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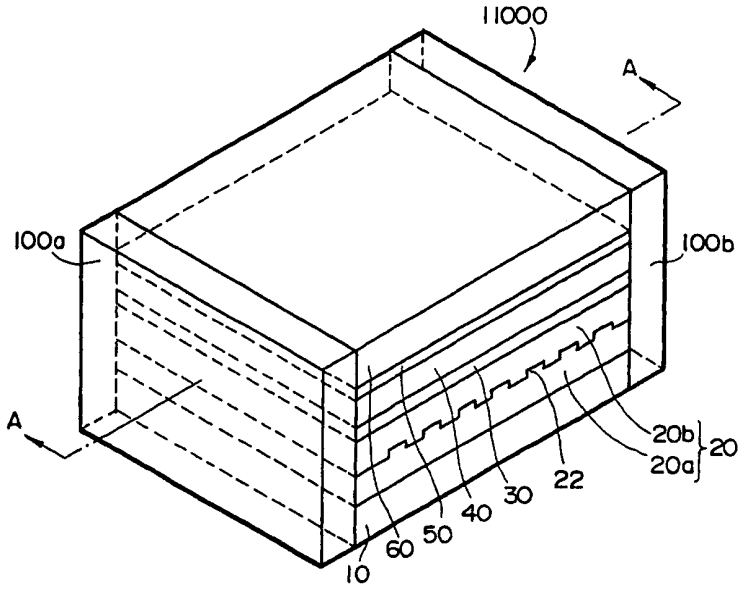
(74) Agents: INOUE, Hajime et al.; Ogikubo TM Building, 2nd Floor, 26–13, Ogikubo 5–chome, Suginami–ku, Tokyo 167–0051 (JP).

(54) Title: LIGHT–EMITTING DEVICE



(57) Abstract

An edge-emitting type light-emitting device (11000, 14000) comprises an organic light-emitting layer (40), a pair of electrode layers (30) and (50) for applying an electric field to the organic light-emitting layer (40), and an optical waveguide which transmits light emitted from the organic light-emitting layer (40) to the edge. The optical waveguide comprises a core layer (20) mainly transmitting light, and cladding layers (10) and (60) having a refractive index lower than that of the core layer (20). The core layer (20) may be a layer different from the organic light-emitting layer (40) or may comprise the organic light-emitting layer. A grating (12) is formed in the core layer (20) or in the boundary area between the core layer (20) and the cladding layer (10). A light-emitting device (31000) may comprise an optical fibre section (200). Another embodiment (43000) may comprise a defect and a grating having a one-dimensional periodic refractive index distribution and constituting a photonic band gap.

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INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/JP 99/07100

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L51/20 G02B6/42 H01S3/16 H01S3/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01S H01L G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	N. NAKAMURA: "Cw Operation of Distributed-Feedback GaAs-GaAlAs Diode Lasers at Temperatures up to 300K" APPLIED PHYSICS LETTERS, vol. 27, no. 7, 1 October 1975 (1975-10-01), pages 176-177, XP002132883 page 176; figures 1,3 ---	1,2,4,5, 15
X	WO 98 50989 A (FORREST STEPHEN R ;BURROWS PAUL (US); KOZLOV VLADIMIR (US); UNIV P) 12 November 1998 (1998-11-12)	1,23
Y	page 14, line 9 -page 27, line 23; figures 5A,5B,13 --- -/--	2,4,5, 15-18

