BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 26 September 1996

Case Number: T 0438/93 - 3.4.1

Application Number: 85302898.3

Publication Number: 0160515

IPC: H01S 3/19

Language of the proceedings: EN

Title of invention:
A semiconductor laser

Patentee:
SHARP KABUSHIKI KAISHA

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (no)"

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0438/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 26 September 1996

Appellant: (Proprietor of the patent)
SHARP KABUSHIKI KAISHA
22-22 Nagaike-cho
Abeno-ku
Osaka 545 (JP)

Representative:
Sunderland, James Harry
HASELTINE, LAKE & CO.
Hazlitt House
28 Southampton Buildings
Chancery Lane
London, WC2A 1AT (GB)

Respondent: (Opponent)
Siemens AG
Postfach 22 16 34
D-80506 München (DE)

Representative:
Seissler, Michael (authorised employee)
Siemens AG
D-80506 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office dated 18 February 1993 revoking European patent No. 0 160 515 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: Y. J. F. Van Henden
H. J. Reich

Summary of Facts of Submissions

I. An opposition to the European patent No. 0 160 515 was filed at the EPO on the grounds set out in Article 100(a) EPC, and in particular on the ground that, having regard to documents

D1: DE-A-3 234 389 and

D2: DE-C-2 856 507, which corresponds to

D2a: DE-A-2 856 507, which was published before the priority date of the patent,

its subject-matter did not involve an inventive step. Revocation of the European patent was accordingly requested.

II. In a reply of 8 April 1992 commenting on the grounds of opposition, the Patentee filed an amended set of claims and cited document

D3: Adir Bar-Lev: "Semiconductors and Electronic Devices", second edition, 1984, Prentice Hall International, Englewood Cliffs, N.J. (USA), pages 175 to 178.

III. In a further letter dated 22 June 1992, the Opponent also referred to documents

D4: R.T. Kersten: "Einführung in die Optische Nachrichtentechnik", 1983, Springer, Berlin, pages 250 to 253 and 428 to 433, and

D5: US-A-4 347 611.

IV. Following a communication from the Opposition Division accompanying a summons to oral proceedings, the Patentee filed on 2 November 1992 a set of five amended claims annexed to a further letter dated 30 October 1992, to be considered during oral proceedings before the Opposition Division and forming the main request.

V. Claim 1 of the set of claims filed on 2 November 1992 reads

"A semiconductor laser comprising a multi-layered crystal structure (110) having an active layer (13) for laser oscillation; an etching blocking (15) layer on said multi-layered crystal structure; and a striped mesa-type multi-layered crystal (100) having a cladding layer (16), which serves as an electroconductive region, on said etching blocking layer, resulting in a difference in the distribution of the refractive index of light with regard to the active layer between the inside and the outside of said striped mesa-type multi-layered crystal; wherein said multi-layered crystal structure (110) comprises a GaAlAs system and said etching blocking layer (15) is GaAs, and wherein the etching blocking layer has a thickness of 0.02 µm or less".

Claims 2 to 5 of that set are dependent upon Claim 1.

VI. Oral proceedings were held on 27 November 1992, during which the patent proprietor filed an auxiliary request based upon a new Claim 1 comprising the subject-matter of Claims 1 and 3 of the main request. At the conclusion of the oral proceedings, the Opposition Division revoked the European patent.

VII. The reasoning of the Opposition Division concerning Claim 1 as filed on 2 November 1992 may be summarized as follows:

With respect to the disclosure in document (D1), Figure 1 and related part of the description, the subject-matter of Claim 1 is distinguished in that (i) the multi-layered crystal structure (110) comprises a GaAlAs system, and (ii) the etching blocking layer is made of GaAs and has a thickness of 20 nm or less. However, as to (i), if a GaAlAs structure is selected, making the latter layer of GaAs is obvious to the skilled person, for selective etching of GaAs and GaAlAs is common practice in the technology of semiconductors. As to (ii), the feature of a layer not thicker that 20 nm aims at controlling more accurately the thicknesses of the underlying cladding layer or optical guiding layer without impairing the optical characteristics of the active region. Formulating this problem, however, is a matter of routine for the skilled person. A skilled person would recognise that the author of document (D1) selected liquid phase epitaxy for reasons of simplicity. Besides, he knows that much thinner, nonetheless efficient etching blocking layers can be produced with vapour phase epitaxy, which layers obviously have a reduced effect upon the optical characteristics of the laser. Finally, the Patentee's argument that document (D1) would not clearly disclose a GaAs/GaAlAs system is not convincing. Despite some confusing indications at page 6, the skilled person understands indeed that document (D1) also covers this classical semiconductor laser system.

