UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SILERGY CORPORATION

Petitioner

v.

MONOLITHIC POWER SYSTEMS, INC.

Patent Owner

Patent No. 8,361,899

Title: MICROELECTRONIC FLIP CHIP PACKAGES WITH SOLDER WETTING PADS AND ASSOCIATED METHODS OF MANUFACTURING

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,361,899 CHALLENGING CLAIMS 1-8 AND 10-11

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EXHIBIT LIST

Exhibit #	*Description*
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Ex. 1002	File History of U.S. Patent No. 8,361,899
Ex. 1003	Declaration of Professor R. Jacob Baker, Ph.D.
Ex. 1004	U.S. Patent No. 8,129,229 to Sirinorakul et al. ("Sirinorakul")
Ex. 1005	U.S. Patent No. 7,049,683 to Sirinorakul et al. ("Sirinorakul '683")
Ex. 1006	U.S. Patent No. 7,691,670 to Eslamy et al. ("Eslamy")
Ex. 1007	U.S. Patent No. 6,593,545 to Greenwood et al. ("Greenwood")
Ex. 1008	U.S. Patent No. 6,482,680 to Khor et al. ("Khor")
Ex. 1009	U.S. Patent No. 5,804,880 to Mathew ("Mathew")
Ex. 1010	U.S. Patent No. 3,436,818 to Merrin et al. ("Merrin")
Ex. 1011	U.S. Patent No. 3,429,040 to Miller ("Miller")
Ex. 1012	Natalia Sobczak et al., *Factors affecting wettability and bond strength of solder joint couples*, 79 (10) PURE APPL. CHEM. 1755-69 (2007) ("Sobczak")
Ex. 1013	Cindy Melton, *The Effect of Reflow Process Variables on the Wettability of Lead-Free Solders*, 45 (7) JOM[1] 33-35 (July 1993) ("Melton")
Ex. 1014	Lei Zhang et al., *Effect of copper oxide layer on solder wetting temperature under a reduced atmosphere*, 8th International Conference on Electronic Packaging Technology (August 2007) ("Zhang")
Ex. 1015	Houghton Mifflin Company, "The American Heritage College Dictionary, Third Edition," 1993, pp. 272-73.
Ex. 1016	ADVANCED ELECTRONIC PACKAGING (William D. Brown, ed., 1999) (excerpts)
Ex. 1017	HANDBOOK OF LEAD-FREE SOLDER TECHNOLOGY FOR MICROELECTRONIC ASSEMBLIES (Karl J. Puttlitz & Kathleen A. Stalter, eds., 2004) (excerpts)
Ex. 1018	Curriculum Vitae of Professor R. Jacob Baker, Ph.D.

[1] Journal of the Minerals, Metals and Materials Society

PETITION FOR *INTER PARTES* REVIEW

Pursuant to the provisions of 35 U.S.C. § 311 and 37 C.F.R. § 42.100 *et seq*., Petitioner Silergy Corporation ("Silergy") hereby petitions the Patent Trial and Appeal Board to institute an *Inter Partes* Review ("IPR") of claims 1-8 and 10-11 of United States Patent No. 8,361,899 ("the '899 patent," Ex. 1001) that issued on January 29, 2013 to Hunt Hang Jiang and, according to USPTO records, is assigned to Monolithic Power Systems, Inc. ("MPS" or "Patent Owner").

I. MANDATORY NOTICES

A. Real Parties-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Petitioner identifies Silergy Corporation, Silergy Technology, Compal Electronics, Inc., and Bizcom Electronics, Inc. as real parties-in-interest.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

As of the filing date of this petition, the '899 patent is involved in litigation in the Northern District of California, captioned *Monolithic Power Systems, Inc. v. Silergy Corporation, et al.*, Case No. 3:14-cv-01745-VC, which was originally filed as Case No. 2:13-cv-08122-MWF in the Central District of California, and then transferred to the Northern District of California on April 14, 2014. Patent application No. 13/706,062, filed on December 5, 2012 and which issued as U.S. Patent No. 8,906,797 on November 29, 2014, claims benefit of the '899 patent's application. Patent application Nos. 14/481,602, filed on September 9, 2014, and 14/612,247, filed on February 2, 2015, which are both pending, also claim benefit

of the '899 patents' application. Petitioner is not aware of any other judicial or administrative matter involving the '899 patent that would affect, or be affected by, a decision in the requested IPR.[2]

C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Pursuant to 37 C.F.R. §§ 42.8(b)(3) and 42.10(a), Petitioner designates counsel as follows:

Lead Counsel	***Back-up Counsel***
Andrew J. Gray IV MORGAN, LEWIS & BOCKIUS LLP 2 Palo Alto Square 3000 El Camino Real, Suite 700 Palo Alto, CA 94306 Phone: 650.843.4000 Fax: 650.843.4001 agray@morganlewis.com USPTO Reg. No. 41,796	Dion M. Bregman MORGAN, LEWIS & BOCKIUS LLP 2 Palo Alto Square 3000 El Camino Real, Suite 700 Palo Alto, CA 94306 Phone: 650.843.4000 Fax: 650.843.4001 dbregman@morganlewis.com USPTO Reg. No. 45,645

D. Service Information Under 37 C.F.R. §§ 42.8(b)(4)

Pursuant to 37 C.F.R. §42.8(b)(4), counsel agrees to service by mail as detailed above, and to electronic service by email to the email address silergy_ipr.service@morganlewis.com.

