

DESCRIPTION

TITLE OF INVENTION: OPTICAL MODULE

Cross-Reference to Related Applications

The present application claims the priority of the Chinese patent application filed with the Chinese Patent Office on July 7, 2023, with the application number CN202310833980.2, titled as "Laser Hair Removal Handle", the entire contents of which are incorporated herein by reference.

Technical Field

The present invention relates to the field of lasers, and more particularly, to an optical module.

Background Art

In the current technological context, the application demand for lasers is continuously increasing, especially in specific fields such as optical communications, laser medicine, and lithography, where higher requirements are placed on the stability and precision of lasers. In high or low temperature environments, differences in the coefficients of thermal expansion (CTE) of different materials may exist, which can cause changes in stress and deformation between the light source module and the light-shaping module. These stresses and deformations can lead to relative displacement between the light source module and the light-shaping module, thereby affecting the stability and accuracy of optical index.

Furthermore, the support structures for the light source module and the light-shaping module may be asymmetric, meaning they may differ in shape and size. This asymmetry may stem from factors such as machining errors during manufacturing, imprecise assembly, or differences in material properties. Due to the asymmetry of the support structures, the light source module and the light-shaping module may experience stress and deformation at different temperatures.

During temperature changes, due to the asymmetry of the support structures, thermal expansion or contraction among different components may be transmitted unevenly throughout the structure. This can lead to different stress distributions and deformation conditions within the structure. Particularly under conditions of rapid temperature change or significant temperature differences, this unevenness in stress and deformation may be more pronounced. The stress and deformation caused by the asymmetry of the support structures further increase the relative displacement between the light source module and the light-shaping module. This relative displacement may cause misalignment between the light source and the optical module, disrupting the transmission and shaping process of the optical signal. Additionally, relative displacement may also cause offset or tilt of optical elements, further affecting beam focusing performance and wavelength stability.

Summary

To solve the above technical problems, embodiments of the present invention aim to provide an optical module that reduces relative displacement between an light-shaping module and a light source by arranging them on the same substrate, thereby ensuring the stability of optical index.

The technical solution of the present invention is implemented as follows:

An embodiment of the present invention provides an optical module. The optical module includes a printed circuit board (PCB), a light-emitting module, and a first light-shaping module. The light-emitting module includes at least two base blocks and at least one chip. The base blocks are directly fixed to the PCB. The chip and the base blocks are arranged spaced apart from each other, with each chip being clamped on both sides by base blocks. A light-emergent direction of the light-emitting module is non-parallel to a plane of the PCB. A number of the light-emitting modules is at least one. The first light-shaping module is fixed on a light-emitting side of the light-emitting module and is configured to shape light emitted by the light-emitting module.

Preferably, the first light-shaping module includes a first support structure and a first lens. The first support structure is disposed on both sides of the light-emitting module and supports the first lens on a light-emitting path of the light-emitting module, such that the first lens has a fixed relative position to a light-emitting surface of the chip and receives light emitted from the chip. By arranging the first support structure on both sides of the light-emitting module, the first lens can be reliably fixed on the light-emitting side of the light-emitting module, aligned with the optical axis of the corresponding chip's emitted beam. Their relative positions are fixed, thereby preventing the directivity and divergence angle stability of the light-emitting module's output from being affected when deformation occurs due to a mismatch in the CTE between the chip and the PCB.

Preferably, the first light-shaping module is fixed to the light-emitting module by the first support structure clamping the two outermost base blocks of the light-emitting module. Directly fixing the shaping module to the light-emitting module can further reduce relative displacement between them caused by PCB deformation or other reasons.

Preferably, the optical module further includes a second light-shaping module. The second light-shaping module includes a second support structure and a second lens. The second light-shaping module is configured such that the second support structure supports the second lens, enabling the second lens to shape all light that has passed through the first light-shaping module.

Preferably, the second light-shaping module is fixed to the first light-shaping

module by the second support structure clamping the first support structure. Directly fixing the second light-shaping module to the first light-shaping module can reduce relative displacement between the two light-shaping modules, thereby further reducing relative displacement from the light source.

Preferably, the light-emergent direction of the light-emitting module is perpendicular to the plane of the PCB. By configuring the light-emitting module to be perpendicular to the PCB, the footprint of the light-emitting module on the PCB can be reduced, improving the flexibility of PCB layout and routing.

