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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)**

To:

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Date of mailing
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Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/US2018/045346

International filing date (day/month/year)
06.08.2018

Priority date (day/month/year)
30.08.2017

International Patent Classification (IPC) or both national classification and IPC
INV. H01L23/16 H01L21/683 H01L23/31

Applicant
QUALCOMM INCORPORATED

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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Date of completion of this opinion

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - the international application in the language in which it was filed.
 - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>5-7, 13-15, 17-20</u>
	No: Claims	<u>1-4, 8-12, 16, 21</u>
Inventive step (IS)	Yes: Claims	
	No: Claims	<u>1-21</u>
Industrial applicability (IA)	Yes: Claims	<u>1-21</u>
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item VIII

Certain observations on the international application

- 1 The application does not meet the requirements of Article 6 PCT, because the following claims are not clear.
 - 1.1 Although claims 1 and 21 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.
 - 1.2 The nature of the "means for forming an air cavity between the die and the substrate" and the "means for encapsulating the die and the means for forming the air cavity on the substrate" in claim 21 is not clearly defined. The intended scope of protection being sought is not clearly defined as a result.
 - 1.3 Claim 1 defines first and second dams as "means for forming an air cavity between the die and the substrate", and a mold as a "means for encapsulating the die and the means for forming the air cavity on the substrate". The present application discloses no alternatives to these "means". Claim 21 therefore also lacks support (Article 6 PCT) in the sense that claim 21 is only supported by the description to the extent that the "means for forming an air cavity between the die and the substrate" are first and second dams and the "means for encapsulating the die and the means for forming the air cavity on the substrate" constitute a mold on the substrate, encapsulating the die and the first and second dams.
 - 1.4 The features "first and second dams" in claims 1 and 9 are misleading. It is clear from the description (cf. figure 3B and paragraph 0029) that the "first and second dams" are not, in fact two separate entities as suggested by the terms "first and second dams", but are in fact a single physical dam formed along the periphery of the die. As acknowledged by the applicant (cf. paragraph 0029), the terms "first" and "second" is used to refer to the side view of the package, but does not in fact correctly describe the three-dimensional form of the dam structure.

Further to this, "first and second dams", understood as defining two separate entities, is inconsistent with the final paragraph of claims 1 and 9, according to which an air cavity is "bounded ... on sides by the inner sidewalls of the first and second dams", resulting in the intended scope of protection being sought not being clearly defined.

- 1.5 It is clear from the description (cf. paragraphs 0007 and 0032) that a photoresist material for the dam material is essential to the definition of the invention. Compared to the underfill dam structure shown in figure 2, a photoresist dam structure retains its shape after patterning and does not, thus, bleed out as is the case for the underfill dams 240 in figure 2. The photoresist dam structure is thus able to retain its vertical sidewalls and the problem of an increase of the keep-out zone associated with figure 2 is solved.

Since independent claims 1, 9 and 21 do not contain this feature they do not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

- D1 JP H09 162693 A (KOKUSAI ELECTRIC CO LTD) 20 June 1997
(1997-06-20)
- D2 WO 2008/078898 A1 (LG INNOTEK CO LTD [KR]; SON KYUNG JOO [KR]) 3 July 2008 (2008-07-03)
- D3 US 8 749 056 B2 (INFINEON TECHNOLOGIES AG [DE]) 10 June 2014
(2014-06-10)
- D4 US 2016/013152 A1 (YU CHEN-HUA [TW] ET AL) 14 January 2016
(2016-01-14)

An English language machine translation has been used to interpret the disclosure in D1. A copy of the translation is annexed to this communication.

- 1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1-4, 8-12, 16 and 21 is not new in the sense of Article 33(2) PCT.
- 1.1 D1 discloses (cf. figures 1-3 and the associated text) a package, comprising:
- a substrate 5;
 - a die 100 above the substrate 5;
 - a dam structure 4 consisting of first to fourth dams formed along a periphery of the die between the die and the substrate; and
 - a mold 7 on the substrate, the mold encapsulating the die 100 and the dam structure 4,
- wherein inner and outer sidewalls of the first and second dams are substantially vertical,
- wherein the outer sidewalls of the first and second dams are outside of the sidewalls of the die, and
- wherein an air cavity 8 is formed in the package, the air cavity being bounded above by a lower surface of the die 100, bounded below by an upper surface of the substrate 5, and bounded on sides by the inner sidewalls of the dam structure 4.
- Thus, and insofar as claims 1 and 21 can be understood (cf. item VIII above), the subject-matter thereof is disclosed in D1.
- 1.2 A method according to claim 9 on file is similarly disclosed in D1 (cf. figures 1-3 and the associated text).
- 1.3 The further features of the following dependent claims are also disclosed in D1:
- Claims 2, 10: paragraphs 0006, 0007
- 1.4 D2 discloses (cf. figures 6 and 7 and the associated text) a package and corresponding method of making the same, the package 200 comprising:
- a substrate 210;
 - a die 220 above the substrate 210;
 - a dam structure 216 including first and second dams between the die 220 and the substrate 210; and

a mold 230 on the substrate, the mold encapsulating the die and the dam structure 216 including the first and second dams,

wherein inner and outer sidewalls of the first and second dams are substantially vertical (cf. figures 6 and 7 and paragraphs 0054 and 0056 - cf. in particular references to "screen printing" and "metal bar"),

wherein the outer sidewalls of the first and second dams are vertically aligned with sidewalls of the die, and

wherein an air cavity 218 is formed in the package, the air cavity being bounded above by a lower surface of the die, bounded below by an upper surface of the substrate, and bounded on sides by the inner sidewalls of the dam structure 216 including the first and second dams.