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[2] Petitioner has concurrently filed a Petition for *inter partes* review of U.S. Patent No. 8,283,758, also asserted in the U.S. District Court proceeding.

E. Power of Attorney Under 37 C.F.R. § 42.10(b)

A Power of Attorney executed by Petitioner accompanies this Petition.

F. Payment of Fees Under 37 C.F.R. § 42.103(a)

The required fees are submitted herewith. If any additional fees are due at any time during this proceeding, the Office is authorized to charge such fees to Deposit Account No. 50-0310 (order no. 0002519-00-0008).

G. Service on the Patent Owner

Pursuant to 37 C.F.R. § 42.105(a), this Petition and its exhibits were served simultaneously with this filing on Patent Owner at the correspondence address of record on file at the USPTO for the ’899 patent, as shown in the attached Certificate of Service. This petition and its exhibits were also electronically served on MPS’ counsel in the above-referenced Northern District of California proceeding.

II. GROUNDS FOR STANDING

Pursuant to 37 C.F.R. § 42.104, Petitioner certifies that the ’899 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the claims of the ’899 patent because it is not a party to any other post-grant or *inter partes* review of the ’899 patent. This petition is filed within one year of real party-in-interest Silergy Technology being served (on February 24, 2014) with a complaint for infringement of the ’899 patent. Petitioner has not filed any separate civil actions challenging the validity of

any claims of the ’899 patent.

III. THE ’899 PATENT AND ITS PROSECUTION

A. Summary of the ’899 Patent

The ’899 patent is directed to methods of manufacturing “flip-chip” semiconductor packages. It claims a method of preventing uncontrolled collapse of the solder balls used to connect a semiconductor die to its leadframe by creating “attachment areas” which are wettable (*i.e.*, receptive) to solder, bounded by “non-attachment areas,” such as oxidized regions, which are less wettable to solder. According to the ’899 patent, the solder balls will be constrained within the attachment areas thus preventing collapse of the solder balls and associated short circuits, and maintaining an adequate distance or separation between the die and leadframe. *See* Ex. 1001, abstract and claims.

Every method claimed in the ’899 patent, however, was well known in the art long before 2010, when the ’899 patent was filed. For example, a patent filed in 1996 describes coating a leadframe with a non-wettable material, and then plating selected regions of the leadframe with a wettable material, which results in solder being “substantially prevented from spreading over portions of the lead frame coated with the non-wettable material.” Ex. 1009 at Abstract. Even earlier, a patent filed in 1965 (45 years earlier than the ’899 patent) describes surrounding wettable connecting areas with material not wettable to solder, to “prevent collapse

of the circuit element and thereby positively space the element from the substrate." Ex. 1010 at Abstract. And another patent filed in 1965 recognizes that "an oxide layer forms on the surface of the copper pattern, thereby restricting solder flow beyond the original solder pattern contact area." Ex. 1011 at 6:8-11.

In the face of the prior art, all that the '899 patent attempts to add, and in only one of its claims, is a step of using a "target degree of migration" of the solder to "determine a target amount" of wettability difference between the attachment and non-attachment areas. The '899 patent's specification alludes to the scientific principle that the wettability difference, as measured by respective "contact angles," is believed to limit the spread of solder. Ex. 1001 at claim 11 and 4:16-38. But providing a scientific explanation for functionality inherent in the prior art—let alone functionality expressly described—is neither inventive nor patentably new, and thus the '899 patent's claims should be found unpatentable under 35 U.S.C. §§ 102 and/or 103. *See Atlas Powder Co. v. Ireco Inc.*, 190 F.3d 1342, 1347 (Fed. Cir. 1999).

B. Prosecution History of the '899 Patent

The application that led to the '899 patent originally contained 23 claims. In response to a restriction/election requirement, the Applicant chose to proceed only with original (unamended) claims 1-17. *See* Ex. 1002 at 56.

