

OPTICAL MODULE

[0001] This application claims the priority of the Chinese patent application filed with the China Patent Office on November 7, 2023, with application number 202322995951.4 and invention name “Optical Module”, all contents of which are incorporated by reference in this application.

TECHNICAL FIELD

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

BACKGROUND ART

[0003] In recent years, the development of emerging technologies such as data centers, high-performance computing, and 5G communication has imposed higher requirements on information transmission rates. Therefore, the market has higher requirements on the rate of optical transceiver modules (hereinafter referred to as the optical module), which are important devices in communication systems, resulting in a significant increase in the power consumption of the optical module. In addition, the national “dual-carbon” strategy and the international pursuit of energy conservation and carbon reduction make it imperative to reduce the energy consumption of data centers. According to the 2019 statistics on the energy consumption of China’s data centers, in traditional data centers using air-cooling technology, about 43% of the energy consumption is used for heat dissipation, which is almost equivalent to the energy consumption of the equipment itself. Therefore, reducing related energy consumption and controlling data center operating costs by improving heat dissipation efficiency has become imperative.

[0004] As one of the most representative advanced cooling solutions at present, immersion liquid cooling is a focal technology that has attracted great attention from related industries recently. To adapt to this situation, there is an urgent market demand to develop an optical module suitable for immersion liquid cooling. Existing air-cooled optical module cannot effectively seal the optical path, and penetration by refrigerant liquid and refrigerant vapor can easily affect optical performance.

UTILITY MODEL CONTENT

[0005] The present application provides an optical module, which can effectively seal optical assembly and has a good sealing effect.

[0006] The present application provides an optical module. The optical module comprises a circuit board; an optical assembly, comprising an optical engine and an optical fiber connector, wherein the optical engine is disposed on the circuit board, and the optical fiber connector is optically connected to the optical engine; a sealing cover assembly, disposed on the circuit board, wherein the sealing cover assembly covers outer peripheries of the optical engine and the optical fiber connector; and an encapsulation assembly, disposed on the circuit board, wherein the encapsulation assembly covers the outer periphery of the sealing cover assembly, and the sealing cover assembly and the encapsulation assembly are configured to cooperate to seal the optical engine and the optical fiber connector on the circuit board.

[0007] In one embodiment of the present application, the sealing cover assembly comprises: a sealing cover, comprising a first cover body portion and a second cover body portion, wherein the first cover body portion is located on a side of the optical engine and the optical fiber connector away from the circuit

board, the second cover body portion is disposed around the optical engine and the optical fiber connector, and the first cover body portion is connected to the circuit board through the second cover body portion.

[0008] In one embodiment of the present application, the sealing cover assembly further comprises: a first connector, wherein the second cover body portion and the circuit board are fixedly connected via the first connector.

[0009] In one embodiment of the present application, the optical assembly further comprises: an optical fiber, connected to the optical fiber connector; wherein the sealing cover assembly further comprises: a sealing gasket, connected to the second cover body portion; wherein, the second cover body portion has a first fiber outlet, the sealing gasket seals the first fiber outlet; the sealing gasket is provided with a first fiber outlet hole, the first fiber outlet hole is smaller than the first fiber outlet, and the optical fiber extends through the first fiber outlet hole and is sealingly connected to the sealing gasket.

[0010] In one embodiment of the present application, the second cover body portion further comprises a sealing groove, wherein the first fiber outlet is in communication with a groove bottom of the sealing groove, and the sealing gasket is embedded in the sealing groove to seal the first fiber outlet.

[0011] In one embodiment of the present application, the encapsulation assembly comprises: a fence, disposed around the sealing cover assembly to enclose an encapsulation cavity; and an encapsulation body, accommodated in the encapsulation cavity, wherein the encapsulation body covers the outer periphery of the sealing cover assembly.

