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Entered: September 6, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SILERGY CORPORATION,
Petitioner,

v.

MONOLITHIC POWER SYSTEMS, INC.,
Patent Owner.

Case IPR2015-00803
Patent 8,283,758 B2

Before MICHAEL R. ZECHER, CHRISTOPHER L. CRUMBLEY, and DANIEL J. GALLIGAN, *Administrative Patent Judges*.

ZECHER, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. BACKGROUND

Petitioner, Silergy Corporation ("Silergy"), filed a Petition requesting an *inter partes* review of claims 1–7 of U.S. Patent No. 8,283,758 B2 (Ex. 1001, "the '758 patent"). Paper 1 ("Pet."). Patent Owner, Monolithic Power Systems, Incorporated ("Monolithic"), filed a Preliminary Response. Paper 5 ("Prelim. Resp."). We also authorized Silergy to file a Reply that was tailored narrowly to address its position that it timely served the Petition and supporting evidence on Monolithic. Paper 6, 3–4. Silergy filed its Reply. Paper 7. Taking into account the arguments presented in Monolithic's Preliminary Response and Silergy's Reply, we first determined that the Petition was served timely, and then determined that the information presented in the Petition established that there was a reasonable likelihood that Silergy would prevail in challenging claim 5 of the '758 patent as unpatentable under 35 U.S.C. § 102(b), and claims 1–4, 6, and 7 as unpatentable under 35 U.S.C. § 103(a). Pursuant to 35 U.S.C. § 314, we instituted this *inter partes* review proceeding on September 11, 2015, as to all the challenged claims. Paper 9 ("Dec. on Inst.").

During the course of trial, Monolithic filed a Patent Owner Response (Paper 11, "PO Resp.") and Silergy filed a Reply to the Patent Owner Response (Paper 13, "Pet. Reply"). Monolithic also filed a Motion for Observation regarding certain cross-examination testimony of Silergy's rebuttal witness, Dr. R. Jacob Baker (Paper 18, "Obs."), and Silergy filed a Response to Monolithic's Motion for Observation (Paper 21, "Obs. Resp.").

An oral hearing was held on May 11, 2016, and a transcript of the hearing is included in the record. Paper 26 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 1–7 of the '758 patent. For the reasons discussed below, we hold that Silergy has demonstrated by a preponderance of the evidence that claim 5 of the '758 patent is unpatentable under § 102(b), and claims 1–4, 6, and 7 are unpatentable under § 103(a).

A. Related Matters

The '758 patent has been asserted in a district court case titled *Monolithic Power Sys., Inc. v. Silergy Corp.*, No. 3:14-cv-01745-VC (N.D. Cal.). Pet. 1; Paper 4, 2. In addition to this Petition, Silergy filed another petition challenging the patentability of claims 1–8, 10, and 11 of U.S. Patent No. 8,361,899 B2 ("the '899 patent"). Pet. 2 n.1; Paper 4, 2. In that case, we instituted an *inter partes* review only as to claims 1–8 and 10 of the '899 patent. *Silergy Corp. v. Monolithic Sys., Inc.*, Case IPR2015-00804, slip op. at 23–24 (PTAB Sept. 15, 2015) (Paper 10).

B. The '758 Patent

The '758 patent, titled "Microelectronic Packages with Enhanced Heat Dissipation and Methods of Manufacturing," issued October 9, 2012, from U.S. Patent Application No. 12/970,729, filed on December 16, 2010. Ex. 1001, at [54], [45], [21], [22]. As the title suggests, the '758 patent generally relates to microelectronic packages with enhanced heat dissipation and associated methods of manufacturing and operation. *Id.* at 1:7–9.

According to the ’758 patent, a semiconductor die typically generates a significant amount of heat that can cause structural or functional failure in microelectronic packages if the heat is not dissipated adequately. *Id.* at 1:29–32. In the prior art arrangement illustrated in Figure 1, a semiconductor die attach adhesive typically provides an adequate thermal path to allow the leads to conduct heat away from the die. *Id.* at 1:32–35. In other applications, however, the semiconductor die may be attached to leads in a flip-chip arrangement with solder balls or bumps, which may not be capable of providing an adequate thermal path to dissipate the heat generated by the die. *Id.* at 1:35–40.

The ’758 patent purportedly addresses this problem by providing several improvements for enhancing heat dissipation in microelectronic packages. Ex. 1001, 1:40–42. In particular, Figure 5 of the ’758 patent, reproduced below, illustrates a schematic cross-sectional diagram of a microelectronic package in accordance with the disclosed invention. *Id.* at 1:58–60.

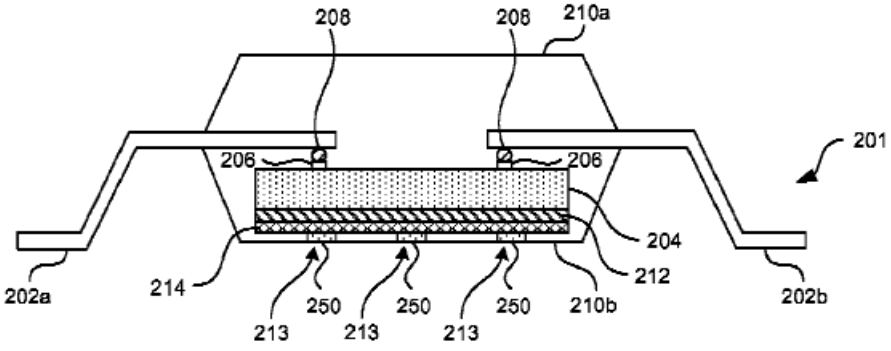


FIG. 5

As shown in Figure 5, electronic package 200 (not labeled) includes lead frame 201, semiconductor die 204, and encapsulant 210a and 210b at least partially encapsulating the lead frame and semiconductor die. Ex. 1001, 2:25–29, 3:36–39, Fig. 5. Semiconductor die 204 has a plurality of bond sites 206 at first side 204a (not labeled). *Id.* at 2:54–55, Fig. 5. Bond sites 206 are coupled to electronic couplers 208, which, in turn, are coupled to corresponding lead fingers 202a and 202b of lead frame 201. *Id.* at 2:55–58, Fig. 5. In at least one embodiment, electrical couplers 208 may include solder balls attached to bond sites 206. *Id.* at 2:58–59, Fig. 5.

The '758 patent further discloses that semiconductor die 204 may include barrier material 212 and thermally conductive material 214 on second side 204b (not labeled) of semiconductor die 204. Ex. 1001, 3:1–3, Fig. 5. Encapsulant 210b may include a plurality of openings 213 that individually expose a portion of thermally conductive material 214. *Id.* at 6:1–4. Openings 213 may be filled with solder paste 250 or other suitable conductive materials before being attached to carrier substrate 220 (not labeled). *Id.* at 6:6–8.

C. Illustrative Claim

Of the challenged claims, only claims 1 and 5 are independent. Both independent claims 1 and 5 are directed to a microelectronic package. Claims 2–4 directly depend from independent claim 1; and claims 6 and 7 directly depend from independent claim 5. Independent claim 1 is illustrative of the challenged claims and is reproduced below:

> 1. A microelectronic package, comprising:
>
> a semiconductor die having a bond site at a first side and a second side opposite the first side, the semiconductor die further including a thermally conductive material formed on the second side of the semiconductor die;
>
> a lead frame proximate the semiconductor die, the lead frame having a lead finger;
>
> a solder ball between the bond site of the semiconductor die and the lead finger, the solder ball forming an electrical connection between the bond site of the semiconductor die and the lead finger of the lead frame;
>
> an encapsulant at least partially encapsulating the semiconductor die, the lead frame, and the solder ball, the encapsulant having a first surface opposite a second surface, and the encapsulant also including a plurality of openings extending toward the semiconductor die from the second surface; and
>
> wherein the plurality of openings individually expose a portion of the thermally conductive material and the thermally conductive material is generally solderable.

Ex. 1001, 6:20–40.

