UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NXP USA, INC.

Petitioner

v.

BELL SEMICONDUCTOR, LLC

Patent Owner

Case No.: IPR2024-00168

Patent No. 7,345,245

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

TABLE OF CONTENTS

I. INTRODUCTION 1
II. AAPA 1
III. CLAIM CONSTRUCTION 2
IV. All Grounds 21
V. Ground 4 Devnani – AAPA renders Claims 1, 2, 4 and 5 obvious 22
i. Claim 1 22
ii. Claim 2 24
iii. Claim 4 25
iv. Claim 5 25
VI. Ground 1 – Devnani-AAPA renders Claim 8 obvious 25
VII. Ground 6 – Devnani-AAPA-Tanahashi renders claim 6 obvious 28
VIII. Ground 7 – Chung-Celeron renders Claims 1, 2 and 5 obvious 28
i. Claim 1 28
IX. Grounds 5 and 8 – Devnani-AAPA-Pillai/Chung-Celeron-Pillai renders Claim 3 obvious 29
X. Ground 9 – Chung-Celeron-AAPA renders Claim 4 obvious 30
XI. Ground 10 – Chung-Celeron-Tanahashi renders Claim 6 obvious 30
XII. Ground 11 – Devnani-Celeron renders Claims 1 and 5 obvious 30
i. Claim 1 30
ii. Claim 5 30
XIII. Ground 12 – Devnani-Celeron-Tanahashi renders Claim 6 obvious 30
XIV. Conclusion 30

I INTRODUCTION

Patent Owner's Response (POR) is based almost entirely on claim construction arguments that contradict the clear language of the '245 Patent, the prosecution history, and claim construction positions that Patent Owner (PO) proposed in parallel district court litigation. In particular, PO's arguments improperly attempt to limit the claims to a preferred embodiment, to read into the claims limitations from the specification, and to rewrite the claims to add new subject matter not found in the specification.

Nevertheless, even under PO's improper claim constructions, the prior art still renders claims 1-6 and 8 obvious.

Further, PO mischaracterizes the operation of the references and the Petition's actual combinations in an attempt to overcome the instituted grounds for unpatentability. Thus, the Board should find all the challenged claims of the '245 Patent unpatentable.

II AAPA

PO disputes whether the existing solutions are AAPA. The existing solutions are AAPA. As noted by the Board in the Institution Decision ("DI"), the existing solutions were listed in the "BACKGROUND OF THE INVENTION SECTION", described as "existing", and are described with reference to Figures 1-3, that are labeled "prior art".

The disadvantages of the existing solutions are also AAPA at least for their placement in the background section and use of reference numerals found in Figures that are labeled "prior art".

III CLAIM CONSTRUCTION

The Board should reject PO's improperly narrow and unsupported constructions for three claim terms as will be discussed below.

1. Claim Term 1: "wherein none of the signal traces of the bottom routing layer are located over ball pads of the ball pad layer which are disposed in an area within two ball pad pitches of the corner of the die" (Claim 1)

The Board correctly interpreted Claim Term 1 to mean "requiring that no signal traces of the bottom routing layer be located over ball pads of the ball pad layer disposed within two ball pad pitches of the corner of the die **if** any such ball pads exist in this location." [1] DI at 22. The Petitioner agrees with the Board's interpretation.

As the Board correctly points out, the plain language of Claim Term 1 "serves to describe the "**signal traces** of the bottom routing layer." *Id* at 22. The Board correctly observes that "[t]he recitation does not affirmatively recite a required location of any ball pads. Likewise, the claim as a whole does not state that the ball pad layer comprises ball pads disposed within two ball pad pitches of the corner of the die.

[1] All emphasis is added unless indicated otherwise.

Rather, the claim recites 'said ball pad layer having a plurality of ball pads' **without** affirmatively indicating where those ball pads **must be located** within the ball pad layer". *Id*.

The Petitioner agrees with the Board that the plain language of Claim Term 1 does not require ball pads in any specific location of the ball pad layer. Further, the intrinsic evidence clearly supports the Board's interpretation.

For Claim Term 1, the "wherein clause" is directed to **the location of the signal traces**, not affirmatively stating a location of the ball pads. Further this "wherein clause" is a **negative** claim element that indicates where "**none of**" the signal traces are located. Thus, the "wherein clause" plainly indicates where signals traces are not present.

Thus, this "wherein clause" is clearly stating that **the location of the signal traces** is not over ball pads, **if** ball pads are present within two ball pad pitches from the corner of the die, *and* **if** any signal traces are present, as signal traces are also not required to be present within two ball pad pitches of the corner of a die, based on the plain language.

The Applicant could have drafted the claims to expressly require ball pads in the defined area had the Applicant wanted the claims so limited. In fact, the Applicant had originally done so in the application as filed. EX1004, 359-60. But later, the Applicant

presented new claims during prosecution, that **removed an affirmative limitation** requiring ball pads within the defined area. In particular, the Applicant cancelled originally filed claims 1-13 and added new claims 14-25. *Id*., 327.

The newly filed claim 14 omitted "**wherein a number of ball pads** of said first layer **are associated with said area**" as was present in cancelled claim 1. *Id*., 359. The newly filed claim 20 omitted "**wherein a portion of ball pads** of said first layer **are associated with said area**" as was present in cancelled claim 7. *Id*., 360. Additionally, both new claims, 14 and 20, removed the word "**throughout**" from an affirmative recitation describing the dispersion of the ball pads as was present in cancelled claims 1 and 7. *Id*., 324-325.

The cancelled claims 1 and 7 and the newly added claims 14 and 20 are shown below with emphasis added with highlighting and comments.