[0012] In one embodiment of the present application, the optical assembly further comprises: an optical fiber, connected to the optical fiber

connector; wherein the encapsulation assembly further comprises: a sealing bushing, connected to the fence; wherein, the fence has a second fiber outlet, the sealing bushing seals the second fiber outlet; the sealing bushing is provided with a second fiber outlet hole, the second fiber outlet hole is smaller than the second fiber outlet, and the optical fiber extends through the second fiber outlet hole and is sealingly connected to the sealing bushing.

[0013] In one embodiment of the present application, the sealing bushing comprises a main body, a first sealing part and a second sealing part, wherein the first sealing part and the second sealing part are respectively located on opposite sides of the main body, a snap-fit groove is formed between the first sealing part and the second sealing part, and a portion of the fence adjacent to the second fiber outlet is embedded in the snap-fit groove to achieve sealing.

[0014] In one embodiment of the present application, the portion of the fence adjacent to the second fiber outlet is inserted into the snap-fit groove in an interference fit manner.

[0015] In one embodiment of the present application, the sealing bushing is a flexible structure.

[0016] In one embodiment of the present application, the encapsulation assembly further comprises: a second connector, wherein the fence and the circuit board are fixedly connected via the second connector.

[0017] In one embodiment of the present application, the optical module further comprises: a housing, having a receiving cavity therein, wherein the circuit board and the optical assembly are received in the receiving cavity; wherein, the optical engine comprises a lens module and an optical emitting chip and/or an optical receiving chip, the optical emitting chip and/or

the optical receiving chip are disposed on the circuit board, and the optical emitting chip and/or the optical receiving chip are optically coupled with the optical fiber connector through the lens module.

[0018] The beneficial effect of the present application is as follows. Different from the prior art, the present application provides an optical module. The optical module comprises a sealing cover assembly and an encapsulation assembly. The sealing cover assembly is disposed on the periphery of the optical engine and the optical fiber connector of the optical assembly, and the encapsulation assembly is disposed on the periphery of the sealing cover assembly. The sealing cover assembly and the encapsulation assembly are used to cooperate to seal the optical engine and the optical fiber connector to the circuit board. In other words, the sealing cover assembly and the encapsulation assembly of the present application form a double-layer sealing structure, which can effectively seal the optical engine and the optical fiber connector, has a good sealing effect, and prevents the coolant entering the optical module from affecting the optical performance of the optical assembly, so that the optical module can be suitable for an immersion liquid cooling environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In order to more clearly illustrate the technical solutions in the embodiments of the present application, the drawings required for use in the description of the embodiments will be briefly introduced below. Obviously, the drawings described below are only some embodiments of the present application. For those skilled in the art, other drawings can be obtained based on these drawings without creative work.

[0020] FIG. 1 is a schematic diagram of the structure of an embodiment of the optical module of the present application;

[0021] FIG.2 is a schematic diagram of an exploded structure of an embodiment of an optical module of the present application;

[0022] FIG.3 is a schematic diagram of an exploded structure of an embodiment of a sealing cover assembly of the present application;

[0023] FIG. 4 is a schematic diagram of the structure of a fence in an embodiment of the present application;

[0024] FIG. 5 is a schematic diagram of the structure of a sealing bushing in an embodiment of the present application; and

[0025] FIGS. 6a-6b are schematic diagrams of the structure of each step in the sealing process of the optical assembly of the present application.

[0026] Description of reference numerals:

[0027] 10 optical module; 12 circuit board; 13 optical assembly; 131 optical engine; 132 optical fiber connector; 133 optical fiber; 14 sealing cover assembly; 141 sealing cover; 1411 first cover body portion; 1412 second cover body portion; 1413 first fiber outlet; 1414 sealing groove; 142 sealing gasket; 1421 first fiber outlet hole; 15 encapsulation assembly; 151 fence; 1511 second fiber outlet; 152 encapsulation cavity; 153 encapsulation body; 154 sealing bushing; 1541 second fiber outlet hole; 1542 main body; 1543 first sealing part; 1544 second sealing part; 1545 snap-fit groove.