D. Prior Art Relied Upon

Silergy relies upon the following prior art references:

Inventor	**U.S. Patent No.**	**Dates**	**Exhibit No.**
Lin ("Lin '556")	5,508,556	issued Apr. 16, 1996, filed Sept. 2, 1994	1004
Bayan[1]	7,705,476 B2	issued Apr. 27, 2010, filed Nov. 6, 2007	1005

[1] For clarity and ease of reference, we only list the first named inventor.

E. Instituted Grounds of Unpatentability

We instituted this proceeding based on the asserted grounds of unpatentability ("grounds") set forth in the table below. Dec. on Inst. 22–23.

Reference(s)	**Basis**	**Claim(s) Challenged**
Lin '556	§ 102(b)	5
Lin '556 and Bayan	§ 103(a)	1–4, 6, and 7

II. ANALYSIS

A. Claim Construction

In an *inter partes* review proceeding, claim terms are given their broadest reasonable interpretation in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142–46 (2016) (upholding the use of the broadest reasonable interpretation standard as the claim construction standard to be applied in an *inter partes* review proceeding). Under the broadest reasonable interpretation standard, we generally give claim terms their ordinary and customary meaning, as would be understood by one of ordinary skill in the art, in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). A claim term, however, "will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the disputed claim term in either the specification or prosecution history." *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002). Although the patentee indeed is free to define the specific claim terms used to describe his

or her invention, "this must be done with reasonable clarity, deliberateness, and precision." *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In its Petition, Silergy proposed a construction for each of the following claim terms or phrases: (1) "thermally conductive material" (all challenged claims); (2) "formed on the second side of the semiconductor die" (all challenged claims); (3) "generally solderable" (all challenged claims); (4) "barrier material" (claim 2); and (5) "in series" (claims 2 and 5–7). Pet. 9–13. In its Preliminary Response, Monolithic asserted that each of these claims terms or phrases should be accorded its ordinary and customary meaning. Prelim. Resp. 8. Monolithic then separately addressed Silergy's construction of "formed on the second side of the semiconductor die" and proposed an alternative construction for this claim phrase. *Id.* at 8–12. We determined in the Decision on Institution that we need only assess the constructions offered by the parties for the claim phrase "formed on the second side of the semiconductor die" because this was the only claim phrase that needed to be construed to resolve a controversy between the parties. Dec. on Inst. 10 (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (only those terms or phrases that are in controversy need to be construed, and only to the extent necessary to resolve the controversy)).

In the Decision on Institution, we agreed with Monolithic that no explicit construction of the claim phrase "formed on the second side of the semiconductor die" was necessary beyond its ordinary and customary meaning. Dec. on Inst. 11–13. We, however, took the opportunity to clarify

that, based on the limited record at that time—particularly, the specification of the '758 patent and the testimony of Silergy's expert witness, Professor R. Jacob Baker, Ph.D.—"formed on" included any one of the following: (1) chemical vapor deposition ("CVD"); (2) atomic layer deposition ("ALD"); (3) other suitable deposition techniques; (4) screen-printing; (5) adhesively attaching; or (6) bonding. *Id.* (citing Ex. 1001, 4:45–53, 5:30–45; Ex. 1003 ¶ 47).

In its Patent Owner Response, Monolithic reiterates the same assertion it presented in its Preliminary Response—namely, this claim phrase should be accorded its ordinary and customary meaning. PO Resp. 9–10. Monolithic then argues that, because "formed on" has a separate and distinct meaning from "preformed" to one of ordinary skill in the art in the context of the '758 patent, "formed on" should be limited to deposition techniques for forming thermally conductive material 214 on second side 204b of semiconductor die 204, such as CVD, ALD, and other suitable deposition techniques. *Id.* at 10–26. To support this argument, Monolithic directs us to the specification of the '758 patent, dictionary definitions for "form" and "preform," and the testimony of its expert witness, Joseph C. McAlexander III, P.E. *Id.* (citing Ex. 1001, 4:39–54, 5:30–45, 6:41–45, Fig. 3B; Ex. 2001 ¶¶ 29–57, App'x B). In its Reply, Silergy contends that we should maintain our construction of the claim phrase "formed on the second side of the semiconductor die" in the Decision on Institution and, despite Monolithic's assertions to the contrary, we should not limit this claim phrase to only those

deposition operations described in a single embodiment in the specification of the '758 patent. Pet. Reply 2–11.

Based on the record developed during trial, we discern no reason to alter our construction of the claim phrase "formed on the second side of the semiconductor die" for the purposes of this Final Written Decision. As we explained in the Decision on Institution, the parties' dispute regarding the claim phrase "formed on the second side of the semiconductor die" centers on the scope and meaning of "formed on." Dec. on Inst. 11. Both parties agree with our initial determination that the specification of the '758 patent does not set forth an explicit definition of "formed on." PO Resp. 11 (citing Dec. on Inst. 11); Pet. Reply 3 (citing the same). We, therefore, refer to its ordinary and customary meaning, as would be understood by one of ordinary skill in the art, in the context of the entire disclosure of the '758 patent. *See Translogic*, 504 F.3d at 1257.

Focusing first on the intrinsic record of the '758 patent, the parties direct us to Figure 3B and its corresponding description in the specification. Figure 3B, reproduced below, illustrates a partial schematic, cross-sectional view of a semiconductor die and lead frame undergoing an assembly process suitable for forming a semiconductor package. Ex. 1001, 1:51–54, 4:25–29.

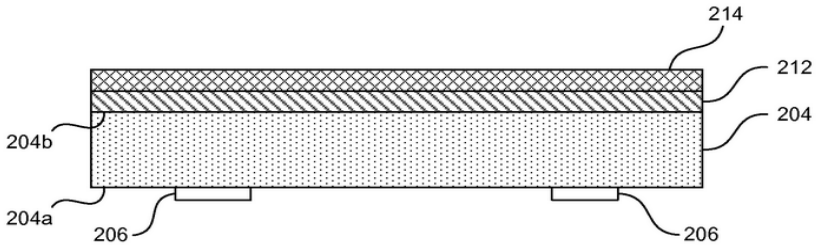


FIG. 3B

The ’758 patent describes Figure 3B as follows:

> FIG. 3B shows a further deposition operation, in which the thermal conductive material 214 is *formed on* the optional barrier material 212. In one embodiment, the thermally conductive material 214 including a titanium/nickel/silver (Ti/Ni/Ag) tri-metal alloy may be formed using CVD, ALD, sputtering, electro-deposition, and/or other suitable techniques. In other embodiments, the thermally conductive material 214 may be screen-printed, adhesively attached, and/or otherwise bonded to the optional barrier material 212.

Ex. 1001, 4:45–53 (emphasis added).

According to Monolithic, Figure 3B and its corresponding description disclose the following two mutually exclusive methods for creating thermally conductive material 214: (1) the “formed on” method that includes a deposition technique for forming thermally conductive material 214 on second side 204b of semiconductor die 204, such as CVD, ALD, and other suitable deposition techniques; and (2) the “preformed” method that includes a non-deposition technique for affixing preformed thermally conductive material 214 on second side 204b of semiconductor die 204, such as screen-printing, adhesively attaching, bonding, or fastening. PO Resp. 11–13. In its Reply, Silergy contends that, because the specification of the ’758 uses variations of the word “form” to describe different aspects of the manufacturing of a semiconductor package, limiting “formed on” as it relates to thermally conductive material 214 to only deposition techniques, as asserted by Monolithic, does not account for the full breadth of this claim phrase and unduly limits its scope to a single embodiment. Pet. Reply 2–8.

As an initial matter, we do not agree with Monolithic that Figure 3B and its corresponding description clearly teaches two mutually exclusive methods for creating thermally conductive material 214. *See* PO Resp. 11–13. Notably absent from the description of Figure 3B reproduced above is an explicit reference to a "preformed" method. Indeed, the only reference in this description of Figure 3B is to thermal conductive material 214 being "formed on" the barrier material 212. Applying the broadest reasonable interpretation standard, each of the embodiments discussed in relation to Figure 3B falls within the purview of the "formed on" method because this is the only method identified in the description of Figure 3B.