1. A semi-conductor substrate package comprising;

a substrate;

a die, said die being engaged with said substrate, said substrate comprising;

a first layer, wherein ball pads are dispersed throughout said first layer; and

a second layer including metal structures and an area proximate to a corner of the die, wherein a number of said ball pads of said first layer are associated with said area and wherein said metal structures of said second layer are routed away from said area.

Originally filed Claim 1

14. (New) A semi-conductor package comprising:

a top layer having a die mounted thereon, said die having a corner; and

a plurality of layers under the top layer, said plurality of layers comprising a bottom routing layer having signal traces thereon, and a ball pad layer under the bottom routing layer, said ball pad layer having a plurality of ball pads, wherein none of the signal traces of the bottom routing layer are located under ball pads of the ball pad layer which are disposed in an area within two ball pad pitches of the corner of the die.

no "throughout", no explicit location

New Claim 14

7. A method of forming a semiconductor package for a die including the steps of:

providing a substrate, said substrate having a first layer, wherein ball pads are dispersed throughout said first layer and a second layer having metal structures;

providing a die;

engaging said die with said substrate;

defining an area proximate a corner of the die, wherein a portion of said ball pads of said first layer are associated with said area; and

routing said metal structures of said second layer away from said area.

Originally Filed Claim 7

20. (New) A semi-conductor package comprising:

a top layer having a die mounted thereon, said die having a corner defining a surrounding area of increased stress; and

a plurality of layers under the top layer, said plurality of layers comprising a bottom routing layer having signal traces thereon, and a ball pad layer under the bottom routing layer, said ball pad layer having a plurality of ball pads dispersed thereon, wherein none of the signal traces of the bottom routing layer are located with the area of increased stress defined by the corner of the die.

no "throughout", no explicit location

New Claim 20

In arguing the new claims, the Applicant stated Horiuchi "does not disclose a bottom routing layer having signal traces thereon and a ball pad layer under the bottom routing layer, where the ball pad layer has a plurality of ball pads, as is specifically claimed in new claims 14 and 20." *Id*., 328.

Notably absent was an argument regarding the specific location of any ball pads. While Applicant further recites language from the new claim that includes Claim Term 1, the reasoning is directed to the location of signal traces, not an affirmance of **where** ball pads are explicitly located. *Id*.

To further this point, the Applicant stated "claim 20 specifically claims that **none of the signal traces** of the bottom routing layer are located within an area of increased stress defined by the corner of the die. Horiuchi et al. does not disclose or suggest this."

EX1004, 328. This shows the Applicant was not stating that **the ball pads must be located within two ball pad pitches of the corner of the die** to distinguish the amended claims over the Horiuchi reference.

To reiterate, original claim 1 read: "**an area** proximate to a corner of the die, wherein **a number of said ball pads of said first layer are associated with said area**". (EX1004, 359) Original claim 7 read: "defining **an area** proximate a corner of the die, wherein **a portion of said ball pads of said first layer are associated with said area**". (EX1004, 360)

There would have been no reason to remove these limitations if the Applicant wished to ***include*** an explicit definition of the location of ball pads as related to the area proximate to the die corner.

PO now attempts to narrow Claim Term 1 to recapture what they amended out of the claims. Thus, the Board should reject PO's proposed construction of Claim Term 1, and instead use the correct construction the Board laid out in the Institution Decision.

A. The PO first argues that grammar requires ball pads to be disposed in an area within two ball pad pitches of the corner of the die. POR at 14-15. However, PO conveniently leaves out the main subject of Claim Term 1 is "signal traces". Thus, this wherein clause is affirming where the signal traces are **not** located. Thus, the grammar

regarding the rest of the limitation does not positively affirm a specific location of ball pads.

B. PO then alleges the stated purpose of the '245 Patent is solving a problem from "increased demand for high density signal routing", which PO purports "**results in ball pads being disposed in the area** surrounding the die corner (e.g., in a **full area ball array**) to provide a high input/output (IO) signal density". *Id*., at 15-16.

There are numerous problems with this reasoning:

a) The Applicant amended the claims and **removed** language that stated ball pads were associated with an area proximate to the die corner. EX1004, 324-25, 359-60.

b) The Applicant amended the claims and **removed** the term "**throughout**" regarding dispersal of the ball pads on the ball pad layer. *Id*.

c) The claims do not use the term "full area ball array" and the specification does not state a full ball area array is required.

d) The specification explicitly states that ball pads "may be dispersed in a **partial or** full-array format." EX1001, 1:44-45.

e) Other examples in the specification belie PO's reading of Claim Term 1. For example, the specification discloses that "**the present invention and**

method of routing signal traces away from the die corner." *Id*., 3:61-62. *See Also Id*., 1:13-19, 2:16-18, 2:33-36.

Thus, it is clear, from the intrinsic evidence above, that *the stated purpose* of the invention is **routing signal traces away from the die corner to prevent cracks in the signal traces** and the '245 Patent wanted this to apply to "**all** packaging technologies", which include BGAs of all types including **partial ball grid arrays**. EX1001, 2:14-15.

Thus, the overwhelming intrinsic evidence does not support PO's improperly narrow construction that the stated purpose of the alleged invention requires a full area ball array.

C. PO further stated that "[i]n light of the specification, the limitation must be construed in the context of solving the problem of reliably routing signal traces in a high density substrate **in which ball pads are disposed** in the area around the die corner." based on *AlterWAN, Inc. v. Amazon.com, Inc.,* 63 F.4th 18, 24 (Fed. Cir. 2023) ("In light of the specification, "non-blocking bandwidth" is properly understood to address the problem of latency, rather than providing for bandwidth **even in the scenario where the Internet is inoperable**."). POR at 16-17.

