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D E C I S I O N
of 17 March 2000

Case Number: T 0990/95 - 3.4.1

Application Number: 93304926.4

Publication Number: 0578407

IPC: H01S 3/06

Language of the proceedings: EN

Title of invention:
Erbium doped optical devices

Applicant:
AT&T Corp.

Opponent:
-

Headword:
Erbium doped optical devices/AT&T Corp.

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
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Boards of Appeal

Chambres de recours

Case Number: T 0990/95 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 17 March 2000

Appellant: AT&T Corp.
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Representative: Watts, Christopher Malcolm Kelway, Dr.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 24 August 1995
refusing European patent application
No. 93 304 926.4 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: G. Davies
Members: H. K. Wolfrum
G. Assi

Summary of Facts and Submissions

- I. European patent application No. 93 304 926.4 (publication No. 0 578 407) was refused by a decision of the examining division dated 24 August 1995, on the ground of lack of inventive step (Articles 52(1) and 56 EPC).
- II. The appellant lodged an appeal against the decision on 16 October 1995 and paid the prescribed fee on the same day. A statement of grounds of appeal was filed on 27 November 1995 together with a set of new claims 1 to 5.
- III. In a communication dated 9 November 1999 the Board made reference *inter alia* to the following documents:
- D1: Applied Physics Letters, vol. 58, no. 10, 11 March 1991, pages 998 to 1000;
- D2: Journal of Applied Physics, vol. 70, no. 7, 1 October 1991, pages 3778 to 3784;
- D4: Applied Physics Letters, vol. 57, no. 26, 24 December 1990, pages 2814 to 2816;
and
- D5: Journal of Applied Physics, vol. 69, no. 11, 1 June 1991, pages 7430 to 7434.

Documents D4 and D5 were introduced by the Board into the proceedings in view of amendments made to the claims. D4 was cited in the European Search Report. D5 is a document which the Board happened to be aware of.

The Board raised objections under Article 56 EPC against the subject-matter of all the claims then on file and, in this context, explicitly drew attention to the fact that mirrors comprising alternating layers of Si and SiO₂ were known from document D5.

IV. The applicant replied with a letter dated 27 January 2000 requesting the grant of a patent on the basis of a new set of claims 1 to 4.

V. Independent claim 1 reads as follows :

"1. A light-emitting device which comprises in an ascending order from a substrate (11), a first mirror (12), an active layer (13), and a second mirror (14), said first and second mirrors being distributed Bragg reflector (DBR) mirrors forming a Fabry-Perot cavity having a fundamental mode; each of said mirrors including a layer that is contiguous with the active layer; said active layer including a light emitting species having an emission wavelength, the thickness of the active layer being a whole number multiple of $\lambda/2$, where λ is said emission wavelength, said whole number being in the range 1 to 5, the fundamental mode of the cavity being in resonance with said emission wavelength;
characterized in that

(a) said light emitting species comprises a rare earth element having an atomic number in the range 57 to 71;

(b) each of said DBR mirrors comprises alternating layers of Si and SiO₂;

- (c) the active layer comprises SiO_2 ;
- (d) each of said DBR mirrors is configured such that the layer that is contiguous with the active layer is a Si layer; and
- (e) each of said first and second DBR mirrors has a reflectivity of at least 98% for radiation of said emission wavelength, one of said mirrors having higher reflectivity than the other."

VI. The appellant's submissions in support of claim 1 may be summarised as follows:

Document D1 concerning a light-emitting device according to the preamble of claim 1 made use of Langmuir-Blodgett (LB) films for the active layer, being advantageous in terms of controlling the thickness to monomolecular layer precision and of reproducibility of high quality films. D1 thus taught away from the invention as defined by features (a) to (e) of claim 1. In particular, nothing in D1 suggested that by using Si/SiO₂ DBR mirrors high-Q microcavities could be attained.

Document D2 disclosed that Er implanted into a variety of materials can exhibit photoluminescence, but nothing in this document suggested incorporation of Er into the active region of a microcavity structure.

Document D4 disclosed a planar microcavity structure with an undoped GaAs multiple quantum well active region. The lower DBR mirror consisted of pairs of AlAs/AlGaAs layers and the upper mirror consisted of

pairs of ZnSe/SiO₂ layers.

D1, together with D2 and D4, did not disclose the claimed invention. Document D5 taught away from the invention, by disclosing that ZnSe/CaF₂ Bragg reflectors had improved optical qualities over Si/SiO₂ reflectors.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. *Right to be heard (Article 113(1) EPC)*

In view of the fact that present claim 1 is an amended version of preceding claim 5, which was dealt with in the Board's communication of 9 November 1999 (cf. in particular points 5.4 and 5.5) anticipating the present amendments, the following decision is solely based on grounds and evidence on which the appellant has had an opportunity to present its comments.