We recognize that there is at least one instance in the specification of the '758 patent where Figure 3B is referenced explicitly followed by a general discussion of both deposition techniques and "preformed" methods. This portion of the specification states, "[w]ith reference to FIGS. 3A-3D, the thermally conductive material 214 is described as having a material deposited onto the optional barrier material 212, in other embodiments, the thermally conductive material 214 may be preformed and fastened to the semiconductor die 204 using other suitable mechanisms." Ex. 1001, 5:30–35. Under Monolithic's interpretation, the former embodiment is the "formed on" method and the latter embodiments are the "preformed" methods. This portion of the specification, however, is followed immediately by a description of the "preformed" methods only in relation to Figures 3E and 3F. *Id.* at 5:35–45. The ambiguity surrounding this general reference to Figure 3B ("FIGS. 3A-3D") followed by the subsequent

description of "preformed" methods only in relation to Figures 3E and 3F, is best explained by highlighting a discussion between counsel for Monolithic and the panel during oral argument.

During oral argument, counsel for Monolithic asserted that Figures 3A and 3B illustrate the "formed on" method, whereas Figures 3E and 3F illustrate the "preformed" methods. Tr. 18:22–19:9, 20:22–25. As pointed out during the oral argument, Figure 3B clearly illustrates that thermally conductive material 214 may be formed on barrier material 212 using any one of CVD, ALD, other suitable deposition techniques, screen-printing, adhesively attaching, or bonding. Figures 3E and 3F, however, do not illustrate thermally conductive material 214 at all. Instead, Figures 3E and 3F illustrate preformed thermally conductive foil 216 attached to optional conductive material 212, and preform 230 attached to second side 204b of semiconductor die 204, respectively. Tr. 23:12–24:3. Although we acknowledge this might by an inadvertent omission of thermally conductive material 214 in the draftsmanship of Figures 3E and 3F, it nonetheless injects ambiguity as to whether the discussion regarding screen-printing, adhesively attaching, or bonding thermally conductive material 214 to barrier material 212, as illustrated in Figure 3B, is somehow constrained to the "preformed" methods discussed in relation to Figures 3E and 3F.

In its Patent Owner Response, Monolithic further contends that dependent claim 2 recites, in relevant part, "the barrier material . . . formed on the second side of the semiconductor die . . . ." PO Resp. 23 (citing Ex. 1001, 6:41–45). Monolithic argues that, because the specification of the

'758 patent only discloses forming the barrier material using a deposition technique, "formed on" as recited in the independent claims should not be construed to include screen printing, adhesively attaching, or bonding. *Id.* at 23–24 (citing Ex. 1001, 2:13–21, 4:39–44). In its Reply, Silergy contends that the '758 patent uses "formed on" in the following contexts: (1) to describe the formation of thermally conductive material 214; and (2) to describe the formation of barrier material 212. Pet. Reply 10. Silergy then argues that one reasonable way to construe "formed on" in these two contexts is as follows: (1) "formed on" as its relates to thermally conductive material 214 includes each of the six techniques disclosed in the specification of the '758 patent and construed by us in the Decision on Institution; and (2) "formed on" as it relates to barrier material 212 includes each of the deposition techniques disclosed in the specification. *Id.* at 10–11.

Although we agree with Silergy that the claim phrase "formed on" as used in the independent claims and dependent claim 2 involves two different contexts, these contexts have subtle differences. That is, "formed on" as recited in the independent claims is used to describe the formation of thermally conductive material 214 on second side 204b of semiconductor die 204, whereas "formed on" as recited in dependent claim 2 is used to describe the formation of both barrier material 212 and thermally conductive material 214 on second side 204b of semiconductor die 204. *Compare* Ex. 1001, 6:22–24, *with id.* at 6:42–45. The relevant portion of the specification of the '758 patent, however, confirms that "formed on" as it relates to barrier

material 212 is not limited to just deposition techniques, as asserted by Monolithic. According to the specification, "formed on" in the context of barrier material 212 "*can* include" CVD, ALD, or other suitable deposition techniques. Ex. 1001, 4:39–44 (emphasis added). Given this permissive language, i.e., "can include," the formation of barrier material 212 on second side 204b of semiconductor die 204 is not limited to just deposition techniques, but also may include other techniques, such as adhesively attaching or bonding. We, therefore, see no reason why the claim phrase "formed on" cannot be understood to have the same meaning across two different contexts.

In summary, upon consulting the intrinsic evidence in its entirety, we reach the following conclusions: (1) Figure 3B and its corresponding description in the specification of the '758 patent refer to a "formed on" method and do not mention a separate and distinct "preformed" method (Ex. 1001, 4:45–53); (2) Monolithic's position regarding the description of Figure 3B, particularly screen-printing, adhesively attaching or bonding, and its purported application to the "preformed" methods discussed in relation to Figures 3E and 3F is ambiguous, at best; and (3) there is no discernable reason that "formed on" in the context of the independent claims and dependent claim 2 cannot have the same meaning. For all these reasons, we agree with Silergy that the intrinsic evidence supports our initial construction of the claim phrase "formed on" in the Decision on Institution. *See* Pet. Reply 2–11.

Turning now to the extrinsic evidence, although the U.S. Court of Appeals for the Federal Circuit has instructed that this type of evidence may be useful in determining the meaning of a particular claim term to one of ordinary skill in the art, it is "less significant than the intrinsic [evidence] in determining the 'legally operative meaning of disputed claim language.'" *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 862 (Fed. Cir. 2004) (quoting *Vanderlande Indus. Nederland BV v. Int'l Trade Comm'n*, 366 F.3d 1311, 1318 (Fed. Cir. 2004)). The parties direct us to the following two classes of extrinsic evidence to support their positions: (1) dictionary definitions of "form," "form on," and "preform;" and (2) the testimony of their expert witnesses.

With respect to the dictionary definitions presented by the parties, Monolithic contends that the definitions of "form" and "preform" highlight the difference between the "formed on" method and "preformed" methods purportedly disclosed in the specification of the '758 patent. PO Resp. 26. Monolithic asserts that MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY (10th ed., 2002) defines "form" as "to give form or shape to: fashion, construction," whereas this same dictionary defines "preform" as "to form or shape beforehand." *Id.* (citing Ex. 2001 ¶ 36, App'x B). In its Reply, Silergy contends that, because the dictionary supplied by Monolithic defines "form on" as "to take up a formation next to," this definition supports our initial construction of "formed on" as including each of the six techniques disclosed in the specification of the '758 patent that thermally conductive material 214 "takes up a formation next to" second side 204b of

semiconductor die 204. Pet. Reply 3–4 (emphasis omitted) (citing Ex. 2001, App'x B; Dec. on Inst. 13). Silergy also argues that "formed" and "preformed" are not mutually exclusive terms because this same dictionary confirms that "preform" is a sub-category of "formed"—namely, "to form or shape beforehand." *Id.* at 9 (citing the same). We have reviewed the dictionary definitions presented by both parties, but we do not view them as dispositive in ascertaining the scope and meaning of "formed on" because each of these definitions can reasonably be read to support both parties' claim construction positions.

With respect to the testimony of each parties' expert witness, on the one hand, Silergy directs us to the testimony of Dr. Baker to support its assertion that the claim phrase "formed on" should not be limited to deposition techniques for forming thermally conductive material 214 on second side 204b of semiconductor die 204, but instead should also include screen-printing, adhesively attaching, or bonding. Pet. 10–11 (citing Ex. 1003 ¶¶ 46–49). On the other hand, Monolithic directs us to the testimony of Mr. Alexander to support its assertion that claim phrase "formed on" should be limited to deposition techniques for forming thermally conductive material 214 on second side 204b of semiconductor die 204. PO Resp. 13 (citing Ex. 2001 ¶¶ 29–57).