After the Applicant's election, the Examiner rejected all claims, and,

significantly, rejected claim 15 in part because (i) "the first wettability is less than the second wettability for a target amount," and (ii) "determining the target amount based on a target degree of migration of the solder ball from the attachment area during reflow" would have been obvious to one of skill in the art because the prior art disclosed the "general conditions of a claim," and thus "discovering the optimum value or working ranges involves only routine skill in the art." *See* Ex. 1002 at 70-71 (citing *In re Aller*, 105 U.S.P.Q. 233). In response, the Applicant traversed each of the rejections based on prior art, but never directly responded to the Examiner's rejection of claim 15 based on obviousness given the disclosure of the general conditions of the claim. *See* Ex. 1002 at 92-93.

After the Applicant's response (which again, did not amend the claims), the Examiner rewrote (via an Examiner's Amendment) the independent claims, incorporating original dependent claim 2 into original independent claim 1 (now issued claim 1); incorporating the final 3 lines of original claim 17 and the entirety of original claim 15 (containing the "target amount" and "target degree" limitations) into original claim 12 (now issued claim 11); and canceling original claims 13, 14 and 16. *See* Ex. 1002 at 110.

IV. STATEMENT OF THE RELIEF REQUESTED

A. Challenged Claims and Statutory Grounds of Challenge

Petitioner asks that the Board review the accompanying prior art and analysis, institute a Trial for *inter partes* review of claims 1-8 and 10-11 of the '899 patent, and cancel those claims as unpatentable under 35 U.S.C. §§ 102 and 103, based on one or more of the eight grounds raised in this petition:

	Statute	***References***	***Claims***
1	35 U.S.C. § 102(e)	Sirinorakul	1-5, 10-11
2	35 U.S.C. § 103(a)	Sirinorakul	6-7, 11
3	35 U.S.C. § 103(a)	Sirinorakul in view of Eslamy	6-7
4	35 U.S.C. § 103(a)	Sirinorakul in view of Khor	8
5	35 U.S.C. § 102(b)	Greenwood	11
6	35 U.S.C. § 103(a)	Greenwood	11
7	35 U.S.C. § 102(b)	Eslamy	11
8	35 U.S.C. § 103(a)	Eslamy	11

The application that led to the '899 patent was filed on December 16, 2010 and does not claim priority to any earlier application. None of the prior art references identified below was before the Patent Office during prosecution of the '899 patent.

U.S. Patent No. 8,129,229 to Sirinorakul et al., "Method of Manufacturing Semiconductor Package Containing Flip-Chip Arrangement" ("Sirinorakul" or "Ex. 1004") was filed December 2, 2010, as a divisional of Application No. 12/288,756, filed October 13, 2008, and claims priority to Provisional Application

No. 61/002,646 filed November 10, 2007. Sirinorakul is prior art under pre-AIA 35 U.S.C. § 102(e) because it was filed more than one year before the '899 patent's priority date.

U.S. Patent No. 7,049,683 to Sirinorakul et al., "Semiconductor Package Including Organo-Metallic Coating Formed on Surface of Leadframe Roughened Using Chemical Etchant to Prevent Separation Between Leadframe and Molding Compound" ("Sirinorakul '683" or "Ex. 1005) was issued on May 23, 2006 . Sirinorakul '683 is expressly incorporated by reference into Sirinorakul; Sirinorakul '683 is prior art under pre-AIA 35 U.S.C. § 102(b) because it was issued more than one year before the '899 patent's priority date.

U.S. Patent No. 7,691,670 to Eslamy et al., "Interconnection of Lead Frame to Die Utilizing Flip Chip Process" ("Eslamy" or "Ex. 1006") was published on November 5, 2009. Eslamy is prior art under 35 pre-AIA U.S.C. § 102(b) because it was published more than one year before the '899 patent's priority date.

U.S. Patent No. 6,593,545 to Greenwood et al., "Laser Defined Pads for Flip Chip Leadframe Package Fabrication Method" ("Greenwood" or "Ex. 1007") was issued on July 15, 2003 . Greenwood is prior art under 35 U.S.C. § 102(b) because it was issued more than one year before the '899 patent's priority date.

U.S. Patent No. 6,482,680 to Khor et al., "Flip-Chip on Lead Frame" ("Khor" or "Ex. 1008") was issued on November 19, 2002. Khor is prior art under

pre-AIA 35 U.S.C. § 102(b) because it was issued more than one year before the '899 patent's priority date.

B. The Person of Ordinary Skill in the Art

As explained by Dr. R. Jacob Baker, who is an expert in this field, a person of ordinary skill in the art at the time of the '899 patent's invention would have had at least a bachelor's degree in Electrical Engineering, Computer Engineering, or a related field and 1-2 years of experience in semiconductor packaging. Ex. 1003 at ¶¶26-27.

C. Background Knowledge in the Art

"The person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention" See MPEP § 2141. The '899 patent relies on principles and techniques so pervasive and long-known in the art that a person of ordinary skill would necessarily have been familiar with them—wettability of materials to solder, masking techniques such as use of photoresist, and printing techniques such as stencil printing. Ex. 1003 at ¶ 28.

