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D E C I S I O N
of 23 September 1999

Case Number: T 1014/97 - 3.4.2

Application Number: 91111501.2

Publication Number: 0466134

IPC: G02B 6/42

Language of the proceedings: EN

Title of invention:
Method for passive alignment of diode laser arrays and optical fibers

Applicant:
GTE Laboratories Incorporated

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes, after amendment)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1014/97 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 23 September 1999

Appellant: GTE Laboratories Incorporated
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 12 May 1997 refusing European patent application No. 91 111 501.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: A. G. Klein
M. Lewenton

Summary of Facts and Submissions

I. European patent application No. 91 111 501.2 (publication No. 0 466 134) was refused by decision of the Examining Division, on the ground that its subject-matter lacked an inventive step within the meaning of Article 56 EPC in view of the contents of the documents:

D2: US-A-4 079 404 and

D5: US-A-3 864 018.

In the Examining Division's opinion, document D2 disclosed a package from which the claimed device was distinguished only in that it comprised two front pedestal structures for abutment of the chip, instead of the known continuous surface of a cylindrical lens. Replacement of the known alignment structure constituted by the lens by an alternative structure having two reference points however merely constituted a straightforward mechanical design option. Moreover, the use of two single pedestal structures for aligning the front of the plate-like chip was known, for instance, from document D5 (see point 2 of the reasons).

The following further citations were evoked in the examining procedure:

D1: Electronics Letters, volume 22, No. 12, June 1986, Stevenage GB, pages 642 to 644; H. Kaufman et al.: "Self-adjusted Permanent Attachment of Fibres to GaAs Waveguide Components";

D3: Japanese Patent Abstracts corresponding to JP-A-1-234 806;

D4: Japanese Patent Abstracts corresponding to JP-A-63-316 009; and

D6: EP-A-394 883.

II. The appellant (applicant) filed an appeal against the refusal of the application.

In a telephone consultation with the appellant the rapporteur of the Board pointed at certain apparent inconsistencies between the wording of independent claims 1 and 10 and the description, and gave the provisional and non-binding opinion of the Board that the feature of the abutment surfaces as provided on the pedestal structures being **orthogonal to the surface of the substrate**, which appeared an essential feature of the invention disclosed in the application, was missing from the wording of the independent claims.

The appellant requested, as his main request, that the Examining Division's decision be set aside and that a patent be granted on the basis of an amended set of claims, of which claims 1 and 10, the only independent claims, filed on 12 April 1999 read as follows:

"1. A package including a substrate (16) for aligning a plurality of active elements (21) integrated on a chip (10) to a plurality of optical receiving elements (11) in integral contact with said substrate of said package,

characterized by

two front or rear pedestal structures (12,13) and one side pedestal structure (14) at respective locations on a surface of said substrate (16), each of said pedestal structures having an abutment surface orthogonal to said surface of said substrate (16);

wherein said chip (10) is mounted on said substrate (16) in concurrent abutting contact with said abutment surfaces of said side pedestal structure (14) and said front or rear pedestal structures (12,13), corresponding to respective side and front or rear abutment surfaces of said chip (10), such that said active elements (21,23) are aligned for optical access with said receiving elements (11)."

"10. A method of passively aligning a plurality of optical receiving elements (11) to a plurality of active elements integrated on a chip (10), comprising the step of providing a substrate (16),

characterized by

forming two front or rear pedestal structures (12,13) and one side pedestal structure (14) at respective locations on a surface of said substrate (16,44) with each pedestal structure having an abutment surface orthogonal to said surface of said substrate (16,44); and

providing said chip (10) in a form which is mountable on said substrate (16) in concurrent abutting contact with said abutment surfaces of said side pedestal

structure (14) and said front or rear pedestal structures (12,13) corresponding to respective side and front or rear abutment surfaces of said chip (10) such that said active elements (23) are aligned for optical access with said receiving elements (11)."

Oral proceedings were requested as an auxiliary measure.

III. In support of his main request the appellant essentially submitted that it was one essential feature of the invention that the abutment surface of the pedestal structures were orthogonal to the surface of the substrate. This allowed for a much easier manufacturing of the substrate and for a very stable alignment. In addition, the optical alignment in the XY directions was made independent from the alignment in the Z direction, which could not be achieved by the prior art devices.

Reasons for the Decision

1. The appeal meets the requirements of Articles 106 to 108 and of Rule 64 EPC. It is admissible, accordingly.

2. The patent application in the Board's view has not been amended in such a way as to contain subject-matter extending beyond the content of the application as filed, in compliance with the requirement of Article 123(2) EPC.