Upon reviewing the cited testimony from each expert witness, we are reluctant to credit one expert witness over the other because each expert witness, to some extent, offers conclusory, unsupported assertions. For instance, Silergy's expert witness, Dr. Baker, testifies that the specification

of the '758 patent broadly describes how thermally conductive material 214 is "formed on" second side 204b of semiconductor die 204 (Ex. 1003 ¶ 47), but this general assertion does little to expand upon what we are able to glean from the intrinsic evidence ourselves. Similarly, Monolithic's expert witness, Mr. Alexander, testifies that "formed on" has a clear meaning to one of ordinary skill in the art that is separate and distinct from "preform" (Ex. 2001 ¶¶ 34, 35), but Mr. Alexander's testimony in this regard does not explain adequately how one of ordinary skill in the art would arrive at this conclusion in light of the entire disclosure of the '758 patent, as discussed in our analysis of the intrinsic evidence above. Given that each expert witness offers testimony of marginal relevance, we see no added benefit in relying on this class of extrinsic evidence to ascertain the scope and meaning of the claim phrase "formed on."

In conclusion, upon weighing all the evidence bearing on the construction of "formed on," the parties' extrinsic evidence does not overcome the intrinsic evidence, particularly Figure 3B of the '758 patent and its corresponding description in the specification. We, therefore, decline Monolithic's invitation to alter our construction of the claim phrase "formed on the second side of the semiconductor die" for the purposes of this Final Written Decision. Consequently, applying the broadest reasonable interpretation, we maintain that "formed on" in the context of the entire disclosure of the '758 patent includes any one of the following: (1) CVD; (2) ALD; (3) other suitable deposition techniques; (4) screen-printing; (5) adhesively attaching; or (6) bonding.

B. Anticipation by Lin '556

Silergy contends that independent claim 5 is anticipated under § 102(b) by Lin '556. Pet. 15–21. In particular, Silergy explains how Lin '556 purportedly describes the subject matter of this challenged claim. *Id.* Silergy also relies upon the Declaration of Dr. Baker accompanying the Petition (Ex. 1003 ¶¶ 60–71) and Dr. Baker's Rebuttal Declaration accompanying the Reply (Ex. 1025 ¶¶ 3–5) to support its positions. In its Patent Owner Response, Monolithic presents two arguments with respect to independent claim 5. PO Resp. 26–38. Monolithic relies upon Mr. McAlexander's Declaration to support its positions. Ex. 2001 ¶¶ 58–68.

We begin our analysis with the principles of law that generally apply to a ground based on anticipation, followed by a brief overview of Lin '556, and then we address to the parties' contentions with respect to independent claim 5.

1. Principles of Law

To establish anticipation, "all of the elements and limitations of the claim must be shown in a single prior reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001). "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros., Inc. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). We analyze this asserted ground based on anticipation with the principles stated above in mind.

2. Lin '556

Lin '556 generally relates to a semiconductor device and, in particular, to a leaded semiconductor device having accessible power supply pad terminals underneath the package body. Ex. 1004, 1:16–19. Figure 2 of Lin '556, reproduced below, illustrates a cross-sectional view of leaded plastic encapsulated semiconductor device 50 having ground solder bumps. *Id.* at 1:61–63, 4:19–21.

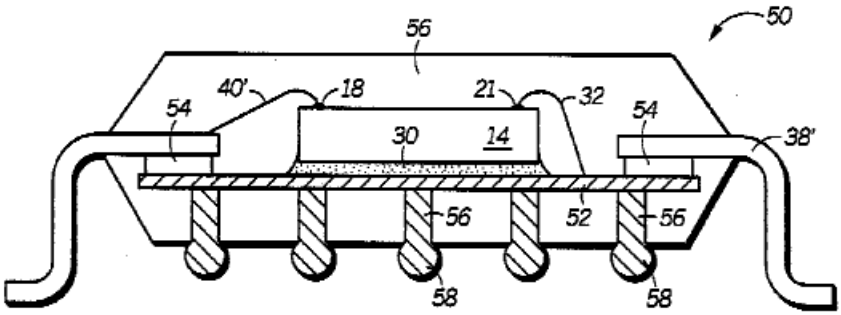


FIG.2

As shown in Figure 2 of Lin '556, semiconductor device 50 includes semiconductor die 14 mounted onto ground plane 52, which is nonplanar with leads 38′. Ex. 1004, 4:22–23. Ground plane 52 serves as the die mounting surface so that the lead frame, itself, does not have a die pad or flag. *Id.* at 4:23–26. Adhesive 30, which is preferably thermally conductive, is used to attach semiconductor die 14 to ground plane 52. *Id.* at 4:26–28. Ground plane 52 is large enough so that it extends below the internal portion of leads 38′ and attaches to the underside of these leads with electrically insulative material 54. *Id.* at 4:29–32. Signal bonding pad 18 of semiconductor die 14 is connected to leads 38′ with wire bond 40′. *Id.* at 4:34–35. Ground bonding pad 21 is connected to ground plane 52 with wire

bonds 32. *Id.* at 4:37–39. According to Lin '556, a plurality of ground bonding pads are present on semiconductor die 14, and these ground bonding pads are connected to ground plane 52. *Id.* at 4:39–41.

Figure 2 of Lin '556 further illustrates that plastic package body 56 encapsulates semiconductor die 14, bonding wires 40′ and 32, ground plane 52, and a portion of leads 38′. Ex. 1004, 4:45–48. Package body 56 has a plurality of apertures in the bottom half of the body. *Id.* at 4:50–51. The apertures allow external access to ground plane 52. *Id.* at 4:56–58. Ground solder bumps 58 extend from the apertures and provide external electrical connections to ground plane 52. *Id.* at 4:58–60.

3. Claim 5

In its Petition, Silergy contends that Lin '556's semiconductor die 14, ground plane 52 attached to thermally conductive adhesive 30, leads 38/38′, package body 56, and plurality of apertures describe the "semiconductor die," "thermally conductive material," "lead frame," "encapsulant," and "plurality of openings," recited in independent claim 5, respectively. Pet. 15–18 (citing to Ex. 1004, Fig. 2).

In its Patent Owner Response, Monolithic contends that Lin '556 does not disclose the following two limitations recited in independent claim 5: (1) "a thermally conductive material formed on the second side of the semiconductor die"; and (2) "the thermally conductive material is generally solderable." PO Resp. 27–36. We address each limitation in turn.

a. Lin '556 describes "a thermally conductive material formed on the second side of the semiconductor die"

Independent claim 5 recites, in relevant part, "a thermally conductive material formed on the second side of the semiconductor die." Ex. 1001, 6:60–61.

In its Petition, Silergy argues that Lin '556's disclosure of using thermally conductive adhesive 30 to attach semiconductor die 14 to ground plane 52 describes "a semiconductor die having a first side and a second side opposite the first side, the semiconductor die further including a thermally conductive material formed on the second side of the semiconductor die in series," as recited in independent claim 5. Pet. 16, 18 (citing Ex. 1004, 4:22–28, Fig. 2; Ex. 1003 ¶¶ 62, 63).

In its Patent Owner Response, Monolithic essentially repeats its claim construction argument that "formed on" should be limited to deposition techniques for forming thermally conductive material 214 on second side 204b of semiconductor die 204, such as CVD, ALD, and other suitable deposition techniques. PO Resp. 28. According to Monolithic, Lin '556 only discloses using thermally conductive adhesive 30 to attach semiconductor die 14 to ground plane 52 and, therefore, cannot anticipate its construction of "formed on." *Id.* at 29 (citing Ex. 2001 ¶¶ 29–57).

In its Reply, Silergy counters that, if we maintain our construction of "formed on" as set forth in the Decision on Institution, we should also maintain that Lin '556's disclosure of using thermally conductive adhesive 30 to attach semiconductor die 14 to ground plane 52 describes "thermally

conductive material formed on the second side of the semiconductor die," as recited in independent claim 5. Pet. Reply 11 (citing Ex. 1004, 4:19–28; Dec. on Inst. 16).

In our claim construction section above, we maintained our construction of "formed on" as set forth in the Decision on Institution. *See supra* Section II.A. That is, we determined that no explicit construction of the claim phrase "formed on the second side of the semiconductor die" was necessary beyond its ordinary and customary meaning. *Id.* We also clarified that "formed on" in the context of the entire disclosure of the '758 patent includes any one of the following: (1) CVD; (2) ALD; (3) other suitable deposition techniques; (4) screen-printing; (5) adhesively attaching; or (6) bonding. *Id.* Consistent with this construction, Lin '556 discloses using thermally conductive adhesive 30 to attach semiconductor die 14 to ground plane 52. Ex. 1004, 4:22–28, Fig. 2. We, therefore, agree with Silergy that Lin '556 describes "a thermally conductive material formed on the second side of the semiconductor die," as recited in independent claim 5. *See* Pet. 16, 18.