1. Wettability to Solder

As Dr. Baker explains, wettability to solder, in the context of electronics in general and semiconductor packaging in particular, means the ability of molten solder to flow over and adhere to a surface. Ex. 1003 at ¶ 29. Knowing this principle is foundational to the understanding of one of skill in the art. Further, a

person of ordinary skill would know that metals typically used in electronics—such as copper, silver, palladium, gold—are generally wettable to solder, whereas oxides are generally not. Consistent with this understanding, one of ordinary skill in the art would thus understand that metals like those described above are more wettable to solder than oxides. *Id*. These basic properties are so well-known that authors in the field mention it without further explanation. *See, e.g.*, Ex. 1013 at 34 ("Also worthy of consideration is the inhibiting effect of oxide formation on solder spread on a copper surface, where the removal of this oxide is necessary for the progression of solder wetting."); Ex. 1014 at 3 ("In order to obtain good wettability, the oxide layers on the solder or the Cu is broken or removed."). At least as early as 1965, it was recognized that "an oxide layer form[ed] on the surface of the copper pattern [restricts] solder flow beyond the original solder pattern contact area." Ex. 1011 at 6:8-11.

Beyond the basic knowledge that materials have different wettabilities to solder, and in particular, that oxides are less wettable than metals, it was already well known in the art by 2010 (when the '899 patent was filed) that solder can be confined to a wettable area (such as part of a lead frame) by an adjacent or surrounding region of less-wettable material. For example, in 1965 Miller explained that when the "connecting areas are wettable with solder" and the "areas immediately surrounding … are not wettable with solder," the solder will be

"maintained in substantially a ball shape." *See* Ex. 1010 at 2:21-37. And in 1996 Mathew explained that "the lead frame is at least partially coated with a non-wettable material" and "regions of the lead frame are plated with a wettable material" resulting in "the molten solder paste [being] substantially confined to the wettable material." Ex. 1009 at 2:34-46.

2. Using a Photoresist Masking Process

Using a masking process, *e.g.*, a photoresistive masking process, is pervasive in semiconductor fabrication and packaging, and well-known to anyone of ordinary skill in the art at the time of invention. Ex. 1003 at ¶ 33-35. In this process, one first applies photoresist (a light-sensitive material) to a surface, and then uses light, followed by a chemical developer, to pattern the photoresist so that some areas of the surface are exposed and some areas remain covered by the photoresist. Then, the surface is treated in some fashion (oxidized, plated, etc.) which affects only the exposed portions, because the covered portion of the surface is protected from the treatment by the photoresist. Ex. 1003 at ¶ 34. Finally, the photoresist is removed. *Id.* This process is so well-known in the art that patents or publications simply refer to the process without describing the steps of the process in detail. Sirinorakul, for example, simply mentions plating with silver "using a photoresist mask." Ex. 1004 at 3:58-61. And even where briefly described, such as in Sirinorakul '683 ("depositing and patterning a photoresist mask layer on the

leadframe, immersing the leadframe in a metal ion containing solution to plate the areas that are not covered by the photoresist and then removing the photoresist mask"), the reference notes that the "process is well known in the art and hence will not be described here." Ex. 1005 at 4:36-38; *see also* Ex. 1003 at ¶ 34,

3. Using Stencil Printing to Apply Solder

Another common process in semiconductor fabrication is printing, via a screen or a stencil. In this process, a stencil with openings is placed in contact with a substrate, such as a lead frame. The printed material, *e.g.*, solder paste, is pressed or scraped over the stencil, and when the stencil is lifted, the material remains where the openings were. Ex. 1003 at ¶ 36. As with photoresist masking, Sirinorakul, in describing the prior art, states simply that "a layer of lead-free (Pb-free) solder paste is printed on the lead or contact," and does not elaborate on the steps of the well-known process. Ex. 1004 at 1:50-52. An even earlier reference gives more detail, adding that the stencil openings are designed to match the desired solder location. Ex. 1008 at 3:66-4:4. In short, stencil printing is another technique that was well-known to those of skill in the art at the time of invention. Ex. 1003 at ¶¶ 36-37.

D. Claim Construction

Pursuant to 37 C.F.R. § 42.100(b), and for purposes of this petition and *inter partes* review, Petitioner construes the claim language to give claim terms their

broadest reasonable interpretation in light of the specification. *In re Am. Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1364, 1369 (Fed. Cir. 2004). Because this standard differs from the standard applied by U.S. district courts, *see id.*, Petitioner reserves the right to argue alternative constructions in any district court or appellate litigation.

1. "controllably collapsing [the solder ball]" (claims 1, 10)

One of ordinary skill in the art would understand the broadest reasonable meaning of "controllably collapsing the solder ball," in light of the specification, to be "governing the shape and size of the solder ball during reflow." Ex. 1003 at ¶¶ 47-49.