DETAILED DESCRIPTION

[0028] The technical solutions in the embodiments of the present application will be clearly and completely described below in conjunction with the drawings in the embodiments of the present application. Obviously, the

described embodiments are only part of the embodiments of the present application, rather than all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by those skilled in the art without making creative work are within the scope of protection of the present application. In addition, it should be understood that the specific implementation methods described herein are only used to illustrate and explain the present application and are not used to limit the present application. In the present application, unless otherwise stated, the directional words used, such as "up", "down", "left", and "right", generally refer to the up, down, left, and right of the device in actual use or working state, specifically the drawing direction in the accompanying drawings.

[0029] In this application, unless otherwise clearly specified and limited, the terms "connected", "connected", "stacked" and the like should be understood in a broad sense, for example, it can be fixedly connected, detachably connected, or integrated; it can be directly connected, or indirectly connected through an intermediate medium, it can be the internal connection of two elements or the interaction relationship between two elements. For ordinary technicians in this field, the specific meanings of the above terms in this application can be understood according to specific circumstances.

[0030] The present application provides an optical module, which is described in detail below. It should be noted that the description order of the following embodiments does not limit the preferred order of the embodiments of the present application. In the following embodiments, the description of each embodiment has its own emphasis. For parts that are not described in

detail in a certain embodiment, please refer to the relevant description of other embodiments.

[0031] Please refer to FIGS. 1 and 2, FIG. 1 is a schematic diagram of the structure of an embodiment of the optical module of the present application, and FIG. 2 is a schematic diagram of an exploded structure of an embodiment of an optical module of the present application. In particular, FIGS. 1 and 2 omit the housing.

[0032] In one embodiment, the optical module 10 comprises a housing. The housing is a basic carrier of the optical module 10 and plays at least a role in bearing and protecting other components of the optical module 10. The housing has a receiving cavity inside that is connected to the outside.

[0033] The optical module 10 also comprises a circuit board 12. The circuit board 12 is accommodated in an accommodating cavity. The circuit board 12 is integrated with a logic control circuit, and the circuit board 12 is used to connect to an external communication device, and the circuit board 12 is also used to realize the photoelectric conversion function of the optical module 10. It should be noted that the accommodating cavity where the circuit board 12 of this embodiment is located is connected to the outside of the housing, so that the coolant can enter the accommodating cavity and can contact the circuit board 12 for heat dissipation, which greatly improves the heat dissipation efficiency of the power-consuming devices on the circuit board 12, that is, the optical module 10 of this embodiment can apply an immersion liquid cooling heat dissipation solution, which has a higher heat dissipation efficiency.

[0034] The optical module 10 also comprises an optical assembly 13. The optical assembly 13 is accommodated in the accommodating cavity, and the

optical assembly 13 is disposed on the circuit board 12. The optical assembly 13 is used to realize the conversion of optical-electrical signals. The external optical signal is converted into an electrical signal by the optical assembly 13 and transmitted to the circuit board 12, and then uploaded to the external communication device through the circuit board 12; the circuit board 12 receives instructions from the external communication device and processes them into corresponding electrical signals and sends them to the optical assembly 13, which are converted into optical signals by the optical assembly 13 and transmitted to the external optical transmission cable. Wherein, the optical assembly 13 comprises an optical engine 131 (Optical Engine, OE), an optical fiber connector 132 and an optical fiber 133. The optical engine 131, the optical fiber connector 132 and the optical fiber 133 are optically connected in sequence, and the optical fiber 133 is also configured to optically connected to the external transmission optical fiber/optical cable, and the end of the optical fiber 133 is fixed to the optical engine 131 through the optical fiber connector 132. In this embodiment, the optical engine 131 comprises an optical emitting chip and/or an optical receiving chip disposed on the circuit board 12, and a lens module covering on the optical emitting chip and/or the optical receiving chip. The lens module is provided with an avoidance cavity on the side facing the circuit board 12 for avoiding the optical emitting chip and/or the optical receiving chip. The lens module is provided with an interface for docking with the optical fiber connector 132 and a coupling lens on the side facing the optical fiber connector 132. The optical fiber connector 132 is fixedly connected to the lens module and optically coupled to each other. Optical connectivity is defined as having an optical signal transmission channel

between the two parties that establish an optical connectivity relationship, and being able to interact with optical signals.