To the extent that Monolithic argues that independent claim 5 is patentable over Lin '556 because this claim distinguishes between layers created using different processes, we do not agree. *See* PO Resp. 28–29. The recitation "formed on" is a product-by-process limitation. It is well settled that the scope of a product-by-process claim for infringement purposes is limited by the process; however, when determining patentability the claim is considered only in view of the resulting product. *Amgen Inc. v.*

F. Hoffman-La Roche Ltd., 580 F.3d 1340, 1370 n.14 (Fed. Cir. 2009) (stating that "a patent is invalid if a product made by the process recited in a product-by-process claim is anticipated by or obvious from prior art products, even if those prior art products are made by different processes"). In other words, a product-by-process limitation generally does not impart patentability to a claim. Only if the process of manufacture results in "structural and functional differences" in the product can the process distinguish the claim over the prior art. *Id.* at 1370; *see also Greenliant Sys., Inc. v. Xicor LLC*, 692 F.3d 1261, 1268 (Fed. Cir. 2012) (stating the same).

Upon considering the record in its entirety, we are not persuaded that the "microelectronic package" of independent claim 5 exhibits structural and functional differences that may be relied upon to distinguish it over Lin '556 semiconductor package. Consequently, even if we were to adopt Monolithic's proposed construction that independent claim 5 is limited to microelectronic packages made using deposition techniques for forming thermally conductive material 214 on second side 204b of semiconductor die 204, such as CVD, ALD, and other suitable deposition techniques, the evidence of record does not demonstrate that the resulting microelectronic package is a unique structure that operates in a functionally distinct manner. We, therefore, conclude that the invention embodied in independent claim 5, particularly "a thermally conductive material formed on the second side of the semiconductor die," is not distinct either structurally or functionally from Lin '556 semiconductor package, which, as explained above, uses thermally conductive adhesive 30 to attach semiconductor die 14 to ground plane 52.

b. Lin '556 describes "the thermally conductive material is generally solderable"

Independent claim 5 recites, in relevant part, "the thermally conductive material is generally solderable." Ex. 1001, 7:5–6.

In its Petition, Silergy contends that, because Lin '556's apertures allow external accessibility to ground plane 52, and its solder bumps 58 are made from solder paste that fill apertures 56 to provide a direct electrical path, Lin '556 describes "the thermally conductive material is generally solderable," as claimed. Pet. 17–18 (citing Ex. 1004, 4:56–58, 4:60–62, Fig. 2). In addition, Silergy argues that one of ordinary skill in the art would have understood that thermally conductive material, such as Lin '556's ground plane 52, was "generally solderable" because solder paste is used to provide a direct electrical path, and this solder paste would be reflowed by heating when "subsequently mounted to appropriate pads on a board." *Id.* at 21 (citing Ex. 1004, 4:62–63; Ex. 1003 ¶¶ 64–66, 70). Silergy also argues that the ground planes disclosed in Lin '556 may be a metal mesh or plane, and metals are well-known to be "readily attachable with a solder." *Id.* at 21 (citing Ex. 1004, 5:8–14, Ex. 1003 ¶¶ 50, 52, 70).

In its Patent Owner Response, Monolithic contends that neither Silergy nor its expert witness, Dr. Baker, identify an explicit disclosure in Lin '556 stating that ground plane 52 is "generally solderable." PO Resp. 32. Monolithic argues that, although Lin '556 discloses various electrical and thermal connections to ground plane 52, it is silent as to the type of material used in the ground plane that would be useful to one of ordinary skill in the art in determining whether it is made of solderable material. *Id.*

at 32–33 (citing Ex. 1004, 4:22–32, 4:37–41, 4:58–62). In addition, Monolithic argues that, because Lin '556 does not mention a reflow process, much less whether ground plane 52 is attached to solder during such a process, one of ordinary skill in the art would not reach the same conclusion as Silergy that Lin '556's ground plane 52 was "generally solderable." *Id.* at 34–35 (citing Ex. 2001 ¶¶ 67, 68).

In its Reply, Silergy counters that Monolithic does not address, much less rebut, the testimony of Dr. Baker in his Declaration accompanying the Petition that metal ground planes, such as Lin '556's ground plane 52, are "generally solderable" because it is made of metal and most solderable materials are metals, or at least contain metal. Pet. Reply 12 (citing Ex. 1004, 3:35–38, 5:8–14; Ex. 1003 ¶¶ 32, 65, 66). Silergy argues that Monolithic and its expert witness, Mr. McAlexander, do not identify a single material property of Lin '556's ground plane 52 other than metal. *Id.* at 13. Silergy also directs us to the testimony of Dr. Baker in his Rebuttal Declaration, in which he attests that, in his thirty (30) years of academic and professional experience, he is not aware of a ground plane in a semiconductor device that is not metallic and not solderable. *Id.* (citing Ex. 1025 ¶¶ 3, 4).

Lin '556 discloses that solder bumps 58, which provide external electrical connections to ground plane 52, are made from solder paste that fill apertures 56 to provide a direct electrical path. Ex. 1004, 4:58–62. Monolithic correctly notes, however, that this cited disclosure in Lin '556 is silent as to the material properties of ground plane 52. *See* PO Resp. 32.

The Federal Circuit, nonetheless, has recognized that "a reference can anticipate a claim even if it 'd[oes] not expressly spell out' all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would 'at once envisage' the claimed arrangement or combination." *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015) (citing *In re Petering*, 301 F.2d 676, 681 (CCPA 1962)). Here, we agree with Silergy that a person of ordinary skill in the art, upon reading Lin '556, would at once envisage that ground plane 52 is "generally solderable" because it is capable of being joined to solder bumps 58 that are made of solder paste in order to create external electrical connections. *See* Pet. 21.

Our understanding in this regard, which is derived from the second embodiment in Lin '556 relied upon by Silergy in its Petition to account for all the limitations recited in independent claim 5 (Pet. 15–18 (citing the second embodiment illustrated in Fig. 2)), is further supported by the description of Lin '556's other embodiments. For instance, when discussing the first embodiment, Lin '556 explicitly mentions "the *metallurgy* of the ground plane." Ex. 1004, 3:35–37 (emphasis added). When discussing the third embodiment, Lin '556 acknowledges that this embodiment differs from the second embodiment in that "ground plane 62 is composed of a *metallic mesh* instead of a solid plane." *Id.* at 5:11–14 (emphasis added). It is clear from both the first and third embodiments disclosed in Lin '556 that each ground plane is metallic and, therefore, "generally solderable." *See* Ex. 1003 ¶ 32 (stating that, because "solder is a metallic substance, most

solderable materials are also metals, or contain metal"). Given that the ground planes of the first and third embodiments disclosed in Lin '556 are metallic, we see no reason to believe that ground plane 52 discussed in Lin '556's second embodiment relied upon by Silergy in its Petition is anything other than metallic and, therefore, "generally solderable."

Lastly, we find Dr. Baker's supporting testimony on this particular issue to be persuasive. Ex. 1003 ¶¶ 64–66, 70; Ex. 1025 ¶¶ 3, 4. Indeed, Dr. Baker attests that, "during my 30 years of experience with semiconductors and semiconductor packaging, I have never encountered a ground plane that is not metallic and not solderable." Ex. 1025 ¶ 4. We credit Dr. Baker's testimony on this particular issue because it is consistent with the disclosures in Lin '556 discussed above. We, therefore, agree with Silergy that Lin '556 properly accounts for "the thermally conductive material is generally solderable," as recited in independent claim 5. *See* Pet. 17–18, 21.

c. Lin '556 describes the remaining limitations

In its Patent Owner Response, Monolithic does not address separately whether Lin '556 describes the remaining limitations recited in independent claim 5. *See generally* PO Resp. 26–38. We have reviewed Silergy's explanations and supporting evidence as to how Lin '556 describes these remaining limitations, and we agree with and adopt Silergy's analysis. *See* Pet. 15–21.

d. Summary

Based on the record developed during trial, we conclude that Silergy has demonstrated by a preponderance of the evidence that independent claim 5 is anticipated by Lin '556.