Preferably, the chip is an edge-emitting laser diode chip. Edge-emitting laser diode chips have high power density and high pulse peak power. When the light-emitting module includes multiple chips, it can constitute an edge-emitting laser array, allowing flexible configuration of the light-emitting module's power. Additionally, by selecting edge-emitting laser diode chips, existing edge-emitting laser chip optical shaping solutions can be reused, allowing direct replacement of similar products using existing edge-emitting lasers as light sources.

Preferably, the PCB is provided with through slots below the chip and/or on both sides of the chip. The configuration of these through slots can reduce internal stress in the PCB.

Preferably, the base blocks are configured as multi-layer structures. For example, the base blocks may be configured with two outermost layers being copper layers and a middle layer being a molybdenum-copper layer or a molybdenum layer, thereby reducing the CTE difference between the chip and the base blocks and reducing stress.

In the optical module, the light-emitting module is directly installed on the PCB, and the light-shaping module is symmetrically arranged on the same substrate as the light-emitting module. This configuration can reduce stress between the light-shaping module and the light source under high and low temperatures. The displacement generated during overall deformation is in the same direction, resulting in smaller relative displacement, ensuring fixed relative positions, and thereby preventing the directivity and divergence angle of the light-emitting module from being affected. Simultaneously, the structural selection for the PCB in this optical module is more flexible, as there is no need to consider the installation of structures required for the light-emitting module or CTE matching issues with the light-shaping module, thus reducing the influence of the PCB structure on the light-emitting module structure.

Brief Description of Drawings

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments consistent with the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a schematic diagram of an optical module 10 according to an embodiment of the present invention.

Fig. 2 is a schematic diagram of an optical module 10 according to another embodiment of the present invention.

Fig. 3 is a schematic diagram of an optical module 20 according to another embodiment of the present invention.

Fig. 4 is a schematic diagram of an optical module 30 according to another embodiment of the present invention.

Fig. 5 is a schematic diagram of an optical module 40 according to another embodiment of the present invention.

Fig. 6 is a schematic diagram of an optical module 50 according to another embodiment of the present invention.

Fig. 7 is a schematic diagram of an optical module 10 according to another embodiment of the present invention.

Fig. 8 is a schematic structural diagram of a base block of an optical module according to an embodiment of the present invention.

Detailed Description of Embodiments

Embodiments of the present invention will be described clearly and completely below with reference to the accompanying drawings. It is apparent that the described embodiments are only some, but not all, embodiments of the present invention. All other embodiments obtained by those of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

In the current technological context, CTE mismatch between the light source module and the light-shaping module, as well as the asymmetry of their support structures, is a key challenge in existing laser technology. These issues lead to certain stress and deformation under high and low temperature environments, thereby causing increased relative displacement between the light source and the optical module, which in turn leads to significant changes in optical index. This is particularly prominent in application requirements for specific fields, such as the automotive LiDAR field.

In the automotive LiDAR field, the performance and stability of lasers are crucial for achieving high-precision target detection and tracking. However, since vehicles operate in different environments with large temperature variations, the CTE mismatch between the light source module and the light-shaping module and the

asymmetry of support structures pose challenges to laser stability and precision. In high-temperature environments, CTE mismatch between the light source module and the light-shaping module may cause stress accumulation and increased deformation between optical elements, leading to changes in optical index. Conversely, in low-temperature environments, relative displacement between the light source module and the light-shaping module may increase due to CTE mismatch, affecting the focusing performance and wavelength stability of the laser beam. These changes may cause non-negligible impacts on the detection range, resolution, and accuracy of the automotive LiDAR system, preventing it from meeting the requirements for high-precision target detection and tracking.

For example, in existing technology, a laser light source is placed at the edge of a PCB, meaning the light-emergent direction of the source is parallel to the PCB, and optical components are placed on the light-emitting side of the laser source. Under high and low temperatures, due to PCB deformation, the light source undergoes a displacement of Δd relative to (e.g., a fast-axis collimating) optical component.

Assuming the focal length of this optical component is f , the pointing angle of the light spot in the fast-axis direction will deviate by an angle θ , as shown by the

relation: $\tan(\theta) = \Delta d/f$. This causes the optical index of the entire laser module to fail to meet practical requirements.