[0035] When the optical module 10 of the above-mentioned embodiment is applied to the environment of the immersion liquid cooling heat dissipation solution, considering that the coolant entering the accommodating cavity will cause the optical performance to attenuate if it enters the optical path, the optical assembly 13 needs to be effectively sealed in this embodiment. In view of this, the optical module 10 also comprises a sealing cover assembly 14 and an encapsulation assembly. The sealing cover assembly 14 is disposed on the circuit board 12, and the sealing cover assembly 14 covers on the outer periphery of the optical engine 131 and the optical fiber connector 132, and the sealing cover assembly 14 is used to protect the optical engine 131 and the optical fiber connector 132. The encapsulation assembly 15 covers on the outer periphery of the sealing cover assembly 14, so as to seal the sealing cover assembly 14, the optical engine 131 and the optical fiber connector 132 therein on the circuit board 12, that is, the sealing cover assembly 14 and the encapsulation assembly 15 cooperate to seal the optical engine 131 and the optical fiber connector 132 on the circuit board 12, so as to effectively prevent the coolant or coolant vapor entering the accommodating cavity from penetrating into the optical engine 131 and the optical path. As the name implies, the encapsulation assembly 15 comprises a colloid formed by encapsulation (i.e., the encapsulation body 153 described below), which can play a sealing role. The encapsulation assembly 15 is disposed on the circuit board 12, and the encapsulation assembly 15 covers on the periphery of the sealing cover assembly 14. The encapsulation assembly 15 is used to seal the

sealing cover assembly 14 and the optical engine 131 and the optical fiber connector 132 therein. The optical fiber 133 connected to the optical fiber connector 132 extends from the sealing cover assembly 14 and the encapsulation assembly 15 to optically communicate with an external optical fiber or optical cable.

[0036] Through the above-mentioned method, the sealing cover assembly 14 and the encapsulation assembly 15 of this embodiment form a double-layer sealing structure, which can effectively seal the optical engine 131 and the optical fiber connector 132, and prevent the coolant entering the accommodating cavity from affecting the optical performance of the optical assembly 13. In addition, the sealing cover assembly 14 of the present application covers on the periphery of the optical engine 131 and the optical fiber connector 132, which means that the sealing cover assembly 14 can effectively protect the top and surrounding of the optical engine 131 and the optical fiber connector 132, and has a good sealing effect. This means that the optical module 10 of this embodiment can meet the sealing requirements by forming a double-layer sealing structure with the sealing cover assembly 14 and the encapsulation assembly 15, while the optical module 10 in the prior art needs to be provided with more layers of sealing structures to meet the sealing requirements. Therefore, the sealing system composed of the sealing cover assembly 14 and the encapsulation assembly 15 of this embodiment has a smaller volume as a whole, and a small sealing area, which is conducive to improving the utilization rate of the internal space of the optical module 10.

[0037] Air-cooled optical modules lack effective sealing means as a whole, which makes them unable to effectively resist the infiltration of coolant.

Especially in a two-phase liquid cooling environment, it is necessary to effectively prevent the intrusion of refrigerant liquid and refrigerant vapor. Once the refrigerant liquid and refrigerant vapor enter the optical path, it will inevitably cause optical performance degradation. In addition, the optical module cannot be sealed by sealing the outer housing. This is because the outer housing structure is complex and easy to deform, and the sealing effect is difficult to guarantee. Moreover, after the outer housing is sealed, the refrigerant cannot enter the optical module to directly contact the power chip, and the heat dissipation effect is also greatly reduced.

[0038] Please refer to FIG. 3, which is a schematic diagram of an exploded structure of an embodiment of a sealing cover assembly of the present application. The sealing cover assembly 14 of the embodiment of the present application is described below.