C. Obviousness Based on the Combination of Lin '556 and Bayan

Silergy contends that claims 1–4, 6, and 7 are unpatentable under § 103(a) over the combination of Lin '556 and Bayan. Pet. 22–40. Silergy explains how this proffered combination purportedly teaches the subject matter of each challenged claim. *Id.* Silergy also relies upon the Declaration of Dr. Baker accompanying the Petition (Ex. 1003 ¶¶ 72–125) and Dr. Baker's Rebuttal Declaration accompanying the Reply (Ex. 1025 ¶¶ 6–14) to support its positions. In its Patent Owner Response, Monolithic presents numerous arguments. PO Resp. 38–53. Monolithic relies upon Mr. McAlexander's Declaration to support its positions. Ex. 2001 ¶¶ 69–103.

We begin our analysis with the principles of law that generally apply to a ground based on obviousness, followed by an assessment of the level of skill in the art, then a brief overview of Bayan, and finally we turn to the arguments presented by the parties.

1. Principles of Law

A claim is unpatentable under § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of

obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) when in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). We analyze this asserted ground based on obviousness with the principles identified above in mind.

2. Level of Skill in the Art

There is sufficient evidence in the record before us that reflects the knowledge level of a person with ordinary skill in the art. Silergy's expert witness, Dr. Baker, attests that a person with ordinary skill in the art in the relevant time frame would be an individual who (1) possesses a bachelor's degree in electrical engineering, computer engineering, or a related field; and (2) has at least one or two years of experience in semiconductor packaging. Pet. 8 (citing Ex. 1003 ¶¶ 24, 25). Patent Owner's expert witness, Mr. McAlexander, essentially agrees with Dr. Baker's assessment, except Mr. McAlexander attests that a person of ordinary skill in the art should have at least three years of experience in semiconductor packaging. *Compare* Ex. 1003 ¶ 25, *with* Ex. 2001 ¶ 25. Even if we were to determine that the number of years of experience in semiconductor packaging required to satisfy the level of the skill in the art is at least three years, both Dr. Baker and Mr. McAlexander exceed this requirement. Ex. 1003 ¶¶ 6–15; Ex. 2001 ¶¶ 9–15, App'x A; Ex. 1015.

In addition, we note that the prior art of record in this proceeding—namely, Lin '556 and Bayan—is indicative of the level of ordinary skill in the art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995).

3. Bayan

Bayan generally relates to the packaging of integrated circuits ("ICs") and, in particular, to an exposed IC die package having improved thermal performance. Ex. 1005, 1:5–7. Figure 1A of Bayan, reproduced below, illustrates a cross-sectional side view of IC package 100. *Id.* at 2:49–52, 3:26–27.

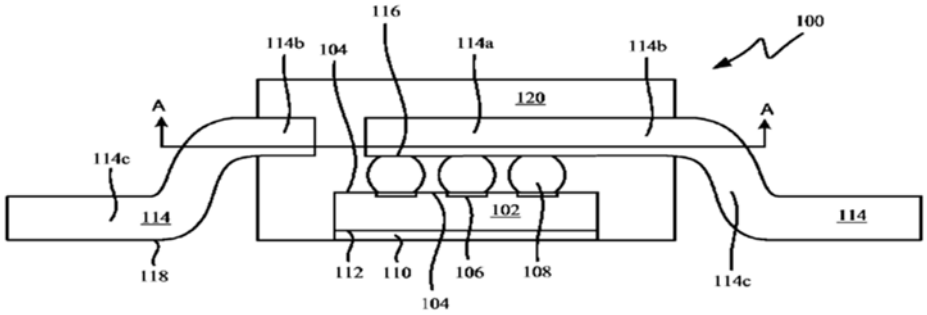


FIG. 1A

As shown in Figure 1A, IC package 100 includes IC die 102 having active surface 104, which, in turn, includes a plurality of bond pads 106. Ex. 1005, 3:32–36. IC die 102 further includes thin metallic layer 110 deposited onto back surface 112 of the die. *Id.* at 3:44–46. Metallic layer 110 serves as a heat dissipation medium for transferring thermal energy out of IC die 102. *Id.* at 3:52–54. IC package 100 also includes a lead frame having a plurality of leads 114 and 115. *Id.* at 3:64–64. The inner portions of leads 114a and 115a include at least one conductive solder pad 116. *Id.* at

4:34–35. These inner portions of the leads are arranged such that solder pads 116 are positioned over corresponding bond pads 106 on active surface 104 of IC die 102. *Id.* at 4:35–38. Each bond pad 106 is connected physically or electrically to one of leads 114 or 115 with solder balls 108. *Id.* at 4:38–40.

4. Claim 1

In its Petition, Silergy contends that Lin '556 teaches each limitation recited in independent claim 1, except "a solder ball between the bond site of the semiconductor die and the lead finger, the solder ball forming an electrical connection between the bond site of the semiconductor die and the lead finger of the lead frame." Pet. 23–34. Silergy turns to Bayan's solder balls 108 as teaching this limitation. *Id.* at 25, 29–31. Silergy then explains why it would have been obvious to one of ordinary skill in the art to combine the teachings of Lin '556 and Bayan. *Id.* at 22–23, 30–33. In its Patent Owner Response, Monolithic contends that Silergy only provides conclusory statements that the challenged claims are obvious, and does not articulate a sufficient reasoning with a rational underpinning that would support a conclusion of obviousness. PO Resp. 40–46.

As an initial matter, Monolithic does not dispute that the combined teachings of Lin '556 and Bayan account for all the limitations recited in independent claim 1. *See generally* PO Resp. 38–51. We have reviewed Silergy's arguments and supporting evidence in this regard, and we agree with and adopt Silergy's analysis. *See* Pet. 23–34. We now turn to the

parties' dispute as to whether Silergy has presented a sufficient rationale to combine the teachings of Lin '556 and Bayan.

In its Petition, Silergy contends that it would have been obvious to one of ordinary skill in the art to replace Lin '556 wire bonds 40/40′ with Bayan's solder balls 108. Pet. 30. To support this argument, Silergy directs us to testimony from its expert witness, Dr. Baker, who explains that solder balls were old and well-known in the art long before they were used in Bayan. *Id.* (citing Ex. 1003 ¶¶ 27, 28). Silergy then asserts that incorporating Bayan's solder balls into Lin '556 semiconductor package would have been a simple substitution of one known element for another—in this case, Bayan's solder balls 108 for Lin '556's wire bonds 40/40′—to achieve a predictable result. *Id.* (citing *KSR*, 550 U.S. at 415–21; Ex. 1003 ¶ 89). Moreover, Silergy contends that Bayan explicitly supports this conclusion of obviousness because it discloses that the current carrying and heat dissipation capabilities of solder balls far exceed those of bonding wires. *Id.* at 30–31 (citing Ex. 1005, 5:42–56). As such, Silergy asserts that incorporating Bayan's solder balls 108 would not only predictably result in improving the heat dissipation and electrical performance of Lin '556's semiconductor package, but also would do so in a predictable way. *Id.* (citing *KSR*, 550 U.S. at 401; Ex. 1003 ¶ 90).

In its Patent Owner Response, Monolithic contends that it would not have been obvious to replace Lin '556 wire bonds 40/40′ with Bayan's solder balls 108. PO Resp. 40. According to Monolithic, because Lin '556 already teaches using solder bumps 58 protruding from the bottom side of

semiconductor device 50, it clearly understood the difference between solder bumps and wire bonds and, therefore, its choice of using wire bonds instead of solder balls was purposeful. *Id.* at 40–42 (citing Ex. 1004, Figs. 1, 2). Monolithic asserts that using solder balls instead of wire bonds in Lin '556's semiconductor package would not bridge the gap between signal leads 38/38′ and bond sites 18 and, therefore, does not qualify as a simple substitution. *Id.* at 42 (citing Ex. 2001 ¶ 80). In addition, Monolithic argues that substituting Bayan's solder balls 108 for Lin '556's wire bonds 40/40′ would require significant structural changes to Lin '556's semiconductor package, such as increased package height, which, according to Monolithic, leads to unpredictable results. *See id.* at 43–45 (citing Ex. 2001 ¶¶ 83–86).