However, in the *AlterWAN* case, the court noted "[t]he specification does not remotely suggest operability when the Internet is unavailable." *AlterWAN, Inc. v. Amazon.com*, 63 F.4th 18, 24 (Fed. Cir. 2023)

In contrast to *AlterWAN*, the specification of the '245 Patent not only suggests, but explicitly states "***all*** packaging technologies", explicitly mentions **partial** ball grid arrays, and on numerous occasions, as shown above, the specification discusses issues with stresses associated with the corner of a die **devoid of any mention** whatsoever of ball pads or balls. EX1001, 2:14, 1:44-45, 1:18-19; 2:16-18; 2:32-34; 2:35-36; 2:36-39; 3:20-21; 3:21-22; 3:24-26; 3:26-28.

Thus, the specification, when viewed in light of *AlterWAN*, cannot be reasonably interpreted to ***require*** ball pads to be disposed in the area around the corner as proposed by the PO.

D. The PO further argues the proposed construction comports with the only embodiment shown and described in the '245 Patent and relies on "*Poly-America, L.P. v. API Indus., Inc.*, 839 F.3d 1131, 1137 (Fed. Cir. 2016). POR at 19.

However, in the Poly-America case, **every section** of the specification indicated the same exact interpretation.

In contrast, the '245 Patent discloses various interpretations for types of packages and ball grid arrays as shown above in Section III.1.C. and states the specific

embodiment shown "is to be considered an exemplification of the principles of the invention and **is not intended to limit the invention to that as illustrated** and described herein". EX1001, 3:3-5.

Thus, even though PO tries to rely on an "only embodiment shown" argument to improperly narrow the claim construction", the facts of this case do not comport to the facts of the Poly-America case. Further, the Federal Circuit has clearly held the "only embodiment shown" argument to be improper. *In re Am. Academy of Science Tech* Ctr., 367 F.3d 1359, 1369 (Fed. Cir. 2004) ("We have cautioned against reading limitations into a claim from the preferred embodiment described in the specification, **even if it is the only embodiment described**, absent **clear** disclaimer in the specification.

E. PO states "the '245 Patent disavows embodiments in which there is no high stress area associated with ball pads under the die corner". POR at 19. The POs rely on selective statements in the '245 Patent, a statement by PO's Expert in paragraph 102 of the Expert Declaration (Ex. 2003), and on *Honeywell Int'l*, Inc., where the court found that "a fuel filter is the only 'fuel injection system component' that the claims covered." *Id*., at 20.

However, in Honeywell, the court noted that "[t]he fuel filter was **the only component** of an EFI system **that the written description disclosed** as having a

polymer housing with electrically conductive fibers interlaced therein" *Honeywell International, Inc. v. ITT Industries, Inc*., 452 F.3d 1312, 1318 (Fed. Cir. 2006)

In contrast to *Honeywell*, the written description of the '245 Patent discloses "all packaging technologies", partial ball grid arrays, and stress associated with a die corner numerous times devoid of any mention of ball pads as discussed supra.

The intrinsic record also emphatically contradicts the POs assertion. The plain language of claim 7 states that "the area of increased stress [is] defined by the die corner." EX1001, 4:47-48.

Further, the specification (excluding the claims) discloses, on 9 different occasions, that stress is associated with the die corner without any mention of ball pads. *Id*., 1:18-19; 2:16-18; 2:32-34; 2:35-36; 2:36-39; 3:20-21; 3:21-22; 3:24-26; 3:26-28. Thus, there was no "clear and unmistakable" disavowal as required.

F. The PO further states that "embodiments without ball pads under the corner of the die were disavowed during prosecution" because "applicant's attorney expressly argued that "[p]roviding that none of the signal traces of the bottom routing layer are located over the ball pads of the ball pad layer which are disposed in an area within two ball pads pitches of the corner of the die is the essence of the present invention". POR at 20-21.

The Federal Circuit has made clear that the standard for disavowal of full claim scope through prosecution history disclaimer is "exacting, requiring clear and unequivocal evidence that the claimed invention includes or does not include a particular feature." *Poly-America, L.P. v. API Industries, Inc.*, 839 F.3d 1131, 1136 (Fed. Cir. 2016) (citations omitted). "Ambiguous language cannot support disavowal." *Id*.

First, this argument made by the Applicant simply repeats the language recited in the claim. This does not provide "clear and unequivocal evidence" of a disavowal of all embodiments where ball pads are not under a die corner. *See Trivascular*, 812 F.3d at 1063–64 ("The party seeking to invoke prosecution history disclaimer bears the burden of proving the existence of a 'clear and unmistakable' disclaimer"); *Avid Tech., Inc. v. Harmonic, Inc.*, 812 F.3d 1040, 1045 (Fed. Cir. 2016) ("Where the alleged disavowal is ambiguous, or even 'amenable to multiple reasonable interpretations,' **we have declined to find prosecution disclaimer**.").

Second, this language, as discussed supra, is regarding location of signal traces, not affirmatively requiring ball pads at a specific location. This is further evidenced by the applicant's attorney arguing that prior art reference Pillai "only shows the bottom routing layer having a single **signal** trace." EX1004, 265.

Third, this statement was made in prosecution **after** submitting claims that expressly removed any affirmative recitation of a location of ball pads. *Id*., 323-331. Thus, there was nothing close to a clear and unmistakable disclaimer in the prosecution.

Based on the foregoing, the Board should construe Claim Term 1 as correctly interpreted in the Institution Decision.