[0039] In one embodiment, the sealing cover assembly 14 comprises a sealing cover 141, which covers on the periphery of the optical engine 131 and the optical fiber connector 132 to seal the optical engine 131 and the optical fiber connector 132. Specifically, the sealing cover 141 comprises a first cover body portion 1411 and a second cover body portion 1412. The first cover body portion 1411 is connected to the circuit board 12 through the second cover body portion 1412, and the second cover body portion 1412 is disposed around the first cover body portion 1411. The first cover body portion 1411 and the second cover body portion 1412 can be an integral structure to form a sealed connection, or the first cover body portion 1411 and the second cover body portion 1412 are separate assembly structures, and the two are hermetically connected by means of sealant or welding. The first cover body portion 1411 is

located on the side of the optical engine 131 and the optical fiber connector 132 away from the circuit board 12, that is, the first cover body portion 1411 is used to seal the top of the optical engine 131 and the optical fiber connector 132. The second cover body portion 1412 is disposed around the optical engine 131 and the optical fiber connector 132, and the second cover body portion 1412 is used to seal around the optical engine 131 and the optical fiber connector 132.

[0040] Furthermore, the sealing cover assembly 14 also comprises a first connector, and the second cover body portion 1412 and the circuit board 12 are fixedly connected by the first connector. The second cover body portion 1412 and the circuit board 12 can be connected by dispensing or welding, that is, the first connector is a colloid formed by dispensing or a weld formed by welding. In this embodiment, after the sealing cover 141 is set on the circuit board 12, the encapsulation assembly 15 is formed by encapsulation colloid, so the connection method between the second cover body portion 1412 and the circuit board 12 can have a sealing effect to prevent the colloid from penetrating into the interior of the sealing cover 141 during the process of forming the encapsulation assembly 15. Certainly, in other embodiments of the present application, since the gap between the second cover body portion 1412 and the circuit board 12 is small, it is difficult for the encapsulation colloid to penetrate through the gap, so the second cover body portion 1412 and the circuit board 12 may not be sealed. Connection, which is not limited here.

[0041] Further, the second cover body portion 1412 has a first fiber outlet 1413, and the optical fiber 133 connected to the optical fiber connector 132 extends from the first fiber outlet 1413. The sealing cover assembly 14 also comprises a sealing gasket 142, which is connected to the second cover body

portion 1412, and the sealing gasket 142 seals the first fiber outlet 1413. The sealing gasket 142 and the second cover body portion 1412 can be connected by a mechanical snap-fit structure, and the connection method between the sealing gasket 142 and the second cover body portion 1412 has a certain sealing effect, so that the sealing gasket 142 seals the first fiber outlet 1413. The sealing gasket 142 is provided with a first fiber outlet hole 1421. The optical fiber 133 is thread through the first fiber outlet hole 1421 and is sealingly connected to the sealing gasket 142. The sealing gasket 142 can be a flexible structure, and the sealing gasket 142 and the optical fiber 133 have an interference fit, so that the sealing gasket 142 and the optical fiber 133 are sealingly connected to each other. By the above-mentioned method, the risk of the encapsulation colloid and the coolant penetrating into the interior of the sealing cover 141 can be reduced. In this embodiment, the sealing gasket 142 can be sleeved on the optical fiber before the optical fiber connector 132; or, the sealing gasket 142 is provided with an optical fiber embedding channel connected to the first optical fiber hole 1421, which is used to embed the optical fiber into the first optical fiber hole 1421 of the sealing gasket 142 through the optical fiber embedding channel after the optical fiber connector 132 is connected to the optical fiber.

[0042] It should be noted that the first fiber outlet hole 1421 is smaller than the first fiber outlet 1413. In other words, the first fiber outlet 1413 is larger, which can facilitate the optical fiber 133 to pass through the first fiber outlet 1413, thereby facilitating the assembly of the sealing cover assembly 14, while the first fiber outlet hole 1421 is smaller, which is conducive to ensuring the sealing effect between the sealing gasket 142 and the optical fiber 133.

