(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 October 2013 (17.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/155240 A3

(51) International Patent Classification:
H01L 31/0203 (2006.01)

(21) International Application Number:
PCT/US2013/036054

(22) International Filing Date:
10 April 2013 (10.04.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/445,857 12 April 2012 (12.04.2012) US

(71) Applicant: **DIGITALOPTICS CORPORATION** [US/US]; 3025 Orchard Parkway, San Jose, CA 95134 (US).

(72) Inventors: **SINGH, Harpuneet**; 3025 Orchard Parkway, San Jose, CA 95134 (US). **HUMPSTON, Giles**; 10 Winwood Drive Quainton Aylesbury, Buckinghamshire PH224AZ (GB). **CHAU, Ellis**; 3025 Orchard Parkway, San Jose, CA 95134 (US). **AZUMA, Eddie**; 3025 Orchard Parkway, San Jose, CA 95134 (US). **PIETRANGELO, Peter**; 3025 Orchard Parkway, San Jose, CA 95134 (US). **WARD, Ocie**; 3025 Orchard Parkway, San Jose, CA 95134 (US).

(74) Agents: **SMITH, Andrew V.** et al.; DigitalOptics Corporation, 3025 Orchard Parkway, San Jose, CA 95134 (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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) Title: COMPACT CAMERA MODULE

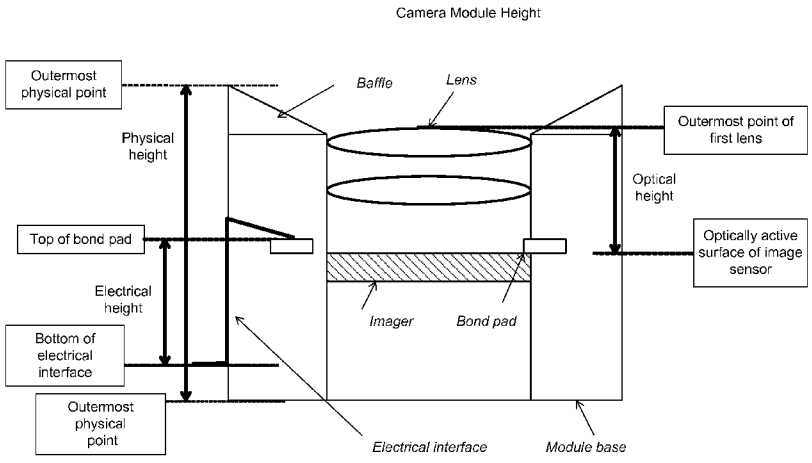

Figure 1

(57) Abstract: A miniature camera module component is formed by creating replicated lens shapes on a protective cover wafer and depositing material to form multiple cavities with the replicated lens shapes respectively disposed therein. A carrier wafer is coupled to the protective cover wafer before it is diced. An intermediate wafer is coupled to the protective cover wafer, and the carrier wafer is removed. An image sensor wafer is coupled to the protective cover wafer, and the intermediate wafer is removed.

WO 2013/155240 A3

WO 2013/155240 A3

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:
5 December 2013

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/036054

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01L 31/0203 (2013.01)
USPC - 257/433
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(8) - G02B 7/02; G03B 17/00; H01L 27/146; H01L 31/0203, 31/0232 (2013.01)
USPC - 257/432, 433; 348/335, 340; 359/819

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H01L 27/14618; H04N 5/2254, 5/2257 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2007/0217786 A1 (CHO et al) 20 September 2007 (20.09.2007) entire document	6,12,13 --- 1-5, 7-11,17-35, 38, 39, 42, 43, 45, 46, 57-58
X -- Y	US 2004/0189862 A1 (GUSTAVSSON et al) 30 September 2004 (30.09.2004) entire document	14-16, 44 --- 1-5,17-43, 45, 46
Y	US 2009/0213262 A1 (SINGH et al) 27 August 2009 (27.08.2009) entire document	2, 7, 8, 52
Y	US 2009/0230499 A1 (WARSOP et al) 17 September 2009 (17.09.2009) entire document	3-5, 9-11
Y	US 2012/0025787 A1 (ROUVALA et al) 02 February 2012 (02.02.2012) entire document	29, 35
Y	US 2009/0309177 A1 (JEUNG et al) 17 December 2009 (17.12.2009) entire document	25, 43, 46, 50-59
Y	US 2009/0021624 A1 (WESTERWECK et al) 22 January 2009 (22.01.2009) entire document	36-41
Y	US 2011/0059572 A1 (BRADY) 10 March 2011 (10.03.2011) entire document	50-59
Y	US 2011/0019282 A1 (LUSINCHI et al) 27 January 2011 (27.01.2011) entire document	53, 54, 59
Y	US 2003/0162313 A1 (KIM et al) 28 August 2003 (28.08.2003) entire document	55, 56