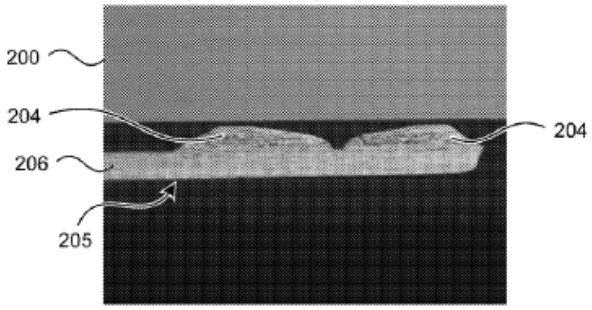
The '899 patent's specification discusses "controllably collapse[ing]" as the alternative to an "uncontrollable collapse." *See* Ex. 1001 at 1:23-36 ("One drawback of the foregoing flip chip technique is that the solder balls tend to *uncontrollably collapse* during reflow … . [T]here is a need for improved flip chip techniques that can at least reduce or eliminate the risk of *uncontrollable collapse* of solder balls during reflow"); *id.* at 6:29-31 ("As clearly shown in FIG. 5A, the solder balls 206 *uncontrollably collapsed* during reflow and came in contact with each other.") (emphasis added in all); *id.* at Fig. 5A (showing that the solder ball has collapsed downward.) This is what one of skill in the art (or a layperson) would expect, given the typical understanding of "collapse" as "to fall down or

inward." *See, e.g.,* Ex. 1015 at 273 (defining "collapse"). The '899 patent further explains that "[i]t has been observed that the lead fingers 106 with the attachment area 112 and the non-attachment area 113 can enable a *controllable collapse* of the electrical couplers 104 during the reflow operation." Ex. 1001 at 4:10-13 (emphasis added). And Fig. 5B illustrates an embodiment of the invention where, in contrast to Fig. 5A, the solder ball has substantially maintained its height. In light of these disclosures, one of ordinary skill in the art would understand "controllably collapsing [the solder ball]" to mean "governing the shape and size of the solder ball during reflow."

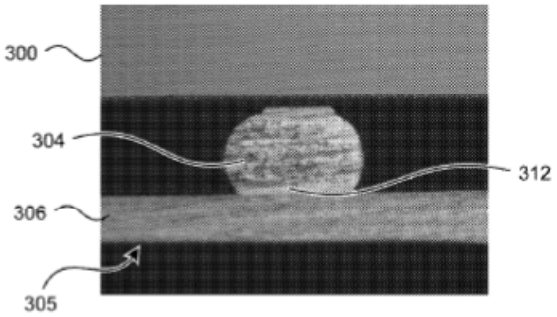
2. "migration | migrating" (claims 1, 10, 11)

One of ordinary skill in the art would understand the broadest reasonable meaning of "migrating" or "migration," in light of the specification, to be "spreading horizontally." The '899 patent analogizes "migration" to "spreading" when it states that "it is believed that the wettability differential … can at least limit or substantially eliminate *migration or spreading* of the reflowed electrical couplers." Ex. 1001 at 4:18-23 (emphasis added). The specification also pairs the verb "migrate" with the adverb "away." *See* Ex. 1001 at 6:39-42 ("[T]he solder ball 304 substantially retained its shape and did not significantly *migrate away* from the contact pad 312"); *id.* at claim 1 ("*migrating away* from the silver in the attachment area"); *id.* at claim 10 ("*migrating away* from the attachment area"); *id.*

at claim 11 (same) (emphasis in all). As the patent calls for the solder balls to be connected to or placed on the attachment areas, migrating (*i.e.*, spreading) "away" from the attachment areas necessarily means spreading horizontally from the attachment areas. Ex. 1001 at 6:22-42 and Figs. 5A-B (describing and showing the difference between Fig. 5A (collapse and migration) and Fig. 5B, where the solder ball did not "significantly migrate."). Ex. 1003 at ¶ 50.



Ex. 1001 at Fig. 5A



Ex. 1001 at Fig. 5B

The term "migration" appears in the phrase "degree of migration." *See, e.g.*, Ex. 1001 at 4:27-38 (referring to small or large "degrees of migration" or a "target degree of migration); *id.* at claim 11 ("target degree of migration"). Here again, it is apparent from the context that the patent is discussing how much spreading (and specifically, horizontal spreading) of the solder ball can be tolerated. Ex. 1003 at ¶ 51.

Thus, the broadest reasonable interpretation, in light of the specification, of "migration" or "migrating" is "spreading horizontally."