2. Claim Term 2: "said die having a corner defining a surrounding area of increased stress" (Claims 7/8).

The PO has proposed an interpretation that impermissibly reads an embodiment of the specification into the claims as PO argues that Claim Term 2 should mean "said die having a corner defining **a surrounding area of increased stress associated with ball pads** under the area." POR at 21-22.

However, Claim Term 2 requires no construction and is clearly defined by the plain language of the claim itself. The plain language states an area of increased stress is **defined by the die corner**, nothing more. Thus, the plain language does not support PO's narrow construction.

Further, the intrinsic evidence does not support POs construction. For example, the '245 Patent includes nine mentions of stress related to die corners devoid of mentioning ball pads as discussed supra, and the extrinsic evidence put forth in the

Petition clearly showed stresses from die corners were very well known in the art. Pet. at 19, 64-65, 68-69; EX1002, ¶52-57.

A. PO's argue embodiments without ball pads under the corner of the die were disavowed during prosecution. POR at 23.

As discussed above, not only were these "embodiments without ball pads" not disavowed, the prosecution history shows that the claims were ***broadened*** to encompass embodiments without ball pads in the area of high. *See Supra* Section III.1, Section III.1.F.

B. PO's argue the '245 Patent disavows embodiments in which there is no high stress area associated with ball pads under the die corner". POR at 23. Not so. *See Supra* Section III.1.E.

C. The PO further argues that the '245 Patent's alleged purpose of "routing signal traces in a high density substrate" somehow definitively indicates ball pads must be disposed in the area around the die corner. POR at 23. As discussed supra in Section III.1.B, the purpose of the '245 Patent is a methodology of routing traces away from the die corner.

3. Claim Term 3: "within two ball pad pitches of the corner of the die" (Claims 1 and 8)

PO contends that Claim Term 3 should be construed as "within two ball pad pitches of the corner of the die in **each routing direction defined by the ball pads**." POR at 23-24. PO's construction again attempts to add subject matter not present in the plain language of the claims or even in the '245 Patent.

PO's claim that the term "two ball pad pitches" somehow defines "an area of high stress **of a specific size and shape**" that is "**no larger than required** to eliminate the occurrence of cracks in signal traces." POR at 24-26.

However, this is merely an attempt to presently invent around the prior art by fabricating a "**routing** direction", which is not present anywhere in the '245 Patent or the prosecution history.

PO is attempting to add this "routing" direction requirement into the claims in order to argue Claim Term 3 somehow defines an important and critical shape of the high stress zone. Somehow, this alleged shape is formed by being "bounded in the horizontal, vertical, and diagonal directions corresponding to signal trace routing directions defined by the ball pads". POR at 27. However, neither the claims, the prosecution history, nor the '245 Patent, provide any detail whatsoever for any specific

particular shape of the high stress area, much less any support extrapolating "routing directions" into a clearly defined bounded area.

In fact, PO's own Expert admitted that the '245 Patent does not use the terms vertical, horizontal, or diagonal (EX1026, 123:16-124:8, 125:3-12) and admitted the '245 Patent "doesn't describe the shape other than to say that it's demonstrated in what is Figure 4". (*Id*., 78:5-6).

POs own Expert then admits that AAPA Figure 3 of the '245 includes "the exact same shape [the '245 Patent] puts in Figure 5" (*Id*., 127:6-7), admits that AAPA Figure 3 along with Figure 5 "shows the same polygonal shape" corresponding to a high stress zone (*Id*., 127:10-11), and admits that the implementation of the patent is how routing occurs through the same high stress zone shown in both AAPA Figure 3, and Figure 5 of the '245 Patent. *Id*., 147:18-148:22. Thus, even if "two ball pad pitches" could somehow be stretched and contorted into a specific shape, PO's own Expert admits this shape is shown by the AAPA.

In contrast to PO's improper construction, the plain language of the claim indicates that "two ball pad pitches" is a distance. This is affirmed by PO's Expert and extrinsically by the art cited in the petition. *Id*., 85:16-17, 88:22-89:3; EX1008, 69.

Further, the '245 Patent simply states the high stress area "extends approximately two ball pitches away from the die corner 56a in each direction."

EX1001, 3:26-27. Thus, even when read in light of the specification, the distance of two ball pad pitches in each direction would form a circle.

However, PO contends that the high stress area shown in Figure 4 is "a polygon" and somehow this polygon shape as opposed to a circle would "needlessly reduce signal density without increasing reliability". POR at 27.

However, there is no basis in this allegation. Instead, PO's attempt to impermissibly read limitations into the claims that do not exist anywhere in the plain language of the claims, the '245 Patent or the prosecution history. If the specific area, outside the edges of a "polygonal" shape, up to the contours bounded by a circle, was critical, the specification does not say so.