☒ Further documents are listed in the continuation of Box C. ☐

* 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	Date of mailing of the international search report
04 September 2013	01 OCT 2013
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. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/036054

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/0006687 A1 (LAM) 17 January 2002 (17.01.2002) paragraphs 16, 35-36; figures 6-7	1-46, 50-59
A	US 7,405,764 B2 (GUSTAVSSON et al) 29 July 2008 (29.07.2008) abstract, column 2, lines 43-60	1-46, 50-59

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/036054

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

See extra 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 additional fees, this Authority did not invite payment of additional fees.

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.:

1-46, 50-59

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 and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/36054

Continuation of Box III.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-13, a solid state camera module having an image sensor coupled in flip-chip orientation to the circuit board.
Group II, claims 14-46, drawn to a miniature camera module wherein a thickness of the image sensor, protective cover, printed circuit, and/or a lens of the optical train does not contribute to a physical Z height in addition to a thickness of the substrate.
Group III, claims 47-49, drawn to a miniature camera module having an optical housing coupled to the substrate; and a flexible printed circuit.
Group IV, claims 50-59, drawn to a method of forming a miniature camera module component by forming multiple replicated lens shapes on a protective cover wafer; providing material onto the protective cover wafer to form multiple cavities with respective multiple replicated lens shapes therein; coupling a carrier wafer to the protective cover wafer on the side with the deposited material; dicing the protective cover wafer; coupling an intermediate wafer to the protective cover wafer on the side opposite the deposited material; removing the carier wafer; coupling an image sensor wafer to the protective cover wafer on the side with the deposited material; rmoving the intermediate wafer.

The inventions listed as Groups I, II, III and IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: an image sensor coupled in flip-chip orientation to the circuit board as claimed therein is not present in the invention of Groups I, II and III. The special technical feature of the Group II invention: a thickness of the image sensor, protective cover, printed circuit, and/or a lens of the optical train does not contribute to a physical Z height in addition to a thickness of the substrate as claimed therein is not present in the invention of Groups I, III and IV. The special technical feature of the Group III invention: an optical housing coupled to the substrate; and a flexible printed circuit as claimed therein is not present in the invention of Groups I, II or IV. The special technical feature of the Group IV invention: a method of forming a miniature camera module component by forming multiple replicated lens shapes on a protective cover wafer; providing material onto the protective cover wafer to form multiple cavities with respective multiple replicated lens shapes therein; coupling a carrier wafer to the protective cover wafer on the side with the deposited material; dicing the protective cover wafer; coupling an intermediate wafer to the protective cover wafer on the side opposite the deposited material; removing the carier wafer; coupling an image sensor wafer to the protective cover wafer on the side with the deposited material; rmoving the intermediate wafer as claimed therein is not present in the invention of Groups I, II or III.

Groups I, II, III and IV lack unity of invention because even though the inventions of these groups require the technical feature of a miniature camera module having an image sensor coupled to a substrate; a cavity having an aperture, the image sensor aligned to the aperture; a lens barrel or optical train of lenses coupled to the circuit board and physically aligned to the image sensor; a protective cover coupled to the image sensor over the active sensor area; a circuit coupled to the image sensor to carry electrical signals; and a printed circuit, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2002/0006687 A1 (LAM) 17 January 2002 (17.01.2002) paragraphs 16, 35-36, 40; figures 6-7.

Groups II and III lack unity of invention because even though the inventions of these groups require the technical feature a miniature camera having the image sensor connected to a printed circuit board, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 7,405,764 B2 (GUSTAVSSON et al) 29 July 2008 (29.07.2008) abstract, column 2, lines 43-60.

Since none of the special technical features of the Group I, II, III or IV inventions are found in more than one of the inventions, unity of invention is lacking.