3. *Amendments*

Present claim 1 is based on original claim 10 and features disclosed on original page 4, lines 13 to 16). The Board is thus satisfied that claim 1 on file complies with the requirements of Article 123(2) EPC.

4. *Inventive step (Articles 52(1) and 56 EPC)*

- 4.1 Document D1 (cf. in particular Figure 1(a) and the corresponding description) is considered the closest prior art. It discloses a light-emitting device which comprises the features given in the preamble of claim 1 under consideration. The DBR mirrors provided on either side of the active layer are formed by stacks of ZnS/SiO₂ layers with a ZnS layer being contiguous with the active layer. Although in the specific example of D1 the active layer is formed by a Langmuir-Blodgett (LB) film, this document nevertheless points to the possibility of using other materials for the active layer (such as organic light-emitting materials or semiconductors) as well (cf. page 1000, right-hand column, third paragraph in D1).
- 4.2 The subject-matter of claim 1 differs from the light-emitting device according to D1 in a specific selection of materials for the active layer, including the light emitting species, and the mirrors (features (a) to (d) of claim 1) and in the requirement that the two mirrors have different reflectivity (feature (e) of claim 1).
- 4.3 The objective problem (see in this respect page 1, line 30 to page 2, line 11, and page 4, lines 14 to 16 of the originally-filed description) associated with the specific choice of materials may be seen in the desire to operate the device at wavelengths other than those accessible with the active material used in D1, in the desire to improve integration into integrated optics systems and in providing a cavity with a sufficiently high quality factor, whereas the problem addressed by feature (e) is to be seen in the desire to provide a cavity which has a preferred direction of light emission.

- 4.4 All aspects of this problem as well as the solutions thereto are known in the art.

From document D2 (cf. in particular the abstract; page 3778, left hand column, second paragraph to right-hand column, second paragraph; the paragraph bridging the two columns on page 3784; and Figures 2 and 3(a)) it was known before the priority date of the present application to use silica including, as light-emitting species, a rare earth element (and in particular Er) as the active material of light-emitting devices, particularly if the device was to be integrated with standard silica-based fiber optics. Therefore, a skilled person, wishing to integrate a microcavity structure as known from D1 into silica fiber optics, would have readily taken into consideration active layer materials (and thus aforementioned features (a) and (c)) as disclosed by D2.

As regards the claimed materials for the DBR mirrors (i.e. aforementioned features (b) and (d)), document D5 (cf. in particular the abstract; and the sections "Introduction" and "Summary" on pages 7430 and 7434, respectively) provides evidence that DBR mirrors formed of stacks of Si/SiO₂ layers, the Si layer being contiguous with the active layer, were commonly used before the priority date of the present application to form Fabry-Perot cavities. Thus, it would have been obvious to the skilled person that these mirror materials and structures are readily combined with an active layer of silica as known from D2 and employed in the light-emitting device according to D1, simply by replacing the ZnS layers by Si layers.

Moreover, the provision of mirrors of differing reflectivity in optical cavities for the purpose of obtaining a preferential direction of light emission and the choice of a minimum reflectivity for the mirrors, as defined by aforementioned feature (e), are, in the Board's opinion, purely conventional measures which fall within the routine competence of a skilled person when selecting mirrors according to a required optical gain and a desired degree of output coupling from an optical cavity. Both measures have even to be considered as relating to basic textbook knowledge in the technical field at issue. Apart from that, a light-emitting device comprising a cavity having mirrors of differing reflectivity, with the reflectivity of one mirror being in the order of 98%, was for instance known from document D4 (cf. in particular Figure 1 with the corresponding description on page 2814).

- 4.5 In consequence, it would have been obvious to the skilled person to devise a light-emitting device as defined by claim 1 under consideration. In this context, the Board cannot accept the appellant's submissions as regards the relevance of the cited prior art. In particular in view of the explicit indication given in D1 as to the use of alternative materials for the active layer, the Board cannot accept the appellant's submission that D1 would have taught away from the invention. Moreover, the argumentation brought forward by the appellant does not properly acknowledge that document D2 envisaged the use of a rare-earth element, such as Er, as the light-emitting species in the optically active material of a light-emitting device. Although the appellant is right in observing that document D5 discloses DBR mirrors formed of

multilayer stacks of ZnSe/CaF₂, which are found to be superior to Si/SiO₂ mirrors in terms of reflectivity and optical loss, the latter type of mirror is nevertheless taught to be conventionally used. Moreover, in the absence of any other distinguishing feature in present claim 1 and the supporting application description, it has to be assumed that the use of the known Si/SiO₂ mirrors results in the same high-Q microcavities as are alleged for the claimed mirrors.

4.6 For the foregoing reasons, in the Board's judgement, the subject-matter of claim 1 on file does not involve an inventive step within the meaning of Article 56 EPC. Claim 1 is therefore not allowable.

4.7 Dependent claims 2 to 4 are also not allowable because of their dependency on an unallowable claim 1.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Beer

G. Davies