3. "wetting material" (claims 3, 5 and 8)

One of ordinary skill in the art would understand the broadest reasonable meaning of "wetting material," in light of the specification to be, "any material wettable to solder or that improves wettability to solder." The '899 patent explains that a "wetting material 111 can include silver (Ag), a nickel (Ni)/gold (Au) alloy, and/or other suitable metal or metal alloys." Ex. 1001 at 3:32-34. And the wetting material may be "sprayed, printed or otherwise formed" on the surface of the lead fingers through the apertures of a stencil. Ex. 1001 at 5:50-53. Because the wetting material is placed on the attachment areas of the lead fingers (which become "more wettable" to solder, Ex. 1001 at Abstract) the wetting material must help make these areas more wettable to solder than the non-attachment areas. Ex. 1003 at ¶ 52. But the wetting material should not be *limited* to recited metals like silver or alloys, because these cannot be printed or sprayed. *Id.* Rather, "wetting material" must at least include solder itself (because it can be printed as a paste) as well as a material like solder flux (because it can be sprayed). *Id.*

Thus, the broadest reasonable interpretation, in light of the specification, of "wetting material" is "material wettable to solder or that improves wettability of a surface to solder."

V. DETAILED GROUNDS FOR UNPATENTABILITY

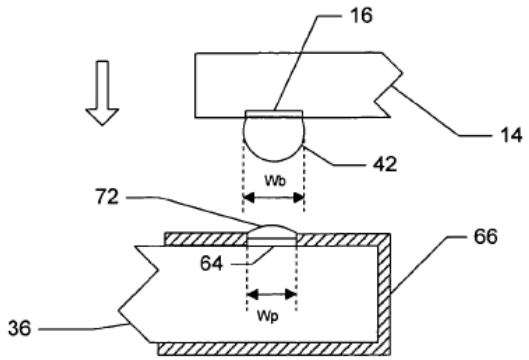
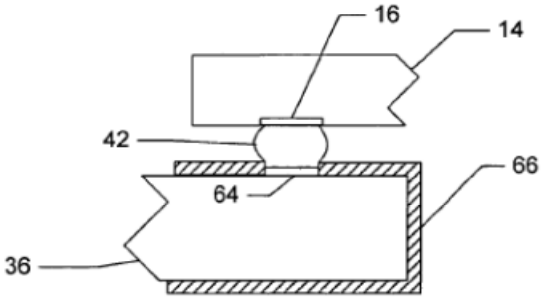
- In Ground 1, Sirinorakul is shown to anticipate independent claim 1.

- Dependent claims 2-5 are anticipated by Sirinorakul (Ground 1).
- Dependent claims 6-7 are obvious over Sirinorakul and the knowledge of a person of ordinary skill in the art (Ground 2), or alternatively, over the combination of Sirinorakul and Eslamy (Ground3).
- Dependent claim 8 is obvious over Sirinorakul and Khor (Ground 4)
- Dependent claim 10 is anticipated by Sirinorakul (Ground 1)
- Independent claim 11 is anticipated by any of Sirinorakul, Greenwood or Eslamy (Grounds 1, 5 and 7) for two independent reasons. First, the reference discloses a member of a claimed range, and second, the claim merely claims use of a scientific principle that was already disclosed in the prior art.
- Independent claim 11 is also obvious over any of Sirinorakul, Greenwood or Eslamy and the knowledge of a person or ordinary skill in the art (Grounds 2, 6 and 8), because claim 11 claims an optimum value, which a skilled artisan could determine by routine experimentation.

A. Ground 1: Claims 1-5 and 10-11 are anticipated under 35 U.S.C. § 102(e) by Sirinorakul.

1. Sirinorakul discloses all of the elements of claim 1.

Claim 1 as disclosed by Sirinorakul
1. A method for fabricating a semiconductor assembly, comprising:
"Method of Manufacturing Semiconductor Package Containing Flip-Chip Arrangement." Ex. 1004 at Title. "A metal leadframe to be used in manufacturing a 'flip-chip' type semiconductor package is treated to form a metal plated layer … During the molding process, the

standoff between the chip and the leadframe allows the molding compound to flow freely, preventing voids in the finished package." Ex. 1004 at Abstract.
(1.a)[3] forming an attachment area and a non-attachment area on a lead finger of a lead frame, the attachment area being more wettable to a solder ball than the non-attachment area during reflow;
"the lead or contact [is] represented here by leadframe **36**." Ex. 1004 at 1:51-52. "a relatively small area of the surface of leadframe **36** is plated with a layer **64** of a metal such as silver (Ag) or an alloy" Ex. 1004 at 3:58-61. "As described above, a small area of leadframe **36** is covered by plated layer **64**, which is surrounded by oxide layer **66**." Ex. 1004 at 4:35-37.
(1.b) contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger;
"FIG. **9**A shows chip **14** with lead-free solder ball **42** attached to bonding pad **16**. Solder ball **42** is approaching leadframe **36**." Ex. 1004 at 4:33-35. *See also* Fig. 9B, below.    Ex. 1004 at Fig. 9A.
(1.c) reflowing the solder ball while the solder ball is in contact with the attachment area of the lead finger; and
"FIG. **9**B shows solder ball **42** during the reflow process." Ex. 1004 at 4:42.    Ex. 1004 at Fig. 9B.
(1.d) controllably collapsing the solder ball to establish an electrical connection between the semiconductor die and the lead finger of the lead frame;

[3] Claim indices (*i.e.*, 1.a, 1.b, …) are provided in the charts for ease of reference.