VIII. The Patentee lodged an appeal against the decision of the Opposition Division and, with its Statement of Grounds of Appeal received at the EPO on 17 June 1993, filed a further set of ten claims.

Claims 1 to 5 of this set are identical to Claims 1 to 5 as filed on 2 November 1992 and considered in the decision of the Opposition Division - see point V above. Claim 6 of the set is dependent upon any one of the preceding claims. Claim 7 reads as follows:

"A method of producing a semiconductor laser having a multi-layered crystal structure, comprising the steps of:

(a) providing a substrate (11);
(b) growing by molecular beam eptitaxy
a buffer layer (11'),
a first cladding layer (12),
a non-doped active layer (13)
a second cladding layer (14),
an etching blocking layer (15),
a third cladding layer (16), and
a cap layer (17)

to form a double heterostructure multi-layered crystal for laser oscillation;

(c) providing a striped photresist (18) on the cap layer (17);
(d) etching around the photresist layer to the approximate depth of 1 µm leaving behind a stripe (100) of unetched material;
(e) continuing the etching beyond the said approximate depth using a substance that selectively etches the material of the third cladding layer (16) but not that of the etching blocking layer (15);
(f) removing the etching blocking layer, except for the portion under the stripe, using a substance that selectively etches the material of the etching blocking layer (15) but not that of the second cladding layer (14);

thereby producing a semiconductor laser constructed such that the thicknesses of the P-cladding layers (14, 16) are different on the outside and inside of the stripe (100) and characterised in that the etching blocking layer is grown to a thickness of 0.02 µm or less."

Claims 8 to 10 are dependent upon Claim 7.

IX. The Respondent (Opponent) having not commented on the grounds of appeal, the Appellant enquired in a further letter dated 23 February 1995 as to whether all was in order in that matter.

X. In a short communication posted on 5 January 1996, the parties were informed that the appeal was currently under consideration by the Board.

XI. By telecopy of 10 January 1996, the Appellant requested oral proceedings in the event that the Board would contemplate reaching any decision other than allowing the appeal in its entirety.

XII. The Board summoned the parties to oral proceedings to be held on 26 September 1996.

XIII. In still a further letter dated 21 August 1996, the Appellant filed submissions on the case in suit.

XIV. During the oral proceedings of 26 September 1996, the Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the following requests:

Main request:
Claims 1 to 10 filed on 17 June 1993;

First auxiliary request:
Claims 1 to 5 filed on 2 November 1992 (corresponding to Claims 1 to 5 of the main request);

Second auxiliary request:
Claims 2 to 6 of the main request combined with Claim 1 of the main request.

The Respondent requested that the appeal be dismissed.

XV. In support of its requests, the Appellant argued in its Statement of Grounds of Appeal, its submission of 21 August 1996 and during the oral proceedings of 26 September 1996 in substance as follows:

The etching blocking layer (125) of the semiconductor laser known from document (D1) has a thickness of 0.2 µm, i.e. twice the minimum thickness achievable with liquid phase epitaxy. Besides, no indication can be found that this thickness might be of any importance whatsoever, an optimal selection of the thickness being suggested there in the only case of layer (25). If the author of document (D1) had been aware of any problem related to the thickness of the blocking layer, he might have made the latter 0.1 µm thick. Furthermore, an easier solution was available, for document (D1) teaches that different ratios of indium, gallium, arsenic and phosphorus in the compounds forming the active layer and the blocking layer may be used, whereby the absorption of light by the blocking layer is reduced.

By contrast, the European patent recognizes that the thickness of the blocking layer is of crucial importance because, in the active zone, a portion of

that layer remains in the crystal after completion of the manufacturing process. Contrary to the opinion of the Opposition Division, it is not evident from prior art that the residual part of the blocking layer has an effect on the optical characteristics of the laser, hence that making this layer thinner will improve any such characteristic. Furthermore the skilled person might doubt that a 20 nm thin blocking layer would still be able to maintain its blocking function. As a matter of fact, the prior art shows that no step towards the use of molecular beam epitaxy for making semiconductor lasers had been taken; moreover, it shows no knowledge of the disadvantages related to the optical absorption by the etch block, namely that the driving current must be increased and the reliability is reduced.