The wording of claim 1 in particular corresponds in substance to the wording of independent claim 27 as

originally filed, with the additional limitation that the pedestal structures are now specified as having abutment surfaces orthogonal to the surface of the substrate. This particular spatial orientation of the abutment surfaces is shown on Figure 1 for the side pedestal structure 14, and it is disclosed implicitly by reference to the vertical extension of the corresponding mating surfaces on the chip, as shown in Figure 2 and specified in the original description (see page 6, lines 5 to 9 and 17 to 24).

Claim 1 has further been amended in such a way as to introduce the alternative of the two pedestal structures being provided at the rear end of the device, instead of the front end, which was proposed also in the original description (see page 10, lines 2 to 4).

Independent method claim 10 substantially comprises the same limitations as apparatus claim 1, in terms of a method.

The configuration of the recessed portion in accordance with claim 2, the channel means in the substrate for the optical receiving elements and the epi-side down mounting of the chip in accordance with claim 3, the fibre-receiving grooves of claim 4, and the metallization pattern of claim 5 were adequately disclosed as well in the original description (see in particular page 5, lines 2 to 5 and 12 to 13, and page 9, lines 24 to 28).

Dependent claims 6 to 9 correspond in substance to claims 4 to 6 as originally filed.

The forming of a plurality of fibre-receiving grooves in the substrate in accordance with dependent claim 11 is disclosed in page 4, lines 24 to 27 of the description as originally filed. The features of dependent claims 12 to 21 in substance correspond to those of claims 3 to 11 and 17 as originally filed.

The description has been amended only for adaptation to the wording of the amended claims, and supplemented with a short summary of the relevant content of document D2, for compliance with the requirements of Rule 27(1)(b) and (c) EPC.

3. *Novelty*

3.1 Document D2 discloses a package including a substrate 10 (Figure 1) for aligning a plurality of active elements (junction lasers) integrated on a chip 20 to a plurality of optical receiving elements 12a to 12m (optical fibres) in integral contact with said substrate of said package, as is set out in the preamble of claim 1.

In this known device, the laser chip is aligned onto the substrate in the longitudinal direction of the fibres by way of a cylindrical lens 14 laid into a transversal groove 10n between the front edge of the chip and the aligned ends of the fibres, the front edge of the chip abutting the cylindrical lens to properly define its longitudinal position. The substrate 10 also comprises two longitudinally extending V-shaped grooves 10p, 10r, in which two short pieces of optical fibres 16, 18 are laid. Cooperation of these pieces of optical fibres with two corresponding V-shaped grooves 20p and

20r etched into the lower surface of chip 20 properly defines both its lateral and vertical positions on the substrate. The two short pieces of optical fibres 16, 18 thus form two side alignment structures.

Thus, the package defined in claim 1 is distinguished from the device disclosed in document D2 in that:

(i) two front or rear alignment structures are provided on the substrate together with one side alignment structure, instead of the known single front alignment and the two side alignment structures;

(ii) the alignment structures are formed by pedestal structures with an abutment surface orthogonal to the surface of the substrate instead of being constituted by cylindrical elements located in grooves of the substrate; and

(iii) the chip comprises respective side and front or rear abutment surfaces in concurrent abutting contact with the abutment surfaces of the side and front or rear pedestal structures, when the chip is mounted on the substrate. In contrast, the chip in the device of document D2 only abuts against the corresponding alignment structures along contact lines.

3.2 Document D5 relates to the alining and splicing of multiple areas of optical fibre cable. To this effect, optical fibres are disposed and maintained between parallel grooves formed in the top and bottom surfaces of thin wafers arranged in a stack (see e.g. Figure 3).

A mounting jig for assembling such stack is shown in Figure 2, with a flat bed 22 comprising vertical stops 18 for the longitudinal positioning of the successive wafer thin of the stack. The stops are constituted by two corner-plates affixed side by side to the upper surface of bed 22.

Document D5 does not relate to the aligning of a plurality of active elements integrated on a chip to a plurality of optical receiving elements in integral contact with a substrate. The two corner-plates disclosed there do not form pedestals, and the device does not comprise a side alignment structure, since the lateral alignment of the respective wafers in the stack is warranted by the optical fibres mounted between the grooves in adjacent surfaces of successive wafers.

3.3 Documents D1, D3 and D4 all disclose assemblies for aligning a waveguide chip to optical fibres mounted on a substrate. In these embodiments, the substrate comprises a receiving groove or recess for a waveguide portion projecting from the bottom side of the wave guide chip.

In these known devices, the chip mounted on the substrate neither comprises active elements, nor side and front or rear abutment surfaces for abutting corresponding front or rear, and side pedestal structures on a surface of the substrate.

3.4 Document D6, which by virtue of Article 54(3) and (4) EPC shall be considered as comprised in the state of the art only for the purpose of assessing novelty of the claimed subject-matter, discloses alignment

structures consisting of mating protrusions and indentations 66 (see Figure 9 and column 9, lines 26 to 45) formed into adjacent surfaces of substrates 70 and 80. These protrusions and indentations do not in particular constitute front or rear, and side structures on one substrate for cooperation with respective side and front or rear abutment surfaces on the other, in the sense of claim 1.