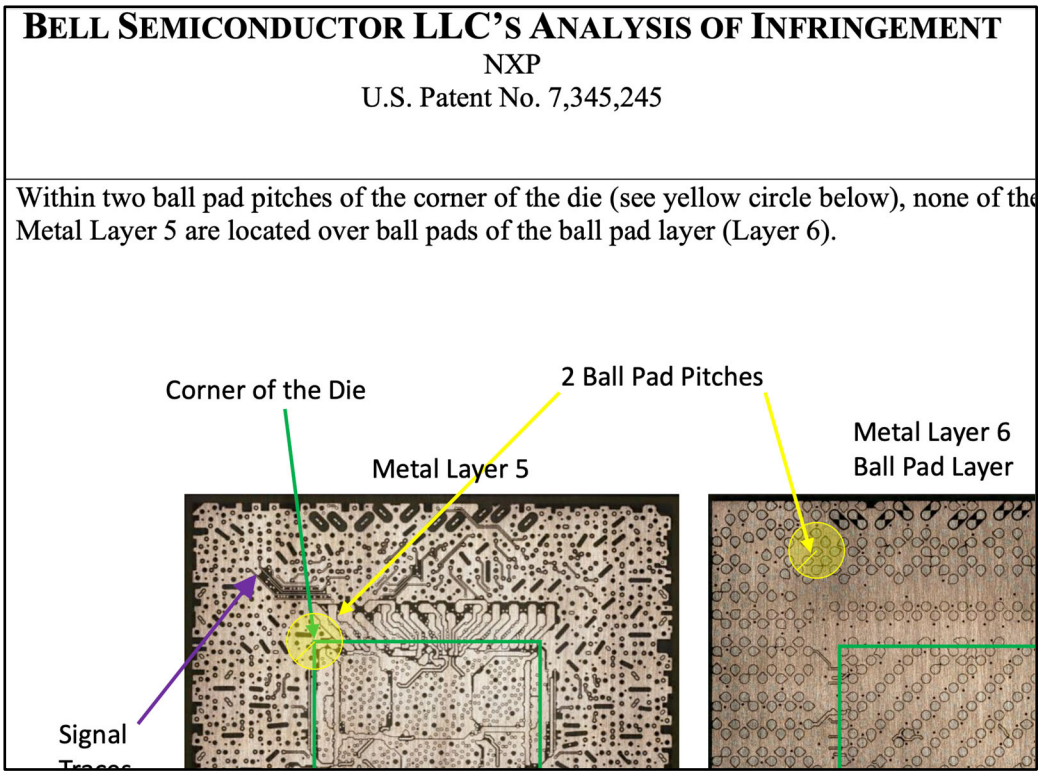
PO further alleges the '245 Patent "disparages the 'existing solution' in which a circular shaped area with a one millimeter radius is defined using the die corner". POR at 27. However, this statement is misleading.

The '245 Patent states the disadvantage is "one millimeter" **distance** from the die corner. It says nothing about the **shape** of the "existing solution". Certainly, had the **shape** of the high stress area been of importance, the '245 Patent would have at least mentioned a specific shape (e.g., said "polygon", defined the number of sides of the shape, defined the length of the edges of the shape, etc.). Further, if a circle was

actually being disparaged, the ’245 Patent would have discussed somewhere that the shape of the high stress area did not include a circle.

While in an embodiment the shape does appear to not be circular, “it is important not [to use claim construction] to import into a claim limitations that are not part of the claim.” *Superguide* Corp. *v. DirecTV Enterprises, Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004).

Further, this new “construction” put forth in the POR directly contradicts PO’s own asserts in parallel district court proceeding where they show and describe Claim Term 3 as a “circle” with a radius of two ball pad pitches. EX1015, 8.

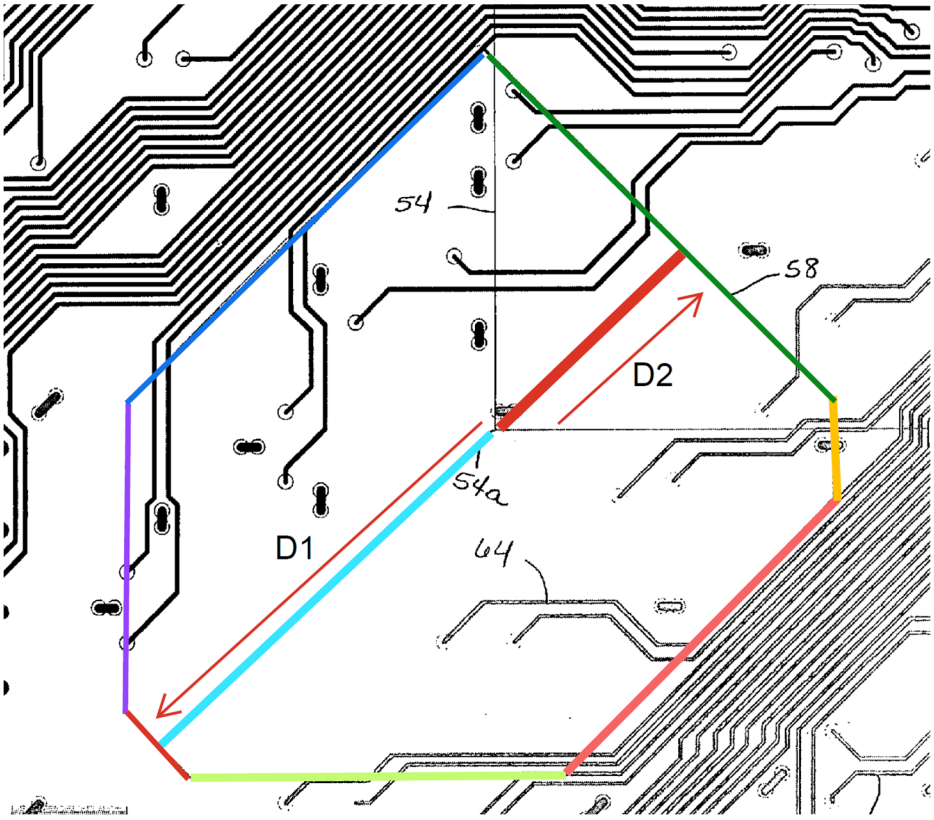


EX1015-Figure 5-excerpt

Further, PO alleges the two ball pad pitch ("2BPP") implementation that defines a shape of the high stress zone is "critical to the invention" and is "clearly defined by the language of claim 1". POR at 38. However, PO has constantly changed its construction of the 2BPP implementation.