However, the semiconductor laser of the claimed invention includes a double heterostructure in which the blocking layer is sandwiched by layers having a broader forbidden band. In such a structure, as the thickness of the blocking layer is reduced, the effective width of its forbidden band increases as a result of a quantum effect. This effect, which is specific to the materials used in the invention, is significant when the thickness of the etching layer is 20 nm or less.

XVI. In addition to the reasons the Opposition Division relied upon for revoking the patent in suit, the Respondent put forward the following:

From the relevant passages of document (D1), any skilled person understands that first and foremost InP systems are described there. Nevertheless, it is clearly stated in document (D1) that GaAs systems are a known alternative. Likewise, GaInAs and GaAlAs are also known alternatives. Furthermore, it was superfluous to

indicate in detail the composition of the successive layers in this case, for this composition is to be taken from document (D2), which is referred to in document (D1). Besides, the part of document (D1) relating to Figure 1 gives an incentive to make the blocking layer (125) of the same material as the active layer (14). If the thickness of said blocking layer exceeds the lower limit achievable with liquid phase epitaxy, it is only because otherwise it would be difficult to make it uniform. Finally, as regards the alleged preclusion of unfavourable optical effects, it shall be noted that only in conjunction with other parameters of the laser, in particular the thicknesses and doping rates of the other layers, a blocking layer of specified thickness can contribute to achieve such result. However, the explicit values of the parameters for such result can be determined by model calculations and routine experiments.

XVII. At the conclusion of the oral proceedings, the decision was announced that the appeal is dismissed.

Reasons for the Decision

1. The only matter at issue is that of inventive step.

2. *State of the art*

2.1 Document (D1) relates to a semiconductor laser comprising a multi-layered crystal structure (12, 13, 14) - see the drawings and the lines 9 to 30 of page 6, stating that the layers of the laser are grown by epitaxy. Said semiconductor laser comprises

(a) an active layer (14) for laser oscillation - see page 6, lines 24 to 26;

(b) an etching blocking layer (125) on said multi-layered crystal structure (12, 13, 14) - see: drawings; page 7, lines 25 to 30; page 9, lines 4 to 7 - and

(c) a striped mesa-type multi-layered crystal serving as an electroconductive region and having a cladding layer (225) on said etching blocking layer (125) - see page 7, lines 6 to 10 and page 8, lines 11 to 14.

As constituent materials of the layers, document (D1) mentions inter alia n-GaInAsP for the active layer (14), p-InP for a (guiding) layer (25) formed between the active layer (22) and the etching blocking layer (125), p$^-$-GaInAsP for the latter layer, p-InP for the cladding layer (225) and p-GaInAsP for a further (cap) layer (16) of the striped mesa-type multi-layered crystal - see respectively: page 6, lines 24 to 26; sentence bridging pages 6 and 7; page 7, lines 3 to 5, 6 to 8 and 10 to 12. Bearing in mind the known physical laws governing the transmission and reflection of light energy by a dioptre, it is clear that the emmission of laser rays in Figure 1 of document (D1) is caused by the following features defined in Claim 1 according to the Appellant's main and first auxiliary request: a "difference in the distribution of the refractive index of light with regard to the active layer between the inside and the outside of the striped mesa-type multi-layered crystal (225, 16)". Otherwise, contrary to Figure 1 of document (D1), most of the laser radiation would indeed escape in a direction normal to the active layer.

2.2 Therefore, the Board agrees with the Opposition Division that, with respect to the prior art which can be derived from document (D1), the subject-matter of Claim 1 is distinguished in that the multi-layered crystal structure (110) comprises a GaAlAs system, and (i) the etching blocking layer (15) is made of GaAs and (ii) has a thickness of 20 µm or less.

3. *Inventive step*

3.1 Feature (i)

In its decision at paragraphs 3.3, 4.1 and 4.2, the Opposition Division held that the realisation of the structure of Claim 1 as a GaAlAs-system represents an obvious alternative to the GaInAsP-system of the embodiment disclosed in Figures 1 and 2 of document (D1), and that selective etching of GaAs and GaAlAs was already common practice in the technology of the semiconductors. With regard to the fact that the portions of the cladding layer (16) to be etched are made of GaAs, the Opposition Division had taken the view that making the etching blocking layer (15) of GaAs was obviously appropriate, especially having regard to the disclosure in document (D2a), which is specifically mentioned in document (D1). These findings were not contested by the Appellant in the Statement of Grounds of Appeal, and the Board agrees with the reasoning and findings of the Opposition Division on this point.

