and application scope. In summary, the content of this specification should not be understood as a limitation on the present application.

CLAIMS

[Claim 1] An optical module, characterized in comprising:

a housing, comprising:

a first cover, provided with a heat sink provided outside thereof; and

5 a second cover, covering the first cover, and an accommodating cavity is formed between the first cover and the second cover; and

a light source assembly, disposed in the accommodating cavity;

wherein the light source assembly comprises a light-emitting device and a light source circuit board, the light-emitting device is electrically connected to the light source circuit board, and the
10 light source circuit board is configured to control the light-emitting device to output an optical signal;

the light-emitting device is fixed to the light source circuit board, and the light source circuit board is directly fixed to the first cover, so that the light-emitting device is fixed at a position on the inner side of the first cover corresponding to the heat sink and is thermally connected to the
15 first cover.

[Claim 2] The optical module according to claim 1, characterized in that

the light-emitting device abuts against the inner side of the first cover and is thermally connected to the first cover directly;

or

20 a thermally-conductive flexible body is provided between the first cover and the light-emitting device, and the thermally-conductive flexible body directly contacts both the first cover and the light-emitting device to thermally connect the first cover and the light-emitting device.

[Claim 3] The optical module according to claim 2, characterized in that

a thermally-conductive flexible body is provided between the first cover and the light-
25 emitting device, and the thermally-conductive flexible body is thermally-conductive putty, a thermally-conductive pad, and/or thermally-conductive adhesive.

[Claim 4] The optical module according to any one of claims 1 to 3, characterized in that the light source assembly further comprises:

a supporting member, connected to the light source circuit board and supporting the light-emitting device on a side away from the heat sink.

5 [Claim 5] The optical module according to claim 4, characterized in that

the optical module has a first direction, a second direction, and a third direction that are mutually perpendicular, the first cover and the second cover overlap in the first direction, and the length of the optical module in the second direction is less than the length of the optical module in the third direction;

10 wherein the light-emitting device is located on one side of the light source circuit board in the second direction, the light-emitting device has a target surface facing the light source circuit board in the second direction, and the supporting member is disposed close to the target surface.

[Claim 6] The optical module according to claim 5, characterized in that

15 the housing is provided with an optical interface at one end in the third direction, and the optical interface is configured to be optically connected to an optical fiber outside the optical module;

the light-emitting device comprises:

a hermetic box, provided with a packaging cavity therein;

20 a tunable laser module, packaged in the packaging cavity, wherein the tunable laser module is configured to generate a wavelength-tunable optical signal; and

an output head, connected to a side of the hermetic box away from the optical interface in the third direction, wherein the output head is configured to output an optical signal generated by the tunable laser module;

wherein in the third direction, the supporting member is disposed close to the output head.

25 [Claim 7] The optical module according to claim 6, characterized in that

the tunable laser module comprises:

a thermoelectric cooler, configured to control the temperature of the packaging cavity;

a semiconductor gain chip;

a collimating lens, optically connected to the semiconductor gain chip;

a tunable filter unit, optically connected to the collimating lens;

5 an isolator, optically connected to the tunable filter unit; and

a coupling lens, optically connected to the isolator;

wherein the semiconductor gain chip, the collimating lens, the tunable filter unit, and the isolator are arranged on the thermoelectric cooler.

[Claim 8] The optical module according to claim 4, characterized in that

10 the supporting member comprises:

a connection portion, connected to a side of the light source circuit board away from the heat sink; and

a supporting portion, connected to an end of the connection portion away from the light source circuit board, wherein the supporting portion supports on a surface of the light-emitting device

15 away from the heat sink.

[Claim 9] The optical module according to claim 8, characterized in that

the connection portion comprises a connection column, the supporting portion comprises a supporting plate, one end of the connection column is fixedly connected to the light source circuit board, the other end is fixedly connected to the supporting plate, and the supporting plate supports

20 on the surface of the light-emitting device away from the heat sink.

[Claim 10] The optical module according to any one of claims 1 to 3, characterized in that

the optical module has a first direction, a second direction, and a third direction that are mutually perpendicular, the first cover and the second cover overlap in the first direction, and the length of the optical module in the second direction is less than the length of the optical module in
25 the third direction;

wherein the accommodating cavity is divided into a first sub-cavity and a second sub-cavity

communicating with each other in the third direction, an inner wall of the first cover facing the first sub-cavity in the first direction and/or an inner wall of the second cover facing the first sub-cavity in the first direction is formed with a groove, such that a maximum length of the first sub-cavity in the first direction is greater than a maximum length of the second sub-cavity in the first direction; and the light source assembly is accommodated in the first sub-cavity.

[Claim 11] The optical module according to any one of claims 1 to 3, characterized in that the light source assembly further comprises:

an electrical connector, the light-emitting device being electrically connected to the light source circuit board by the electrical connector, wherein the electrical connector is connected to a side of the light source circuit board away from the heat sink.

[Claim 12] The optical module according to any one of claims 1 to 3, characterized in that the housing is provided with an optical interface and an electrical interface at opposite ends; the optical interface is configured to be optically connected to an optical fiber outside the optical module; the optical module further comprises a main circuit board electrically connected to the light source assembly, and one end of the main circuit board is electrically connected to an equipment outside the optical module via the electrical interface;

wherein the light source assembly and the heat sink are disposed close to the optical interface.

[Claim 13] The optical module according to any one of claims 1 to 3, characterized in that the light source circuit board is a rigid circuit board.