The subject-matter of claims 1, 9 and 21 is therefore disclosed in D2.

1.5 The further features of the following dependent claims is also disclosed in D2:

Claims 2, 10: paragraphs 0054, 0056

Claims 4, 12: figures 6 and 7 and paragraph 0054, interconnects 222

Claims 8, 16: figure 7

1.6 D3 discloses (cf. figure 3a and the associated text) a package and a corresponding method of manufacture, the package comprising:

a (semiconductor) substrate 304;

a die 308 above the substrate 304;

a dam structure 306 including first and second dams between the die and the substrate; and

a mold 340 on the substrate, the mold encapsulating the die and the first and second dams,

wherein inner and outer sidewalls of the first and second dams are substantially vertical,

wherein the outer sidewalls of the first and second dams are vertically aligned with sidewalls of the die 308, and

wherein an air cavity 307 is formed in the package, the air cavity being bounded above by a lower surface of the die, bounded below by an upper surface of the substrate, and bounded on sides by the inner sidewalls of the first and second dams.

The dam structure 306 may be a photoresist (see column 3, lines 62-64: SU-8™).

Thus, D3 discloses the subject-matter of claims 1-3, 8-11, 16 and 21.

2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 3, 5-7, 11, 13-15 and 17-20 does not involve an inventive step in the sense of Article 33(3) PCT.

2.1 Starting from D2, the subject-matter of claims 3 and 11 on file differs from the disclosure therein in that the material of the first and second dams is a photoresist material.

D2 discloses a variety of materials for the dam structure 216 (cf. paragraphs 0054 and 0056). The skilled person understands from this that these are example materials which may be used and that other materials might also be used.

According to D2 (cf. paragraph 0061), the dam structure 216 acts as a barrier (or dam) preventing resin materials from flowing into the air cavity space. Clearly, then, for the skilled person, other materials used in the art for such a purpose might be used.

The use of photoresist material for flow barriers when encapsulating with resin is known per se in the art - see for example D3, figure 3a and the associated text, in particular column 3, lines 62-64 and column 4, lines 7-9 and also D4, figures 1-9 and the associated text, in particular paragraphs 0020 and 0026. D4 furthermore explicitly teaches dam structures 120 with vertical sidewalls (paragraph 0023).

It is therefore considered that the skilled person starting from D2 would arrive at the subject-matter of claims 3 and 11 on file in an obvious manner given the further disclosures in D3 and/or D4 being in the same technical field.

2.2 The further method steps defined in claims 17-20 are either standard measures in the art or are rendered obvious by the cited prior art documents:

2.2.1 Claim 20 on file defines forming the photoresist dam structures at the wafer level, followed by dicing the wafer.

Wafer-level processing is, however, a standard batch processing technique in the art, having the well-known advantage of providing increased throughput.

D2 discloses a batch process in which the sealing portions are formed on the substrate. Forming the sealing portion 216 on the die in D2 at the wafer level is an obvious alternative for the skilled person concerned with improved throughput.

The method of claim 20 is thus considered to be merely one of a limited number of batch processing options from which the skilled person will select, in accordance with circumstances and without the exercise of inventive skill, whenever increased throughput is desired.

- 2.2.2 Moreover, batch processing of diced chips using a carrier is also a well-known technique. Such a technique is disclosed in D4 (cf. figures 1-3) where the die 102 are provided on carrier 110 and dam structures 120 (optionally made of photoresist material) are subsequently provided on the die, optionally by deposition and patterning (paragraph 0024), followed by detaching the die from the carrier again.

The further features of claims 17 and 19 on file are consequently considered to be obvious options in the light of the disclosures in D2 and D4.

- 2.2.3 Reflow is implicit to the "flip method" disclosed in paragraph 0058 of D2. Depending on the material of the dam structure 216, a curing step will be effected in accordance with the circumstances.

No inventive contribution is therefore recognised in claim 18 on file.

- 2.2.4 In respect of the features defined in claims 5-7 and 13-15 on file, these define aspects of the dam structure arrangement shown in figure 3A and described in paragraphs 0033 and 0034 of the description. According to paragraphs 0033 and 0034, none of these dam structure features are essential, furthermore no technical effect is disclosed as being associated with these features. Indeed, and with reference to figure 5 of the application, these features are merely the consequence of a specific method of manufacturing the dam structure (which is not defined in method claims 13-15) without having any technical significance in the completed package 300 per se. In fact, since the dam structure 340 extends beyond the sidewalls of the die 310 the keep-out zone in this package 300 is increased over that of the package 400 shown in figure 4 and thus represents a disadvantageous dam structure.

Consequently, claims 5-7 and 13-15, defining features having no technical effect per se, relate to arbitrary modifications of the packages and methods of D1-D3 and do not contribute inventive merit.