[0043] Furthermore, the second cover body portion 1412 further has a sealing groove 1414, the first fiber outlet 1413 is connected to the bottom of the sealing groove 1414, and the sealing gasket 142 is embedded in the sealing groove 1414 to seal the first fiber outlet 1413. In this way, the sealing gasket 142 of this embodiment is embedded in the sealing groove 1414, which can avoid the sealing gasket 142 from significantly affecting the overall volume of the sealing cover assembly 14 as much as possible, which is conducive to ensuring that the sealing cover assembly 14 has a smaller volume as a whole, and further conducive to improving the utilization rate of the internal space of the optical module 10.

[0044] Please refer to FIG. 4 and FIG. 5 together. FIG. 4 is a schematic diagram of the structure of a fence in an embodiment of the present application, and FIG. 5 is a schematic diagram of the structure of a sealing bushing in an embodiment of the present application. The encapsulation assembly 15 in an embodiment of the present application is described below.

[0045] In one embodiment, the encapsulation assembly 15 comprises a fence 151, which is disposed around the sealing cover assembly 14 to enclose an encapsulation cavity 152. The encapsulation assembly 15 also comprises an encapsulation body 153, which is accommodated in the encapsulation cavity 152, and the encapsulation body 153 covers on the periphery of the sealing cover assembly 14. In this embodiment, the encapsulation cavity 152 is surrounded by the fence 151 on the periphery of the sealing cover assembly 14, and the height of the fence 151 is higher than the height of the sealing cover assembly 14. Then, colloid is poured into the encapsulation cavity 152, so that the colloid wraps the top and the periphery of the sealing cover assembly 14,

and then the colloid is solidified to form the encapsulation body 153 covered on the periphery of the sealing cover assembly 14.

[0046] Furthermore, the encapsulation assembly 15 also comprises a second connector, and the fence 151 and the circuit board 12 are fixedly connected by the second connector. The fence 151 and the circuit board 12 can be connected by dispensing or welding, that is, the second connector is a colloid formed by dispensing or a weld formed by welding. In this embodiment, the connection between the fence 151 and the circuit board 12 can have a sealing effect to prevent the coolant from penetrating into the interior of the fence 151. Certainly, in other embodiments of the present application, since the gap between the fence 151 and the circuit board 12 is small, the fence 151 and the circuit board 12 may not be sealed, which is not limited here.

[0047] Furthermore, the fence 151 has a second fiber outlet 1511, and the optical fiber 133 connected to the optical fiber connector 132 extends out from the sealing cover assembly 14 and then extends out through the second fiber outlet 1511. The encapsulation assembly 15 also comprises a sealing bushing 154, which is connected to the fence 151, and the sealing bushing 154 seals the second fiber outlet 1511. The fence 151 and the sealing bushing 154 of this embodiment have a good sealing effect, which can effectively prevent the coolant from penetrating and the encapsulation colloid from overflowing, and can protect the optical fiber 133. The sealing bushing 154 is provided with a second fiber outlet hole 1541, and the optical fiber 133 extends through the second fiber outlet hole 1541 and is sealingly connected to the sealing bushing 154.

[0048] It should be noted that the second fiber outlet hole 1541 is smaller than the second fiber outlet 1511. In other words, the second fiber outlet 1511 is larger, which can facilitate the optical fiber 133 to pass through the second fiber outlet 1511, thereby facilitating the assembly of the fence 151, while the second fiber outlet hole 1541 is smaller, which is conducive to ensuring the sealing effect between the sealing bushing 154 and the optical fiber 133.