3.5 The other documents on the file do not come closer to the claimed subject-matter. The subject-matter of claim 1 therefore is novel within the meaning of Article 54 EPC.

4. *Inventive step*

4.1 The device of document D2 indisputably constitutes the closest prior art.

The invention defined in claim 1 is distinguished from the device of document D2 essentially in that it comprises two front or rear pedestal structures and one side pedestal structure on a surface of the substrate, each of said pedestal structures having an abutment surface orthogonal to the surface of the substrate, the chip having corresponding respective side and front or rear abutment surfaces for abutment against the orthogonal surfaces of the pedestal structures. As compared to the cylindrical lens used in the closest prior art for longitudinally aligning the laser chip and the two short sections of optical fibres inserted between respective V-shaped grooves formed into the adjacent surfaces of the substrate and of the chip for the transversal alignment thereof, the claimed

alignment technique certainly achieves reduction of the manufacturing costs and it thus solves the technical problem underlying the invention as is set out in the description (see page 2, lines 1 to 27).

4.2 Although reducing manufacturing costs is a most common endeavour of the skilled person in any technical field, the claimed solution does not in the Board's opinion result in an obvious manner from the available prior art.

In particular, the cylindrical lens of document D2 in addition to its mechanical cooperation with the edge of the chip also achieves the essential optical effect of collecting the divergent light from the junction lasers in the chip to couple it into the individual optical fibres (see column 2, lines 30 to 32). The skilled person would therefore not have had any obvious reason to dispense with the cylindrical lens, so that the need for warranting longitudinal alignment of the chip by any different means would not actually have arisen.

The provision of pedestal structures with abutment surfaces orthogonal to the surface of the substrate in accordance with claim 1 also results in the alignment in both the longitudinal and the transversal directions being entirely independent from the positioning in the vertical direction. This allows for an easier control of the soldering procedure, when the laser chip as pressed downwards onto the substrate follows a strictly vertical path. In contrast, the arrangement of document D2 does not provide correct positioning in the longitudinal and transversal directions until the laser chip has reached its exact vertical position, with the

grooves formed in its bottom surface contacting the short fibre sections in the mating grooves of the substrate.

The only alignment structure with orthogonal abutment surfaces to be found in the citations on the file is disclosed in document D5, in the quite different context of a mounting jig for multiple linear arrays of optical fibres. The orthogonal surfaces are formed there by corner-plates mounted side by side on a base surface (see Figure 2). The mounting jig only achieves longitudinal alignment with respect to each other of the plurality of wafers assembled in a stack. No precise alignment of the wafers with respect to the base surface being required, the precise positioning of the corner-plates on the surface itself is not required. In the alignment of active elements of a laser chip with respect to optical fibres on a substrate, like in document D2, such corner-plates would clearly not achieve the required position control, in the micrometer range, as is afforded by pedestal structures in the sense of claim 1.

Such pedestal structures are not suggested either by documents D1, D3, or D4, which for the alignment of a waveguide projecting from the bottom side of a waveguide chip all call for a recess being formed into the substrate for receiving the chip therein. The arrangements of documents D1 and D3 do not provide longitudinal positioning of the waveguides with respect to the substrate, since optical fibres mounted within grooves of the substrate have to be aligned manually in the longitudinal direction (see document D1, page 642, right-hand column, the first and second sentences below

Figure 1; document D3, penultimate sentence). The arrangement of document D4 requires manual alignment in the transversal direction (see last sentence).

Thus, the subject-matter of claim 1 in the Board's opinion involves an inventive step within the meaning of Article 56 EPC.

5. For these reasons, the subject-matter of claim 1 is patentable (Article 52(1) EPC), and so is the subject-matter of independent claim 10, which comprises substantially the same limitations in terms of an aligning method, and of the remaining claims by virtue of their dependency on either claim 1 or 10.

The description has been adequately supplemented with a short reference to the relevant content of document D2, and adapted to the amended wording of the independent claims, in compliance with the requirements of Rule 28(1)(b) and (c) EPC.

The appellant's main request thus being allowable, his auxiliary request for oral proceedings does not need to be considered further.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the

order to grant a patent in the following version:

Claims: Nos. 1, 10 and 12 as filed with appellant's letter dated 12 April 1999; and
Nos. 2 to 9, 11 and 13 to 21 as filed with appellant's letter dated 18 September 1997

Description: pages 1 to 3 and 5 to 11 as filed with appellant's letter dated 18 September 1997; and
page 4 as filed with appellant's letter dated 12 April 1999

Drawings: Sheets 1/4 to 4/4 with Figures 1, 2, 3, 4A and 4B as originally filed.

The Registrar: The Chairman:

M. Beer E. Turrini