As shown above, PO views the 2BPP as a circle at district court. In the POPR, PO states "the shape of the high stress zone is clearly defined by the language of claim 1" but never discusses a particular shape of the 2BPP. POPR at 35. In the POR, the area of high stress from the 2BPP implementation that is **shown in an embodiment** is defined as a "polygonal" shape. POR at 25. Then, PO's Expert in deposition, admits that the shape from the 2BPP implementation is actually "octagonal", and then "an exact octagon". EX1026, 126:18-20, 147:6-14.

Thus, PO's have defined two ball pad pitches to mean a circle, a polygon, octagonal, and an exact octagon based on an embodiment shown below, which has been annotated to show the edges of the shape and distances D1 and D2 from the die corner to and edge of the shape.



EX1001-Figure 5-exerpt-annotated

As such, PO's arguments for its proposed construction of Claim Term 3 fails. Based on the foregoing, the Board should therefore reject all of PO's overly narrow constructions.

IV All Grounds

The majority of POs arguments are based on new and improper claim constructions. Thus, these arguments fail when claims are properly construed.

V Ground 4 Devnani – AAPA renders Claims 1, 2, 4 and 5 obvious

i. Claim 1

PO's state that even if the Board rejects their proposed Claim Term 1 claim construction, that Devnani-AAPA does not render claim 1 obvious. POR at 36. These arguments under Section V.A.1.a(iii) of the POR are thus being made under the improper proposed constructions regarding Claim Terms 2 and 3, and thus fail. Further, even under the improperly narrow construction, Claims 1, 2, 4 and 5 are obvious over Devnani-AAPA.

Dr. Baker provided several reasons why a POSITA would combine Devnani and AAPA. EX1002, ¶73-77, 108-12; Pet. at 24-27, 39-42. PO do not address any of them. Instead, PO argues under their incorrect constructions that there is no motivation to combine Devnani with AAPA because Petitioner relies on "the disadvantages of the purported AAPA solution" and cites sections of the Petition regarding claim 8. POR at 40. This is incorrect. The Petition does not use any disadvantages of the purported AAPA solution in Ground 4 regarding claim 1. Pet. 36-42.

The Petition does state that "A POSITA implementing the semiconductor package of Devnani would have good reason to look to AAPA to route signal traces away from a high stress area associated with the corner of a die as they both are in the same field of semiconductor packages.…the corner of the die and the ball pads near

the corner of the die experience the most stress during thermal cycling. Thus, a POSITA would have been motivated to move traces away from high stress areas to prevent trace cracking." Pet. at 24.

The Petition further states "[a] POSITA would have been motivated…to select a high stress zone that is larger than the AAPA Solution to reduce potential damage to signal traces of a package during thermal cycling. A POSITA would have been motivated to select dimensions of such a high stress zone based upon an analysis of thermal expansion characteristics of die 100, the package 300, and a PCB upon which the package mounts as these characteristics were all well known as evidenced by the AAPA and the numerous contemporaneous references discussed above." Pet. at 26-27.

Thus, the motivation to combine was not based on the admitted disadvantage of the 1mm circle of the AAPA solution. In contrast, the disadvantage confirms that a POSITA, applying basic engineering, would conclude that 1mm may not be enough and would consider the distance of two ball pad pitches or **any** distance greater than 1mm. PO's Expert, Dr. Bernstein, confirmed this interpretation. 158:21-159:2-6.

Further, it was known at the time of the '245 Patent that a ball pad pitch could be .5mm. EX1024, 5, Table 7. As the '245 Patent did not state a range of ball pad pitches, a POSITA would understand that, when the ball pad pitch in the AAPA was .5mm, "two ball bad pitches" would be 1mm. A POSITA would have found it obvious

to use any existing ball pitches, .5mm included, in the AAPA as necessitated by the design constraints of the IC package. Pet. at 26-27. EX1002, ¶24-25,112.

Thus, a slightly larger distance, such as 1.1mm, would be a distance greater than 1mm and would be obvious to POSITA to use such an area (simply expanding the known area would be obvious to try a POSITA trying to reduce signal trace cracking) based on a thermal cycling analysis. In fact, the POSITA would have known that Celeron discloses removing ball pads (areas of stress) 3.1mm away (i.e., 6.2 ball pad pitches for a .5mm ball pad pitch) from a die corner, which was greater than a distance of two ball pad pitches (2.54mm) for Celeron's package. Thus, ball pad pitches larger than two would have been obvious.

Further, AAPA is broader than the existing 1mm solution. As laid out in the Petition, AAPA included warpage from thermal excursions, known stress around the die corner, and stress near ball pads. Pet. at 23-27, 38-41; EX1002, ¶46-47, 52-57, 73-77, 107,108, 111.

ii. Claim 2

PO further argues Petitioner has not shown how Devnani-AAPA renders claim 2 obvious. POR at 44. Not so. Petitioners showed how Devnani inherently teaches routing signals away from an area around the die corner, AAPA in one example taught a specific distance of 1mm, and that the prior art knowledge available to a POSITA

showed it was well known that thermal characteristics of the package was a source of stress that could crack signal traces and to keep signal traces away from such an area. Therefore, it would have been obvious to a POSITA to route signals away from any high stress areas, including one defined by "two ball pad pitches", which as shown by EX1024, would equal 1mm, the same distance as the AAPA solution.

iii. Claim 4

Petitioner's Expert stated it would have been obvious to a POSITA to combine Devnani and AAPA to arrive at the limitations of claim 4. EX1002, ¶115-16; Pet. at 43-44. PO does not rebut Expert's reasoning. Thus, claim 4 should be found unpatentable.