Furthermore, even if the laser light source and optical components are fixedly connected to the PCB via bonding or adhesive in the above structure, such packaging methods involve issues related to the underlying circuit board and/or mechanical structure. The different thermal expansion coefficients of the laser diode chip and the optical components can generate alternating stress during temperature cycling, causing deformation of the circuit board and/or mechanical structure. This can induce relative displacement and/or rotation between the chip and the optical assembly, reducing chip reliability, risking cracking or detachment of adhesive between the optical components and the mechanical structure. Additionally, relative displacement between the chip and the optical components can cause the divergence angle or directivity of the entire optical module to fail to meet practical requirements.

To solve the above technical problems, an embodiment of the present invention provides an optical module. The optical module includes a PCB, a light-emitting module, and a light-shaping module. The light-shaping module includes a first light-shaping module. Laser light emitted from the light-emitting module is shaped by the light-shaping module into a light spot. The light-emitting module is directly installed on the PCB, and the light-shaping module is arranged on the same substrate as the light-emitting module, thereby reducing changes in optical index caused by relative

displacement between the light-emitting module and the light-shaping module under high and low temperatures. Compared to existing structures where the light source is installed on the edge of the PCB and the light-shaping module is installed on other structural components, this optical module can reduce stress between the light-shaping module and the light source under high and low temperatures. The displacement generated during overall deformation is in the same direction, resulting in smaller relative displacement, thereby ensuring the stability of the directivity and divergence angle of the light-emitting module. Simultaneously, the PCB structure in this proposal offers greater freedom of choice. Since it is not installed at the edge position of the PCB, there is no need to consider the installation of structures required for the light-emitting module or CTE matching issues with the light-shaping module, thus reducing the influence of the PCB structure on the light-emitting module structure.

Referring to Fig. 1, it shows an optical module 10 according to an embodiment of the present invention. The optical module 10 includes a PCB 11, one light-emitting module 12, and one first light-shaping module 13. The PCB 11 is made of insulating material with conductive paths printed on its surface for supporting and connecting electronic components. The light-emitting module 12 is directly installed on the PCB 11 and electrically connected to the conductive paths to receive current and generate stimulated laser emission. By being directly fixed and electrically connected to the PCB 11, the conductive path is reduced, effectively minimizing electrical parasitic.

The light-emitting module 12 includes at least two base blocks 121 and at least one chip 122. The chip 122 is an edge-emitting laser diode chip. Edge-emitting laser diode chips have high power density and high pulse peak power. When the light-emitting module includes multiple chips, it can constitute an edge-emitting laser array, allowing flexible configuration of the light-emitting module's power. Additionally, by selecting edge-emitting laser diode chips, existing edge-emitting laser chip optical shaping solutions can be reused, allowing direct replacement of similar products using existing edge-emitting lasers as light sources. The base blocks 121 are directly fixed to the PCB 11 by soldering or adhesive bonding, using simple processes to securely fix the base blocks 121 to the PCB 11. The base blocks 121 and the chip 122 are fixedly electrically connected by soldering, conductive adhesive bonding, or direct clamping. Referring to Fig. 1, the light-emitting module 12 includes two base blocks 121 and one chip 122. The base blocks 121 are directly fixed to the PCB 11. The base blocks 121 establish an electrical connection with the printed circuit on the PCB via the aforementioned fixing method to supply power to the chip 122 and drive it to emit light. The chip 122 and the base blocks 121 are arranged spaced apart. The chip 122 is disposed between the two base blocks 121. Simultaneously, the base blocks 121 are fixedly connected to the side surfaces of the chip 122, such that the chip 122 is clamped and fixed on its upper and lower sides by the two base blocks 121. The base blocks 121 are directly connected to the circuit on the PCB 11 to form a current path. In this configuration, the base blocks 121 disposed on both

sides of the chip 122 serve as the anode and cathode of the chip 122, providing power connections. The base blocks 121 hold the chip 122 by clamping, causing the plane in which the chip 122 lies to form an angle with the plane of the PCB 11. It should be noted that "forming an angle" here refers to the plane of the chip 122 and the plane of the PCB 11 having an angle between 0° and 180° (excluding 0° and 180°). It can be understood that the purpose of "the plane of the chip 122 forming an angle with the plane of the PCB 11" is to make the light-emergent direction of the chip 122 non-parallel to the plane of the PCB 11. Referring to Fig. 1, in the configuration of the optical module 10 shown, the light-emergent direction of the light-emitting module 12 is as indicated by arrow P. Here, the two base blocks 121 form a 90° angle with the PCB 11, and the chip 122 is held perpendicular to the PCB 11, so that the light-emergent direction of the chip 122 is perpendicular to the plane of the PCB 11. Preferably, the plane of the chip 122 is perpendicular to the plane of the PCB. In this configuration, the degree of freedom in PCB design is maximized, assembly of the light-emitting module and the light-shaping module is simpler, and vertically emitted light is also easier to control.