In its Reply, Silergy essentially repeats the arguments presented in its Petition. *Compare* Pet. Reply 19–20, *with* Pet. 30–31. In addition, Silergy contends that Monolithic's assertion that the choice of wire bonds instead of solder balls in Lin '556 was purposeful is incorrect because certain claims of Lin '556 allow electrical connections other than wire bonds between the bond sites and the lead fingers. *Id.* at 20. Silergy further argues that Monolithic's assertion that substituting Bayan's solder balls 108 for Lin '556's wire bonds 40/40′ would lead to significant structural changes in Lin '556 semiconductor package is speculative, at best, and based on unsubstantiated attorney argument and expert opinion. *Id.* at 21–22. Lastly, Silergy argues that Monolithic's assertion that the proposed combination of Lin '556 and Bayan would result in a taller semiconductor package is based

on the mistaken premise that a particular combination must be preferred or optimal in order for the combination to be obvious. *Id.* at 22–23.

The relevant inquiry here is whether Silergy has set forth "some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006), *cited with approval in KSR*, 550 U.S. at 418. When describing examples of what may constitute articulated reasoning with some rational underpinning that would support a conclusion of obviousness, the Supreme Court recognized that the simple substitution of one known element for another is likely to be obvious if it does no more than yield predictable results. *See KSR*, 550 U.S. at 416–17.

Upon considering the record in its entirety, we determine that the rationale to combine the teachings of Lin '556 and Bayan presented by Silergy and its expert witness, Dr. Baker, suffices as articulated reasoning with rational underpinnings that supports the conclusion of obviousness. Pet. 30 (citing Ex. 1003 ¶ 89). Silergy presents undisputed evidence, in the form of testimony from Dr. Baker, that the use of solder balls was old and well-known in the relevant art to connect electrically the leads of a lead frame to external circuitry, such as a semiconductor die. Ex. 1003 ¶ 27. Silergy also directs us to an explicit disclosure in Bayan that one of ordinary skill in the art would have appreciated that "the current carrying and heat dissipation capabilities of solder ball joints far exceed those of bonding wires." Ex. 1005, 5:42–55. Taking into account the testimony from Dr. Baker regarding the established function of solder balls, as well as Bayan's

acknowledgement that using solder balls instead of wire bonds improves electrical performance, we conclude that the mere substitution of Bayan's solder balls 108 for Lin '556's wire bonds 40/40′ predictably uses prior art elements according to their established function—an obvious improvement. *See KSR*, 550 U.S. at 416–17.

We do not agree with Monolithic's argument that Silergy's proposed combination would not render independent claim 1 obvious because Lin '556's choice of using wire bonds instead of solder balls was purposeful. *See* PO Resp. 40–42. Regardless of whether the choice of wire bonds instead of solder balls in Lin '556 was purposeful, this has little bearing on whether one with ordinary skill in the art would have recognized that solder balls are a viable substitute for wire bonds. To some extent, Monolithic's discussion in this regard appreciates that wire bonds and solder balls indeed are interchangeable components, yet Lin '556 simply chose wires bonds instead of solder balls. This perceived interchangeability is reinforced further by the testimony from Dr. Baker regarding the established function of solder balls, as well as the explicit reference in Bayan that one of ordinary skill in the art would have appreciated that using solder balls instead of wire bonds improves electrical performance. Ex. 1003 ¶ 27; Ex. 1005, 5:42–44.

We also do not agree with Monolithic's argument that substituting Bayan's solder balls 108 for Lin '556's wire bonds 40/40′ would require significant structural changes to Lin '556's semiconductor package, such as increased package height, that would preclude a conclusion of obviousness. *See* PO Resp. 43–45. The Federal Circuit has recognized that "a given

course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate [a rationale] to combine." *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). Along the same lines, "[t]he fact that the motivating benefit comes at the expense of another benefit, however, should not nullify its use as a basis to modify the disclosure of one reference with the teachings of another. Instead, the benefits, both lost and gained, should be weighed against one another." *Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 n.8 (Fed. Cir. 2000).

In this case, although using solder balls instead of wire bonds in Lin '556's semiconductor package may involve certain tradeoffs, this, by itself, does not prevent Silergy's proposed combination. As instructed by the Federal Circuit, we must weigh the advantages and disadvantages associated with using solder balls instead of wire bonds in Lin '556's semiconductor package. Beginning with the advantages, once again, Bayan discloses that one of ordinary skill in the art would have appreciated that using solder balls instead of wire bonds improves electrical performance. Ex. 1005, 5:42–55. In addition, Silergy's expert witness, Dr. Baker, testifies that Monolithic and its expert witness, Mr. McAlexander, "fail[] to acknowledge that the height of a semiconductor package varies depending upon its application." Ex. 1025 ¶ 14. For example, Dr. Baker testifies that even Figure 3A of the '758 patent "describes the variables that are used to determine the target thickness." *Id.* (citing Ex. 1001, 4:29–39). According to Dr. Baker, when evaluating the impact of using Bayan's solder balls 108 instead of Lin '556's

wire bonds 40/40′ in Lin ’556’s semiconductor package, “[such a combination] would result in an almost imperceptible height increase of the semiconductor package.” *Id.* ¶ 13.

Turning to the disadvantages, the “Background of the Invention” section in Lin ’556 provides a few disparaging remarks regarding increasing the size of a semiconductor package. *See, e.g.*, Ex. 1004, 1:34–37 (stating a desire not to “unduly increase package size”), 1:48–50 (stating that, “[because] the industry trend is toward miniaturization where possible, a large size packaged device can pose design problems when board space is limited”). In addition, Monolithic’s expert witness, Mr. McAlexander, testifies that “[i]t well known that minimizing package height is a priority in semiconductor design, and [Silergy’s proposed] combination would increase package height.” Ex. 2001 ¶ 83.

When weighing these advantages and disadvantages, on balance, we determine the improved electrical performance achieved by using Bayan’s solder balls 108 instead of Lin ’556 wire bonds 40/40′ in Lin ’556’s semiconductor package outweighs the disadvantages associated with an increase in the height of this package. The primary driver of our determination in this regard is that, apart from asserting that such a substitution may result in increasing the height of Lin ’556’s semiconductor package, Monolithic does not present sufficient or credible evidence that Lin ’556 semiconductor package would become inoperable. Absent evidence to the contrary, we are satisfied that one of ordinary skill in the art would have accepted a purported increase in the height of Lin ’556’s semiconductor

package in exchange for the improved electrical performance achieved by using Bayan's solder balls 108.

Based on the record developed during trial, we conclude that Silergy has demonstrated by a preponderance of the evidence that independent claim 1 is unpatentable over the combination of Lin '556 and Bayan.

5. Claims 2–4

In its Patent Owner Response, Monolithic relies upon the same arguments presented against independent claim 1 to rebut Silergy's explanations and supporting evidence as to how the combination of Lin '556 and Bayan teaches the subject matter of dependent claims 2–4. *See* PO Resp. 38–51. For the same reasons discussed above with respect to independent claim 1, we do not agree with Monolithic's arguments.

We have reviewed Silergy's arguments and supporting evidence set forth in the Petition regarding dependent claims 2–4, and we agree with and adopt Silergy's analysis. *See* Pet. 34–38. Based on the record as developed during trial, we conclude that Silergy has demonstrated by a preponderance of the evidence that these dependent claims are unpatentable over the combination of Lin '556 and Bayan.

6. Claims 6 and 7

Dependent claims 6 and 7 each recite, in relevant part, "the thermally conductive material includes a titanium/nickel/silver (Ti/Ni/Ag) tri-metal alloy." Ex. 1001, 7:8–9, 8:2–13.