3.2 Feature (ii)

The etching blocking layer (125) of the semiconductor laser described in document (D1) is said there to be grown by liquid epitaxy and to be 200 nm thick. Based on the fact that the method is suitable for achieving half that thickness, the Appellant submitted that

document (D1) does not hint at eventual problems related to the presence of the blocking layer and even leads away from reducing its thickness to only 20 nm.

The Board nonetheless observes that the invention starts from a prior art disclosure which would not exhibit the deficiency to be obviated if, without disrupting the continuity of the mesa portion in the direction normal to the active layer, it were possible to achieve uniform thickness of the thinner portions of the layer (4) which flanks said mesa portion - cf. Figure 1 of the patent in suit. Therefore, any person of average skill working in the field of semiconductor lasers would understand - or at least observe while carrying out routine experiments - that the provision of an etching blocking layer is liable to influence negatively the operation of a laser.

Furthermore, the Appellant did not contest the relevance of the Respondent's submission that, in the semiconductor laser known from document (D1) and comprising an etching blocking layer grown by liquid phase epitaxy, achieving uniformity of said layer's thickness would be difficult if the latter were chosen too small. Having regard thereto, the Board agrees with the Opposition Division that the mention of liquid epitaxy in document (D1) was not liable to mislead the skilled person, and that no exercise of inventive ingenuity was required from him to recognise the existence of the alleged problems and to solve them by providing an etching blocking layer not thicker than 20 nm, whereby a double heterostructure in which the forbidden band of the blocking layer is broader is automatically achieved.

The Appellant furthermore submitted that light absorption by the etching blocking layer would not merely originate in the presence of said layer but also

in its thickness. Regarding that point, however, the Board agrees with the Opponent (Respondent) that it is only in conjunction with such parameters of the laser as the thicknesses and doping rates of the various other layers that the blocking layer can produce the alleged effects. Besides, it is clear to anyone of average skill that the thinner a layer is, the less it absorbs light energy and, in the case of a blocking layer forming part of an injection laser, the less the driving current has to be increased. Bearing in mind that, as acknowledged by the Appellant, molecular beam epitaxy was known before the date of the priority claimed in the European patent, it was consequently obvious to the skilled person to perform routine experiments with thinner blocking layers in order to optimize the conflicting parameters homogenity and absorption and so determine the upper limit of 20 nm without having to display inventive talent.

3.3 In the Board's judgement, therefore, Claim 1 according to any of the Appellant's main and first auxiliary request lacks an inventive step within the meaning of Article 56 EPC.

3.4 Claim 7 according to the Appellant's main request does not specify any materials for forming the claimed layer of the double heterostructure nor any paricular parameter of the epitaxial growing process. The Appellant did not contend that the provision of the claimed layer structure would not be known in the field of semiconductor lasers, nor that it would be inventive to grow these layers by molecular beam epitaxy. Producing a mesa structure according to steps (c) to (f) of the method forming the subject-matter of Claim 7 according to the Appellant's main request is obviously needed to provide the features of the semiconductor

laser mentioned in Claim 1 and disclosed in document (D1). Growing the etching blocking layer to a thickness of 20 nm or less is obvious for the reasons set out in paragraph 3.2 above.

In the Board's judgment, therefore, Claim 7 according to the Appellant's main request also lacks an inventive step.

4. Therefore, Claims 1 and 7 according to the Appellant's main request and Claim 1 according to the Appellant's first auxiliary request are not allowable - EPC, Article 52(1) in conjunction with Article 56.

The Claims 2 to 6 of the main request and 2 to 5 of the first auxiliary request fall because of their dependency on Claim 1, and the Claims 8 to 10 of the main request fall because of their dependency on Claim 7.

5. During the oral proceedings of 26 September 1996, the Appellant did not put forward any argument in support of its second auxiliary request. Furthermore, the Board is satisfied that the features mentioned in Claims 2 to 6 of the Appellant's main request are known from prior art. In the Board's judgment, therefore, an independent claim formed by combining Claims 2 to 6 of the Appellant's main request with Claim 1 of said request would, because of lack of inventive step, not be allowable - EPC, Article 52(1) in conjunction with Article 56.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Beer G. D. Paterson