To address the technical problem of large relative displacement between the light source and the optical module 10, leading to significant changes in divergence angle, the present invention arranges all light-shaping modules on the same substrate as the light-emitting module 12, i.e., both the light-shaping module and the light-emitting module 12 are arranged on the PCB 11. In this configuration, when the PCB 11 deforms, the displacement of the light-emitting module 12 and the light-shaping module is in the same direction, thereby reducing relative displacement and ensuring the stability of optical index. In another embodiment of the present invention, referring to Fig. 8, the first light-shaping module 13 is disposed on the light-emitting path of the light-emitting module 12. The first light-shaping module 13 is disposed on the PCB. In this configuration, the first light-emitting module and the light-emitting chip are arranged on the same board plane. When the PCB is subjected to stress or deformation, this configuration can reduce relative displacement between the light-emitting module 12 and the first light-shaping module 13, ensuring the stability of the directivity and divergence angle of the light-emitting module 12. Further, when the PCB undergoes greater bending deformation, the light-emitting module 12 is located more centrally compared to the first light-shaping module 13. Therefore, the relative position between the light-emitting module 12 and the first light-shaping module 13 may change, potentially affecting the stability of its divergence angle. Referring to Fig. 1, the first light-shaping module 13 is disposed above the light-emitting module 12 for shaping the light emitted by the light-emitting module 12 to achieve beam shaping. The light-shaping module may include lenses of various constructions or other optical shaping elements to focus light onto a specific area or point. Compared to the configuration shown in Fig. 8, the

configuration shown in Fig. 1 further reduces relative displacement between the first light-shaping module 13 and the light-emitting module 12, ensuring alignment between the light source and the optical shaping device, and preventing changes in the divergence angle of the light-emitting module 12.

The first light-shaping module 13 includes a first support structure 131 and a first lens 132. The first support structure 131 is used to support the first lens 132 above the light-emitting module 12, placing the first lens 132 on the light-emitting path of the light-emitting module, and the first lens 132 has a fixed relative position to the light-emitting surface of the light-emitting module 12. In this configuration, the light emitted from the light-emitting module 12 can completely pass through the first lens 132, and the first light-shaping module 13 and the light-emitting module 12 are symmetrical structures. In Fig. 1, the first support structure 131 is fixed to the two outermost base blocks 121 of the light-emitting module 12. The top of the first support structure 131 is fixed with the first lens 132, which has a fixed relative position to the light-emitting surface of the chip 122. Specifically, the first support structure 131 includes two first support members. The two first support members are directly fixed in a non-conductive manner to the two outermost base blocks 121 of the light-emitting module 12. The two first support members and the two base blocks 121 are all symmetrical structures, further avoiding the influence of PCB 11 deformation on the chip 122. The first light-shaping module 13 is directly fixed to the light-emitting module 12 via the first support structure 131, making the relative displacement between the first lens 132 and the light-emitting module 12 zero, thereby achieving reduced relative displacement between the light-emitting module 12 and the light-shaping module and fixing their relative positions. In another embodiment of the present invention, the first light-shaping module 13 includes only a first lens. The first lens is directly fixed to the light-emitting surface of the light-emitting module 12 via adhesive bonding, thereby reducing the overall volume of the light-shaping module, simplifying the size of components on the PCB, expanding the degree of freedom in PCB layout design, reducing mechanical gaps, and further ensuring a fixed relative position between the first lens and the chip.

The optical module 10 further includes a second light-shaping module 14. Specifically, referring to Fig. 1, the first light-shaping module 13 and the second light-shaping module 14 combine to form an light-shaping module. The light-shaping module is disposed above the light-emitting module 12 for shaping the light emitted by the light-emitting module 12 to achieve beam shaping. The light-shaping module may include lenses of various constructions or other optical shaping elements to focus light onto a specific area or point. The emitted light passes through the first light-shaping module 13 and then moves along the shaped direction into the second light-shaping module 14. The second light-shaping module 14 includes a second support structure 141 and a second lens 142. The second support structure 141 includes two second support members. The second lens 142 is for shaping all light beams. The two second support members are disposed on the outer sides of the first

light-shaping module 13, here "outer sides" relative to the light-emitting module 12 located inside the two first support members. In the above configuration, the second support structure 141 spans above the light-emitting module 12, enabling the second lens 142 to cover all light shaped by the first lens 132. The second light-shaping module 14 and the first light-shaping module 13 have the same configuration, both supporting a lens via a support structure.