In its Petition, Silergy contends that the combined teachings of Lin '556 and Bayan account for this disputed limitation. Pet. 38. In particular,

Silergy argues that Lin '556's ground plane 52 attached to thermally conductive adhesive 30 accounts for "the thermally conductive material," whereas Bayan discloses a metal alloy of titanium, nickel, and silver. *Id.* at 38–39 (citing Ex. 1005, 3:44–54); *see also id.* at 23–24, 28 (arguing Lin '556's ground plane 52 attached to thermally conductive adhesive 30 teaches "the thermally conductive material"). In further support of its argument, Silergy directs us to the testimony of its expert witness, Dr. Baker, who explains that using various metal alloys in semiconductor packaging, such as a titanium, nickel, and silver tri-metal alloy, was old and well-known in the art. *Id.* at 39 (citing Ex. 1003 ¶ 30). Silergy then asserts that it would have been obvious to one of ordinary skill in the art to incorporate Bayan's titanium, nickel, and silver tri-metal alloy into Lin '556's semiconductor package because this would be nothing more than combining known prior art elements to achieve predictable results, which includes improved adhesion, heat transfer, solderability, and electrical conductivity. *Id.* (citing Ex. 1003 ¶ 118; *KSR*, 550 U.S. at 401). Silergy relies upon the same assertions and conclusion to support its contention that the combination of Lin '556 and Bayan renders the same limitation recited in dependent claim 7 unpatentable. *Compare* Pet. 40, *with id.* at 38–39.

In its Patent Owner Response, Monolithic contends that Lin '556 discloses that the metal that should be used is "preferably gold, palladium-silver, or other metallization materials with wire-bondable surface finishing." PO Resp. 52–53 (citing Ex. 1004, 2:57–65). Monolithic also argues that Silergy's expert witness, Dr. Baker, does not state that Ti/Ni/Ag

has wire-bondable surface finishing. *Id.* (citing Ex. 2001 ¶ 102). For at least these reasons, Monolithic asserts that the combination of Lin '556 and Bayan does not account properly for "titanium/nickel/silver (Ti/Ni/Ag) tri-metal alloy" composition of the thermally conductive material, as required by dependent claims 6 and 7. *Id.* at 53.

In its Reply, Silergy contends that Monolithic misleadingly omits a quote from the portion of Lin '556 relied upon by Silergy in its Petition, which states, in relevant part, that "[t]hese conductors may be of any suitably conductive metals." Pet. Reply 24 (citing Ex. 1004, 2:61–63). Silergy also argues that Lin '556 does not require that its metals have "wire-bondable surface finishing," as asserted by Monolithic, but instead explains that "[m]ethods of wire bonding are known in the art." *Id.* (citing Ex. 1004, 3:35–38).

We agree with Silergy that the combined teachings of Lin '556 and Bayan properly account for "titanium/nickel/silver (Ti/Ni/Ag) tri-metal alloy" composition of the thermally conductive material, as required by dependent claims 6 and 7. *See* Pet. 38–40. Lin '556 discloses that conductors, one of which includes a ground plane, "may be of any suitably conductive metals." Ex. 1004, 2:61–63. As just one example of what may constitute "any suitably conductive metals," Bayan discloses a metal "alloy of titanium, nickel and silver." Ex. 1005, 3:48–50. Dr. Baker indeed confirms that a titanium, nickel, and silver tri-metal alloy was old and well-known in the relevant art as an adhesive promoter. Ex. 1003 ¶ 30. Based on the cited disclosures in Lin '556 and Bayan, as well as Dr. Baker's relevant

testimony regarding the established function of titanium/nickel/silver tri-metal alloy, we are satisfied that one of ordinary skill in the art would have understood that Lin '556's ground plane, such as ground plane 52 attached to thermally conductive adhesive 30 illustrated in Figure 2, is capable of including a titanium, nickel, and silver tri-metal alloy.

To the extent Monolithic argues that Lin '556 alone does not teach the "titanium/nickel/silver (Ti/Ni/Ag) tri-metal alloy" composition of the thermally conductive material, as required by dependent claims 6 and 7, Monolithic's argument is misplaced. *See* PO Resp. 52–53. As we explained above, Silergy does not rely solely on the teachings of Lin '556, but instead relies upon the combined teachings of Lin '556 and Bayan, as well as the supporting testimony of Dr. Baker, to account for this claim limitation. *See* Pet. 38–39.

To the extent Monolithic argues that the metal disclosed in Lin '556 should be limited to gold, palladium-silver, or other metallization materials with wire-bondable surface finishing, we do not agree. *See* PO Resp. 52–53. Monolithic either overlooks or ignores Lin '556's disclosure that conductors, one of which includes a ground plane, may be made of "*any suitably conductive metals*". Ex. 1004, 2:61–65 (emphasis added). It is clear from this cited disclosure that the metals that make up conductors, such as ground plane 52 attached to thermally conductive adhesive 30 illustrated in Figure 2 of Lin '556, are not limited to gold, palladium-silver, or other metallization materials with wire-bondable surface finishing, but instead may include any suitable conductive metals, such as titanium/nickel/silver tri-metal alloy.

Based on the record developed during trial, we conclude that Silergy has demonstrated by a preponderance of the evidence that dependent claims 6 and 7 are unpatentable over the combination of Lin '556 and Bayan.

7. Silergy Performs a Proper Graham Analysis

In its Patent Owner Response, Monolithic contends that Silergy does not perform a proper *Graham* analysis because it fails to determine (1) the scope and content of Lin '556 and Bayan; (2) the difference between the teachings of these prior art references and claims 1–4, 6, and 7; and (3) the level of skill in the art at the time of the invention. PO Resp. 53–55.

In its Reply, Silergy counters—and we agree—that Monolithic's argument is without merit because it performed a proper *Graham* analysis. Pet. Reply 25. We are satisfied that Silergy and its expert witness, Dr. Baker, applied the relevant factors because (1) they analyze the scope and content of Lin '556 and Bayan; (2) they analyze the differences between the teachings of these prior art references and claims 1–4, 6, and 7, and explain why the subject matter of each challenged claim in light of those differences would have been obvious; and (3) they provide an assessment of the level of skill in the art. Pet. 22–40; Ex. 1003 ¶¶ 22–40. Regarding the final *Graham* factor, Monolithic must first present argument or evidence as to secondary considerations of non-obviousness that may be weighed against Silergy's asserted evidence of obviousness. In this case, because Monolithic does not present argument or evidence regarding secondary considerations of non-obviousness in its Patent Owner Response, Silergy had no obligation to raise any such argument or evidence on its own accord.

D. Monolithic's Motion for Observation

Monolithic filed a Motion for Observation on the cross-examination testimony of Silergy's rebuttal witness, Dr. Baker (Ex. 2002). Obs. Silergy, in turn, filed a Response. Obs. Resp. To the extent Monolithic's Motion for Observation pertains to testimony purportedly impacting Dr. Baker's credibility, we have considered Monolithic's observations and Silergy's responses in rendering this Final Written Decision, and we have accorded Dr. Baker's rebuttal testimony appropriate weight where necessary. *See* Obs. 3–5; Obs. Resp. 1–4.

On their face, Silergy's responses labeled "Petitioner's Observation Number 5" and "Petitioner's Observation Number 6" do not respond to any of Monolithic's "Observation Number[s] 1–4." Obs. Resp. 4–5. As such, we did not consider Silergy's responses labeled "Petitioner's Observation Number 5" and "Petitioner's Observation Number 6" because they are contrary to the guidance we provided in the Scheduling Order. *See* Paper 10, 5 (instructing that "[t]he opposing party may respond to the observation," which does not amount to authorizing the opposing party to file new, additional observations with its response).

III. CONCLUSION

Silergy has demonstrated by a preponderance of the evidence that: (1) claim 5 of the '758 patent is anticipated under § 102(b) by Lin '556; and (2) claims 1–4, 6, and 7 of the '758 patent are unpatentable under § 103(a) over the combination of Lin '556 and Bayan.

IV. ORDER

In consideration of the foregoing, it is

ORDERED that claims 1–7 of the ’758 patent are held to be unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to this proceeding seeking judicial review of our decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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