[0049] Specifically, the sealing bushing 154 comprises a main body 1542, a first sealing part 1543 and a second sealing part 1544. The first sealing part 1543 and the second sealing part 1544 are respectively located on opposite sides of the main body 1542, that is, the sealing bushing 154 is dumbbell-shaped as a whole. The second fiber outlet hole 1541 penetrates the main body 1542, the first sealing part 1543 and the second sealing part 1544. A snap-fit groove 1545 is formed between the first sealing part 1543 and the second sealing part 1544. The sealing bushing 154 can be a flexible structure. The part of the fence 151 adjacent to the second fiber outlet 1511 is embedded in the snap-fit groove 1545 to achieve sealing. Specifically, the part can be embedded in the snap-fit groove 1545 with interference fit, so that a good sealing effect can be ensured between the sealing bushing 154 and the fence 151, and the sealing bushing 154 is easy to assemble with the fence 151.

[0050] It should be noted that the embodiment of the present application has fewer connection positions. Specifically, it is only necessary to glue or weld the sealing cover assembly 14 to the circuit board 12, and to glue or weld the fence 151 to the circuit board 12, and then perform glue sealing (i.e., form an encapsulation body 153). Therefore, the embodiment of the present application requires fewer gaps to be sealed and has higher sealing reliability.

[0051] Furthermore, the embodiment of the present application is not limited to the sealing cover assembly 14 being provided with the sealing gasket 142 and the encapsulation assembly 15 being provided with the sealing bushing 154. In other embodiments of the present application, the setting positions of the sealing gasket 142 and the sealing bushing 154 can be swapped, that is, the sealing cover assembly 14 is provided with the sealing bushing 154 and the encapsulation assembly 15 is provided with the sealing gasket 142, which is not limited here. Certainly, in other embodiments of the present application, the sealing gasket 142 and the sealing bushing 154 can also be omitted, and instead, the position of the optical fiber 133 can be sealed by dispensing glue or the like.

[0052] Please refer to FIGS. 6a-6b, which are schematic diagrams of the structure of each step in the sealing process of the optical assembly of the present application. The sealing process of the optical assembly 13 of the embodiment of the present application is described below.

[0053] As shown in FIG. 6a. The optical engine 131 and the optical fiber connector 132 are covered on the circuit board 12 through the sealing cover 141. The optical fiber 133 connected to the optical fiber connector 132 extends from the first fiber outlet 1413 on the sealing cover 141. Afterwards, the sealing gasket 142 is installed on the sealing groove 1414 on the sealing cover 141, and the optical fiber 133 extends from the first fiber outlet hole 1421 on the sealing gasket 142, and the optical fiber 133 and the sealing gasket 142 are interference fit. As shown in FIG. 6b. Afterwards, the sealing bushing 154 is installed on the fence 151, and the fence 151 is covered on the outer periphery of the sealing cover 141, and the optical fiber 133 extends from the sealing gasket 142 and

then extends through the second fiber outlet 1511 on the fence 151 and the second fiber outlet hole 1541 on the sealing bushing 154. Afterwards, the encapsulation colloid is encapsulated in the encapsulation cavity 152 surrounded by the fence 151, and finally the encapsulation body 153 is formed. At this point, the sealing process of the optical assembly 13 is completed.

[0054] In summary, the present application provides an optical module. The optical module comprises a sealing cover assembly and an encapsulation assembly. The sealing cover assembly is disposed on the periphery of the optical engine and the optical fiber connector of the optical assembly, and the encapsulation assembly is disposed on the periphery of the sealing cover assembly. The sealing cover assembly and the encapsulation assembly are used to cooperate to seal the optical engine and the optical fiber connector to the circuit board. In other words, the sealing cover assembly and the encapsulation assembly of the present application form a double-layer sealing structure, which can effectively seal the optical engine and the optical fiber connector, has a good sealing effect, and prevents the coolant entering the optical module from affecting the optical performance of the optical assembly, so that the optical module can be suitable for an immersion liquid cooling environment.