The emitted light first passes through the first lens 132, then enters and passes through the second lens 142 to form a light spot. The first lens 132 is fixed to the base blocks 121 via the first support structure 131. Therefore, in the solution of the present invention, to further reduce relative displacement between the light source and the optical shaping lens, optical elements with high sensitivity to alignment can be directly connected to the electrodes, thereby further reducing changes in optical index caused by relative displacement from the light source. This ensures the shaping effect and quality of highly sensitive elements. For example, the first lens 132 is a fast-axis collimating lens, and the second lens 142 is a slow-axis collimating lens. The fast-axis collimating lens has higher sensitivity to alignment with the light source compared to the slow-axis collimating lens. Placing the fast-axis collimating lens at the position of the first lens 132 ensures its collimation effect is unaffected.

Based on the above, fixing the first light-shaping module 13 to the light-emitting module 12 can further reduce relative displacement between the first lens 132 and the light source. Based on this concept, referring to Fig. 2, fixing the second light-shaping module 14 to the first light-shaping module 13 can further reduce relative displacement between the entire light-shaping module and the light source, thereby further improving light spot quality. For example, the first support structure 131 includes two first support rods, and the second support structure 141 includes two second support rods. The two first support rods are fixed to the two outermost base blocks 121 of the light-emitting module 12 using insulating material or adhesive bonding in a non-conductive manner. The two second support rods are fixed to the two first support rods via adhesive bonding or the like. In this configuration, both the first lens 132 and the second lens 142 have fixed relative positions to the light-emitting surface of the chip 122 in the light-emitting module 12.

In the optical module of the present invention, the number of light-emitting modules is at least one. Multiple light-emitting modules can be jointly excited to emit light to meet different illumination area requirements and increase light spot size. The light-emitting modules can be modularized into multiple units, improving the design flexibility and ease of expansion of the optical module. Multiple light-emitting modules on the PCB can be controlled independently or integrated, enabling flexible adjustment and expansion of system functionality and performance. For example, referring to Fig. 3, it shows another embodiment of an optical module 20 of the present invention. The optical module 20 includes a PCB 21, three light-emitting modules 22, three first light-shaping modules 23, and one second light-shaping

module 24. It should be noted that in the present invention, the first light-shaping module 23 is for directly shaping the light emitted by the light-emitting module 22. Therefore, a separate first light-shaping module 23 is disposed above each individual light-emitting module 22, for example, for collimation processing. The second light-shaping module 24 is for shaping the light corrected by the first light-shaping modules 23, for example, for homogenization processing. This only lists an embodiment requiring two different shaping needs. Those skilled in the art will understand that light-shaping modules can be flexibly arranged according to different optical system requirements.

In the present invention, the light-emitting module includes at least two base blocks and at least one chip. By expanding the number of base blocks and chips in the light-emitting module, the power of the light-emitting module can be increased. Referring to Fig. 4, it shows another embodiment of an optical module 30 of the present invention. The number of base blocks 321 is four, and the number of chips 322 is three. The base blocks 321 and the chips 322 are arranged spaced apart, such that each chip 322 is clamped on both sides by two base blocks 321. In this example, the number of first light-shaping modules 33 for shaping the light emitted by the light-emitting module is one.

In all the aforementioned optical modules, by directly fixing the light-emitting module to the PCB and having its light-emergent direction non-parallel to the plane of the PCB, the light-shaping module can reduce changes in optical index caused by relative displacement between the light-emitting module and the light-shaping module under high and low temperatures. Under high and low temperatures, the PCB deforms generating stress, and the large CTE difference between the base blocks and the PCB also leads to stress generation. The stress generated as above can cause changes in the light emission angle of the light-emitting module. Based on this, the present invention proposes another embodiment of an optical module 40, where the PCB 41 is locally provided with grooves. Referring to Fig. 5, the grooves are disposed on both sides of the light-emitting module 42. Providing grooves at its bottom helps release stress, thereby reducing the degree of deformation of the light-emitting module 42. Additionally, disposing them on both sides of the light-emitting module 42 can reduce stress in the installation area of the entire light-shaping module and the light-emitting module 42 on the PCB 41, thereby reducing changes in optical index caused by deformation under high and low temperatures. For example, the grooves can also be provided directly below the chip 422 to further reduce the influence of PCB 41 stress on the light emission angle of the chip 422; the grooves can also be provided on both sides of the second support structure 441.

