



- (51) International Patent Classification:
H01S 5/34 (2006.01)
- (21) International Application Number:
PCT/US2016/059662
- (22) International Filing Date:
31 October 2016 (31.10.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/275,351 6 January 2016 (06.01.2016) US
- (71) Applicant: NORTHWESTERN UNIVERSITY
[US/US]; 633 Clark Street, Evanston, Illinois 60208 (US).
- (72) Inventor: RAZEGHI, Manijeh; 1500 Sheridan Rd., Suite 8A, Wilmette, Illinois 60091 (US).
- (74) Agents: POREMBSKI, N. Meredith et al.; Bell & Manning, LLC, 2801 W. Beltline Hwy., Ste. 210, Madison, Wisconsin 53713 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

- (88) Date of publication of the international search report:
8 September 2017

(54) Title: MONOLITHICAL WIDELY TUNABLE QUANTUM CASCADE LASER DEVICES

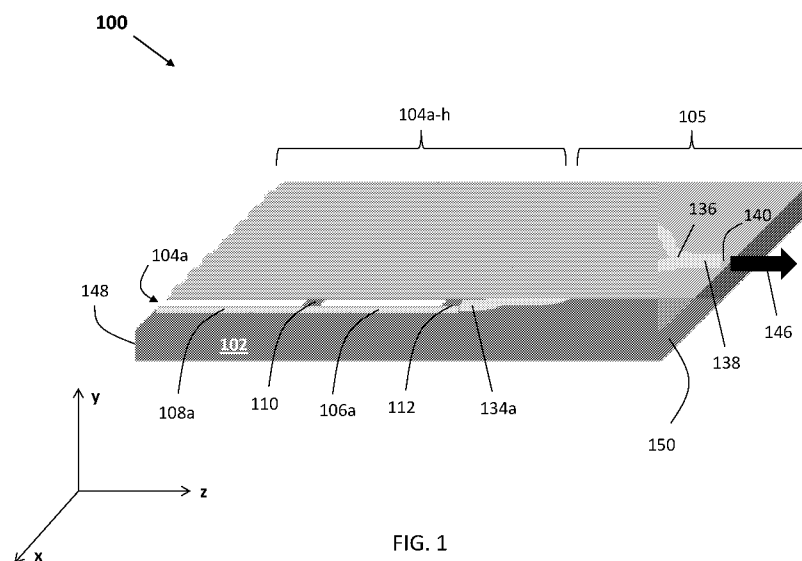


FIG. 1

(57) Abstract: Monolithic, wavelength-tunable QCL devices are provided which comprise a substrate, an array of QCLs formed on the substrate and an optical beam combiner formed on the substrate electrically isolated from the array of QCLs. In embodiments, the QCL devices are configured to provide laser emission in the range of from about 3 μm to about 12 μm, a wavelength tuning range of at least about 500 cm⁻¹, and a wavelength tuning step size of about 1.0 nm or less.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/59662

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01S 5/34 (2017.01)

CPC - H01L 29/15; H01L 29/122; B82Y 20/00; H01S 5/18397; H01S 5/34

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)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2004/0228384 A1 (OH et al.) 18 November 2004 (18.11.2004), para [0022], [0043]-[0048]	1-5, 8-11 ----- 6, 7, 12, 13
Y --- A	US 2002/0110328 A1 (BISCHEL et al.) 15 August 2002 (15.08.2002), para [0002], [0017], [0062], [0074]-[0076], [0121], [0122]	1-5, 8-11 ----- 6, 7, 12, 13
Y	US 6,195,381 B1 (BOTEZ et al.) 27 February 2001 (27.02.2001), col 1, ln 13-15, claim 14	5, 8
A	US 2012/0287418 A1 (SCHERER et al.) 15 November 2012 (15.11.2012), entire document	1-13

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 June 2017

Date of mailing of the international search report

06 JUL 2017

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774