"When the leadframe is pretreated in this manner, the solder ball does not spread out or collapse during reflow. Instead, the solder ball remains laterally constricted and a good standoff distance between the chip and the leadframe is maintained." Ex. 1004 at 2:30-34.

"FIG. **9**B shows solder ball 42 during the reflow process. As indicated, solder ball **42** does not spread out significantly beyond the limits of plated layer **64**. FIG. **9**C shows the structure after it has been encapsulated in molding compound **46**. Solder ball **42** remains in a tight configuration and has not spread out." Ex. 1004 at 4:42-47.

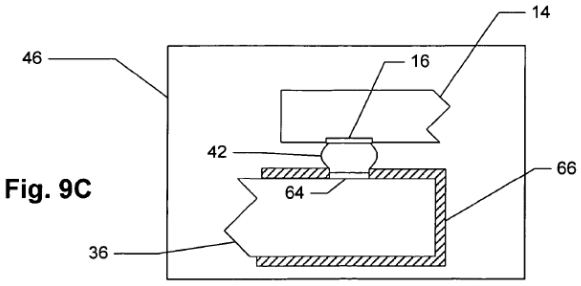


Fig. 9C

Ex. 1004 at Fig. 9C.

"[T]he solder in each ball or bump is heated or "reflowed" to form an electrical path between the chip and the lead or contact." Ex. 1004 at 1:25-27.

(1.e) and wherein the method further includes attaching the solder ball to a contact pad of the semiconductor die;

See 1.b, above.including figures.

forming the attachment area and the non-attachment area includes:

(1.f) depositing a photoresist on a surface of the lead finger containing copper (Cu);

(1.g) patterning the photoresist to form an opening corresponding to the attachment area, the opening exposing a first portion of the surface of the lead finger, a second portion of the surface being covered by the photoresist;

(1.h) depositing silver (Ag) on the first portion of the surface of the lead finger through the opening in the photoresist;

(1.i) removing the photoresist from the second portion of the surface of the lead finger having the deposited silver;

"Typically, leadframe **36** is made of Cu or a Cu alloy." Ex. 1004 at 4:1.

"In accordance with this invention, as shown in FIG. 7A, a relatively small area of the surface of leadframe **36** is plated with a layer **64** of a metal such as silver (Ag) or an alloy *using a photoresist mask* to cover the reminder [sic] of leadframe **36**." Ex. 1004 at 4:58-61 (emphasis added).

"U.S. Pat. No. 7,049,683 … is incorporated herein by reference in its entirety." Ex. 1004 at 4:21-22.

"The various plating patterns . . . can be formed by first depositing and patterning a photoresist mask layer on the leadframe, immersing the leadframe in a metal ion-

containing solution to plate the areas that are not covered by the photoresist and then removing the photoresist mask. This process is well known in the art and hence will not be described here." Sirinorakul '683 (Ex. 1005) at 4:31-38.
(1.j) and oxidizing the second portion of the surface of the lead finger thereby forming copper oxide (CuxO);
"leadframe **36** is exposed to a heat treatment to produce an oxide layer **66** in the area that is not covered by plated layer **64**, as shown in FIG. 7B. . . . As it is heated, oxide layer **66** changes in color from red-brown or copper to a deep blue." Ex. 1004 at 4:7-12.
controllably collapsing includes: **(1.k) preventing the solder ball from migrating away from the silver in the attachment area with the copper oxide in the non-attachment area; and**
"This problem is solved by plating a small area of the lead frame where the solder ball is to be attached with a metal or alloy. The leadframe is then heated to produce an oxide layer surrounding the plated area or, alternatively, the leadframe may be processed so as to form an organometallic layer surrounding the plated area. When the leadframe is pretreated in this manner, the solder ball does not spread out or collapse during reflow. Instead, the solder ball remains laterally constricted and a good standoff distance between the chip and the leadframe is maintained." Ex. 1004 at 2:25-37. "FIG. **9**B shows solder ball 42 during the reflow process. As indicated, solder ball **42** does not spread out significantly beyond the limits of plated layer **64**. FIG. **9**C shows the structure after it has been encapsulated in molding compound **46**. Solder ball **42** remains in a tight configuration and has not spread out." Ex. 1004 at 4:42-47.
(1.l) establishing an electrical connection between the contact pad of the semiconductor die and the lead finger of the lead frame via the solder ball;
See 1.b-d, above.
(1.m) and the method further includes at least partially encapsulating the semiconductor die, the solder ball, and the lead finger with an encapsulant.
"FIG. **9**C shows the structure after it has been encapsulated in molding compound **46**." Ex. 1004 at 4:44-46. *See also* Ex. 1004 at Fig. 9C, reproduced in 1.d, above.