When the base blocks are fixed to the PCB by bottom-bonded soldering, the vertical surfaces of the base blocks require good flatness and perpendicularity. It can also cause mutual stress between the base blocks and the PCB. Therefore, configuring the base blocks as insertable type, referring to Fig. 6, which shows

another embodiment of an optical module 50 proposed by the present invention. The base blocks 521 are inserted into the PCB 51 and fixed by soldering using methods such as side fill soldering and/or bottom spot soldering as indicated by arrows in the figure. This reduces the requirements for flatness and perpendicularity of the base blocks 521. The soldering process simplifies operation and is suitable for mass production, while also avoiding short circuits between the two base blocks 521 after soldering. Preferably, using soft solder can further reduce stress between the base blocks 521 and the PCB 51.

In another embodiment of the present invention, the base blocks are made of a multi-layer structure. Referring to Fig. 7, the base blocks are configured as a three-layer material. Preferably, the two outermost layers of the base block are made of copper, and the middle layer is made of molybdenum-copper, which has high electrical and thermal conductivity. Molybdenum-copper material is a pseudo-alloy composed of two mutually insoluble metal phases in its microstructure. It combines the characteristics of both constituent metals and can compensate for shortcomings, achieving good comprehensive performance. The outermost layer of the multi-layer configured base block is a copper layer. Transient heat from the chip can be effectively dissipated in the copper layer, offering better performance compared to copper-tungsten structures. Therefore, it can help lower junction temperature and increase power. Additionally, the multi-layer configured base block has a CTE close to that of the chip, thus preventing cracks during bonding with the chip.

It should be noted that the technical solutions recorded in the embodiments of the present invention can be combined arbitrarily without conflict.

The foregoing descriptions are merely specific embodiments of the present invention, but the protection scope of the present invention is not limited thereto. Any person skilled in the art could readily conceive of changes or substitutions within the technical scope disclosed in the present invention, and these changes or substitutions should be covered by the protection scope of the present invention. Therefore, the protection scope of the present invention should be subject to the protection scope of the claims.

What is claimed is:

1. An optical module, comprising a PCB, a light-emitting module, and a first light-shaping module, characterized in that:

the light-emitting module comprises at least two base blocks and at least one chip, said base blocks are directly fixed onto the PCB, said chip is arranged spaced apart from said base blocks, each said chip is clamped by said base blocks on both sides thereof, the light-emergent direction of the light-emitting module is non-parallel to a plane in which the PCB is located, and a number of said light-emitting module is at least one;

the first light-shaping module is fixed on a light exit side of the light-emitting module and is configured to shape light emitted from the light-emitting module.

2. The optical module according to claim 1, characterized in that the first light-shaping module comprises a first support structure and a first lens, the first support structure is arranged on two sides of the light-emitting module and supports the first lens on a light exit path of the light-emitting module, so that a relative position between the first lens and a light exit surface of the chip is fixed and the first lens receives light emitted from the chip.

3. The optical module according to claim 2, characterized in that the first light-shaping module is fixed to the light-emitting module by the first support structure clamping two outermost base blocks of the light-emitting module.

4. The optical module according to claim 2 or 3, characterized in that the optical module further comprises a second light-shaping module, the second light-shaping module comprises a second support structure and a second lens, and the second light-shaping module is configured such that the second support structure supports the second lens to allow the second lens to shape all light that has passed through the first light-shaping module.

5. The optical module according to claim 4, characterized in that the second light-shaping module is fixed to the first light-shaping module by the second support structure clamping the first support structure.

6. The optical module according to claim 1, characterized in that the light-emergent direction of the light-emitting module is perpendicular to the plane in which the PCB is located.

7. The optical module according to claim 1, characterized in that the chip is an edge-emitting laser chip.

8. The optical module according to claim 1, characterized in that the PCB is provided with through slots below the chip and/or on two sides of the chip.

9. The optical module according to claim 1, characterized in that the base block is configured as a multi-layer structure.

10. The optical module according to claim 9, characterized in that the base block is configured such that its two outermost layers are copper layers and its middle layer is a molybdenum-copper layer or a molybdenum layer.