[0055] The optical module provided by the present application is introduced in detail above. Specific examples are used in this article 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 of the present application and its core idea; at the same time, for general technical personnel in this field, according to the idea of the present application, there will be changes in the specific implementation method 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, comprising:
- a circuit board;
 - an optical assembly, comprising an optical engine and an optical fiber connector, wherein the optical engine is disposed on the circuit board, and the optical fiber connector is optically connected to the optical engine;
 - a sealing cover assembly, disposed on the circuit board, wherein the sealing cover assembly covers outer peripheries of the optical engine and the optical fiber connector; and
 - an encapsulation assembly, disposed on the circuit board, wherein the encapsulation assembly covers the outer periphery of the sealing cover assembly, and the sealing cover assembly and the encapsulation assembly are configured to cooperate to seal the optical engine and the optical fiber connector on the circuit board.
- [Claim 2] The optical module according to claim 1, wherein the sealing cover assembly comprises:
- a sealing cover, comprising a first cover body portion and a second cover body portion, wherein the first cover body portion is located on a side of the optical engine and the optical fiber connector away from the circuit board, the second cover body portion is disposed around the optical engine and the optical fiber connector, and the first cover body portion is connected to the circuit board through the second cover body portion.
- [Claim 3] The optical module according to claim 2, wherein

the sealing cover assembly further comprises:

a first connector, wherein the second cover body portion and the circuit board are fixedly connected via the first connector.

[Claim 4] The optical module according to claim 2, wherein

the optical assembly further comprises:

an optical fiber, connected to the optical fiber connector;

wherein the sealing cover assembly further comprises:

a sealing gasket, connected to the second cover body portion;

wherein, the second cover body portion has a first fiber outlet, the sealing gasket seals the first fiber outlet; the sealing gasket is provided with a first fiber outlet hole, the first fiber outlet hole is smaller than the first fiber outlet, and the optical fiber extends through the first fiber outlet hole and is sealingly connected to the sealing gasket.

[Claim 5] The optical module according to claim 4, wherein

the second cover body portion further comprises a sealing groove, wherein the first fiber outlet is in communication with a groove bottom of the sealing groove, and the sealing gasket is embedded in the sealing groove to seal the first fiber outlet.

[Claim 6] The optical module according to claim 1, wherein

the encapsulation assembly comprises:

a fence, disposed around the sealing cover assembly to enclose an encapsulation cavity; and

an encapsulation body, accommodated in the encapsulation cavity, wherein the encapsulation body covers the outer periphery of the

sealing cover assembly.

- [Claim 7] The optical module according to claim 6, wherein the optical assembly further comprises:
an optical fiber, connected to the optical fiber connector;
wherein the encapsulation assembly further comprises:
a sealing bushing, connected to the fence;
wherein, the fence has a second fiber outlet, the sealing bushing seals the second fiber outlet; the sealing bushing is provided with a second fiber outlet hole, the second fiber outlet hole is smaller than the second fiber outlet, and the optical fiber extends through the second fiber outlet hole and is sealingly connected to the sealing bushing.
- [Claim 8] The optical module according to claim 7, wherein the sealing bushing comprises a main body, a first sealing part and a second sealing part, wherein the first sealing part and the second sealing part are respectively located on opposite sides of the main body, a snap-fit groove is formed between the first sealing part and the second sealing part, and a portion of the fence adjacent to the second fiber outlet is embedded in the snap-fit groove to achieve sealing.
- [Claim 9] The optical module according to claim 8, wherein the portion of the fence adjacent to the second fiber outlet is inserted into the snap-fit groove in an interference fit manner.
- [Claim 10] The optical module according to claim 8, wherein the sealing bushing is a flexible structure.

- [Claim 11] The optical module according to claim 6, wherein
the encapsulation assembly further comprises:
a second connector, wherein the fence and the circuit board are
fixedly connected via the second connector.
- [Claim 12] The optical module according to claim 1, wherein
the optical module further comprises:
a housing, having a receiving cavity therein, wherein the circuit
board and the optical assembly are received in the receiving
cavity;
wherein, the optical engine comprises a lens module and an
optical emitting chip and/or an optical receiving chip, the optical
emitting chip and/or the optical receiving chip are disposed on the
circuit board, and the optical emitting chip and/or the optical
receiving chip are optically coupled with the optical fiber
connector through the lens module.