iv. Claim 5

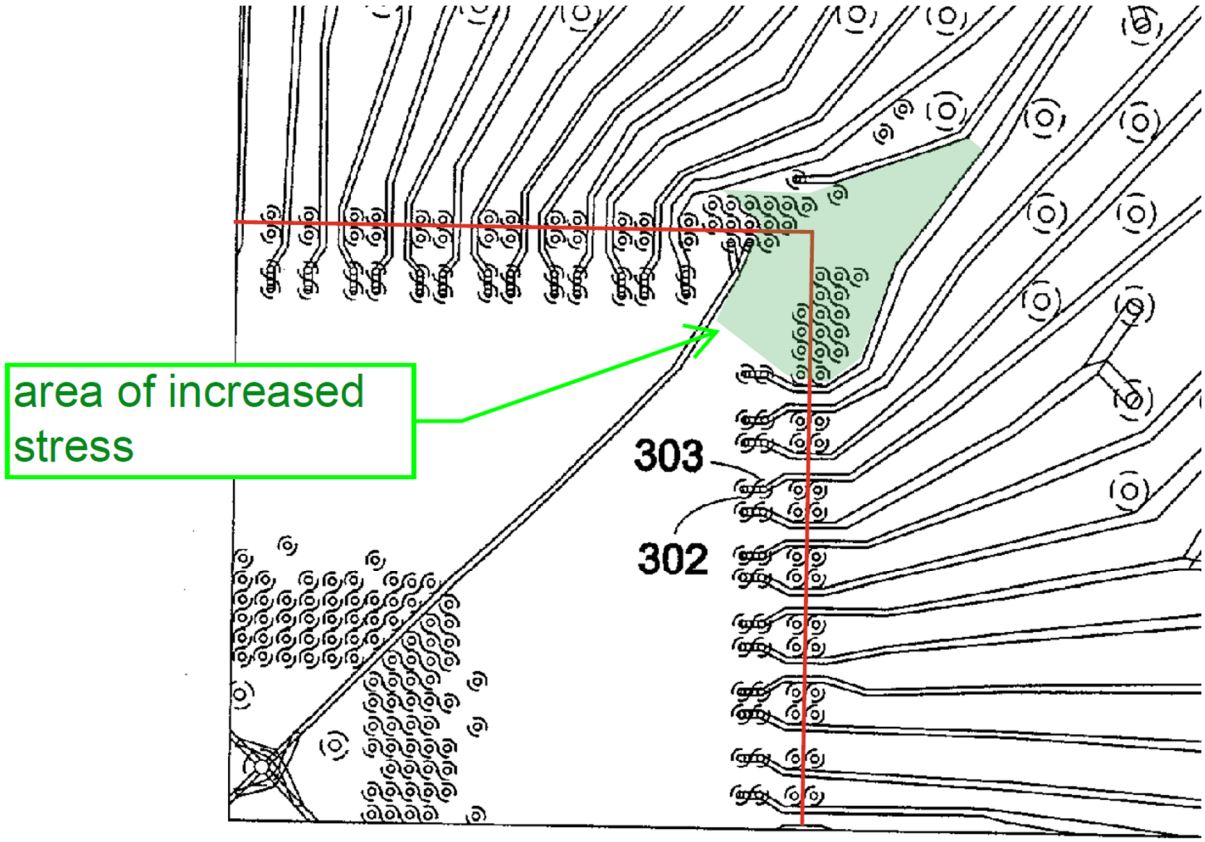
PO does not raise any additional argument for claim 5 beyond its dependance from independent claim 1. Thus, claim 5 is unpatentable for the reasons set forth in the Petition. Pet. at 30-32, 44; EX1002, ¶85-87, 117-20.

VI Ground 1 – Devnani-AAPA renders Claim 8 obvious

PO argues that even if the Board rejects the (improperly narrow) proposed constructions, it would not have been obvious to define the "surrounding area of increased stress" as "an area within two ball pad pitches of the corner of the die" POR at 54. Not so.

As discussed above with reference to Ground 4, the disadvantage was not relied upon for motivation, but for defining the distance of "two ball pad pitches". As the prior art showed ball pad pitches could be .5mm, two ball pad pitches would be a distance of 1mm. Celeron discloses moving stress points further than 2 ball pad pitches away (i.e., 6.2). Thus, it would have been obvious to a POSITA to route signals away from the die corner 1mm, which is two ball pad pitches or slightly larger (e.g., up to 3.1mm away from die corner) to avoid routing signal traces near stresses near the die corner that could cause signal traces to crack.

Further, A POSITA would have picked any distance where stresses near the die corner would cause signal traces to crack, which could result in a non-circular shape. As the AAPA solution used a distance of 1mm, it would have been obvious to simply expand that based on the thermal characteristics of the Devnani-AAPA package. In fact, Devnani shows in Figure 3 an absence of signal traces in a non-circular area as shown below.



EX1025-exerpt of Figure 3 of EX1005-annotated

VII Ground 6 – Devnani-AAPA-Tanahashi renders claim 6 obvious

Both Petitioner's Expert and the Examiner during prosecution stated Tanahashi taught a voltage bus bar. Pet. at 45; EX1002, ¶92-95, 124-28; EX1004, 314. PO's conclusory assertions do not rebut this evidence.

VIII Ground 7 – Chung-Celeron renders Claims 1, 2 and 5 obvious

i. Claim 1

The arguments PO puts forth rely on improper claim constructions. However, even under these improper constructions, Chung-Celeron renders claim 1, 2 and 5 obvious.