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 May 2000	30. 06. 00

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	MCGEHEE M D ET AL: "SEMICONDUCTING POLYMER DISTRIBUTED FEEDBACK LASERS" APPLIED PHYSICS LETTERS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 72, no. 13, 30 March 1998 (1998-03-30), pages 1536-1538, XP000742887 ISSN: 0003-6951	1,23
Y	the whole document	2,4,5, 15-18
P,X	WO 99 35721 A (KALLINGER CHRISTIAN ;HILMER MARTIN (DE); LEMMER ULRICH (DE); FELDM) 15 July 1999 (1999-07-15) page 11, line 1-20; figure 4	1,15,23
P,X	EP 0 940 894 A (BAYER AG) 8 September 1999 (1999-09-08) column 5, line 50 -column 7, line 10; figure 5B	1,15,23
A	S.M.SZE: "Physics of Semiconductor Devices " 1981 , JOHN WILEY & SONS , NEW YORK XP002133090 page 713; figure 31B	2
X	STANLEY R P ET AL: "IMPURITY MODES IN ONE-DIMENSIONAL PERIODIC SYSTEMS: THE TRANSITION FROM PHOTONIC BAND GAPS TO MICROCAVITIES" PHYSICAL REVIEW, A. GENERAL PHYSICS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 48, no. 3, 1 September 1993 (1993-09-01), pages 2246-2250, XP002005646 ISSN: 1050-2947	1,19-21
Y	the whole document	22,24
Y	HIRAYAMA H ET AL: "NOVEL RADIATION PATTERN OF SPONTANEOUS EMISSION FROM PHOTONIC BANDGAP CRYSTAL CAVITY LASER" INTERNATIONAL CONFERENCE ON SOLID STATE DEVICES AND MATERIALS,JA,JAPAN SOCIETY OF APPLIED PHYSICS. TOKYO, vol. CONF. 1996, 1 January 1996 (1996-01-01), pages 220-222, XP000694037 abstract; figures 2,3	22,24

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INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/JP 99/07100

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	BERGGREN M ET AL: "ORGANIC LASERS BASED ON LITHOGRAPHICALLY DEFINED PHOTONIC-BANDGAP RESONATORS" ELECTRONICS LETTERS,GB,IEE STEVENAGE, vol. 34, no. 1, 8 January 1998 (1998-01-08), pages 90-91, XP000773626 ISSN: 0013-5194 the whole document	24
A	US 5 784 400 A (JOANNOPOULOS JOHN D ET AL) 21 July 1998 (1998-07-21) abstract; figures 2,4	19-22,24
A	MEADE R D ET AL: "NOVEL APPLICATIONS OF PHOTONIC BAND GAP MATERIALS: LOW-LOSS BENDS AND HIGH Q CAVITIES" JOURNAL OF APPLIED PHYSICS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 75, no. 9, 1 May 1994 (1994-05-01), pages 4753-4755, XP000562393 ISSN: 0021-8979 abstract; figure 1	19-22,24
X	US 5 673 284 A (PANG LILY Y ET AL) 30 September 1997 (1997-09-30)	1
Y	column 7, line 1 -column 7, line 26; figure 8	12-14
Y	FROLOV S.V.: "Cylindrical microlasers and light emitting devices from conducting polymers" APPL. PHYS. LETTERS, vol. 72, no. 22, 1 June 1998 (1998-06-01), pages 2811-2813, XP002137674 abstract; figures 2,3	12-14
X	US 4 980 895 A (NISHIMURA MICHIYO) 25 December 1990 (1990-12-25)	1,3,6-10
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X	US 5 452 318 A (MAKINO TOSHI ET AL) 19 September 1995 (1995-09-19) column 2, line 66 -column 3, line 68; figure 1	1,3,6-10

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INTERNATIONAL SEARCH REPORT

national application No.
PCT/JP 99/07100

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1,2,4,5,15-18,23

   Light-emitting device having a core layer including a layer which is different from the light-emitting layer.

2. Claims: 3,6-11

   Light-emitting device having a core layer comprising a layer which includes the light-emitting layer.

3. Claims: 12-14

   Light-emitting device comprising an optical fibre section formed in one body, wherein the optical waveguide is formed continuously with at least one of the core layer and the cladding layer of the optical fibre section.

4. Claims: 19-22,24

   Light-emitting device comprising a grating having a defect and a one dimensional refractive index distribution which constitutes a photonic band gap and the defect is designed so that the energy level caused by the vacancy is within a specific emission spectrum.

INTERNATIONAL SEARCH REPORT

...formation on patent family members

Inter onal Application No
PCT/JP 99/07100

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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