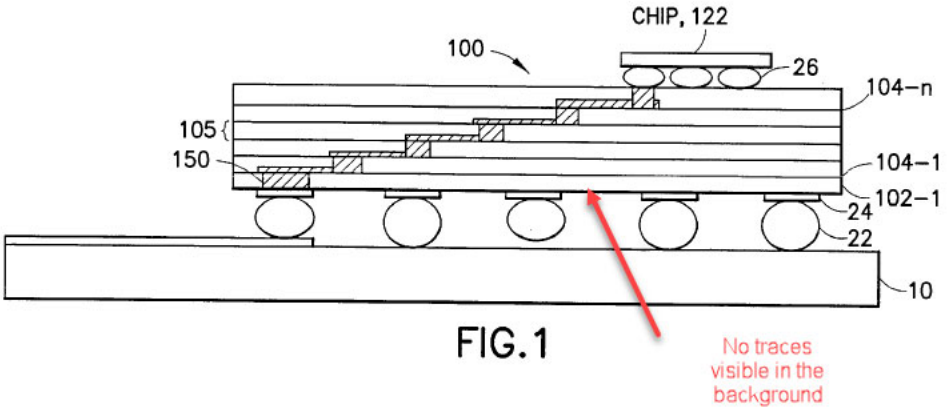
PO's claim none of the references teach the vertical and horizonal layers would be associated with increased stress. POR at 64. Not so. Chung itself explains there are "CTE mismatches between the die and the vertical section" and "CTE mismatches between the vertical and horizontal sections". EX1006, ¶75-76.

PO's claim there would be no motivation to combine because "the horizontal section in Chung" converts "the pitch along the x-axis from the bond pad pitch of the IC" to a larger pitch at the bottom of the horizontal section. POR at 65. This is misleading. The "larger" pitch is in comparison to a pitch on the bottom of the IC, not expanding a first smaller pitch to a second larger pitch on the bottom of the horizontal

section. This pitch difference in IC pad pitch versus solder bump pitch was known as stated by Dr. Baker in his deposition. Ex. 2004, 72:19-73:3.

IX Grounds 5 and 8 – Devnani-AAPA-Pillai/Chung-Celeron-Pillai renders Claim 3 obvious

PO's assertion that Pillai's FIG. 1 is insufficient to prove there are no traces on Pillai's bond pad layer is wrong. PO fails to appreciate that, if there were traces not in the cut plane, those traces would be visible in the background between bond pads. No such traces are shown.



EX1007 – FIG. 1 – annotated

Additionally, even if Pillai fails to disclose no traces whatsoever on the ball pad layer, Pillai at least teaches using vias to have no traces on a portion of the ball pad layer. This teaching is still relevant. As described in the Petition, a POSITA would have found it obvious to use Pillai's teaching regarding using vias to route metal traces away

from the ball pad layer to "NOT have metal traces on the ball pad layer" to "reduce potential damage to metal traces [] during thermal cycling." Pet, 32-33.

X Ground 9 – Chung-Celeron-AAPA renders Claim 4 obvious

PO does not raise any additional argument for claim 4 beyond its dependance from independent claim 1. Thus, claim 4 is unpatentable for the reasons set forth in the Petition. Pet. at 44, 57-58; EX1002, ¶149-53.

XI Ground 10 – Chung-Celeron-Tanahashi renders Claim 6 obvious

See Supra Section VII. PO's conclusory assertions do not rebut this evidence.

XII Ground 11 – Devnani-Celeron renders Claims 1 and 5 obvious

i. Claim 1

PO's only arguments rely on their improper claim construction. Thus, these arguments fail.

ii. Claim 5

PO does not raise any additional argument for claim 5 beyond its dependance from independent claim 1. Thus, claim 5 is unpatentable for the reasons set forth in the Petition. Pet. at 61, 44; EX1002, ¶163.

XIII Ground 12 – Devnani-Celeron-Tanahashi renders Claim 6 obvious

See Supra Section VII. PO's conclusory assertions do not rebut this evidence.

XIV Conclusion

Based on the foregoing, Petitioner respectfully requests the Board find the challenged claims unpatentable.

Respectfully Submitted,

Dated: November 13, 2024

By: /Timothy D. Taylor/
Timothy D. Taylor (Reg. No. 76,643)
Counsel for Petitioner

CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), the undersigned hereby certifies that the foregoing **PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE** contains 5,586 words, excluding the parts exempted under 37 C.F.R. § 42.24(c)(1), as measured by the word-processing system used to prepare this paper.

Respectfully Submitted,

Dated: November 13, 2024

By: /Timothy D. Taylor/
Timothy D. Taylor (Reg. No. 76,643)
Counsel for Petitioner

CERTIFICATE OF SERVICE

I hereby certify that on November 13, 2024, Petitioner's Reply to Patent Owner's Response was filed on P-TACTs today and served via electronic service on the counsel of record for Patent Owner Bell Semiconductor, LLC; Bell-NXP-IPR@devlinlawfirm.com.

Devlin Law Firm LLC
1526 Gilpin Avenue
Wilmington, DE 19806

Lead Counsel

Jason M. Shapiro, Reg. No. 35,354
jshapiro@devlinlawfirm.com

Back-Up Counsel

Timothy Devlin, Reg. No. 41,706
tdevlin@devlinlawfirm.com

Andrew Sherman, Reg. No. 74,042
asherman@devlinlawfirm.com

Respectfully Submitted,

Dated: November 13, 2024 By: /Timothy D. Taylor/

Timothy D. Taylor (Reg. No. 76,643)
Counsel for Petitioner