With reference to the claim chart above, Sirinorakul discloses all of the elements and limitations of claim 1. To the extent that the preamble is a limitation,

Sirinorakul discloses it. In addition to its Title and Abstract, Sirinorakul describes the invention as a method in which a leadframe is attached to a chip and then encapsulated, which is a "method for fabricating a semiconductor assembly," as set forth in claim 1's preamble. Ex. 1004 at 2:25-433; Ex. 1003 at ¶ 55.

With respect to limitation 1.a, Sirinorakul discloses forming an attachment area (*e.g.*, plated layer 64) and a non-attachment area (*e.g.*, oxide layer 66) on a lead finger of a lead frame (*e.g.,* leadframe 36), the attachment area being more wettable to a solder ball than the non-attachment area during reflow. Sirinorakul discloses that the attachment area (plated metal such as silver) is more wettable to solder than the non-attachment area (an oxide), because one of ordinary skill in the art would known that a metal is more wettable to solder than an oxide. *See* Ex. 1003 at ¶ 56.

With respect to limitations 1.b and 1.c, as shown above, Sirinorakul discloses contacting a solder ball (*e.g.*, solder ball 42) carried by a semiconductor die (*e.g.*, attached to bonding pad 16 of chip 14) with the attachment area of the lead finger, and reflowing the solder ball while it is in contact with the lead finger *See* Ex. 1003 at ¶¶ 57-58.

As required by limitation 1.d, Sirinorakul discloses "controllably collapsing the solder ball to establish an electrical connection between the semiconductor die and the lead finger of the lead frame," *i.e.*, governing the shape and size of the

solder ball during reflow, describing how the solder ball does not spread out or collapse. Ex. 1004 at 2:30-34. And in addition to explicitly disclosing the electrical connection, in general, between die and lead frame, one of ordinary skill in the art would know that an electrical connection is formed because the bonding pad of the die, the solder ball, the plated metal of the attachment area, and the metal lead frame itself are all electrically conductive, and they are all connected. *See* Ex. 1003 at ¶¶ 59-60.

Limitation 1.e of claim 1, attaching the solder ball to a contact pad of the semiconductor die is disclosed by the same portion of Sirinorakul as 1.b, *i.e.*, solder ball 42 being attached to bonding pad 16 of the chip 14. *See* Ex. 1003 at ¶ 61.

Note that limitations 1.e-l refer back to, and expand on, steps of the method introduced in limitations 1.a-d, and as such the order of the elements in the claim does not prescribe the order in which the steps must be carried out. "Unless the steps of a method actually recite an order, the steps are not ordinarily construed to require one." *Interactive Gift Exp., Inc. v. Compuserve Inc.*, 256 F.3d 1323, 1342 (Fed. Cir. 2001).

Limitations 1.f-i of claim 1 recite that the leadframe contains copper, and further recite the use of a photoresist process to deposit silver on the surface of the lead finger. As shown in the claim chart, Sirinorakul discloses copper leadframes,

and describes plating the leadframe with silver by "using a photoresist process," thus disclosing using the well-known-in-the-art photoresist process to deposit silver on a first portion of the lead finger. The steps of the photoresist process, as recited in claim 1, are expressly disclosed by Sirinorakul '683, which is incorporated by reference into Sirinorakul. Ex. 1004 at 4:20-22. In any event, the steps are inherently disclosed by Sirinorakul as plating with silver "using a photoresist process" necessarily requires *first*, depositing photoresist on the surface of the finger; *second,* patterning the photoresist to form an opening corresponding to the deposition area while leaving the photoresist in place to mask the area where no deposition is desired; *third*, depositing silver through the opening; and *fourth*, removing the remaining photoresist—this is simply how photoresist processes work. *See* Ex. 1003 at ¶¶ 33, 62-64,

With respect to limitation 1.j, Sirinorakul discloses oxidizing the second portion of the surface of the lead finger (*e.g.*, the portion not covered by plated layer 64) to form copper oxide (CuxO). Sirinorakul inherently discloses this because when an oxide layer is produced on a copper leadframe ("typically made of Cu or a Cu alloy" Ex. 1004 at 4:1), the resulting oxide layer is necessarily a copper oxide (*i.e.*, CuxO). Ex. 1003 at ¶ 65.

With respect to limitation 1.k, as shown above, Sirinorakul discloses that the attachment area is plated silver and the non-attachment area is copper oxide. In the

portions excerpted in the chart above, Sirinorakul further explains that it is the non-attachment area that prevents the solder ball from migrating, or spreading, away from the attachment area. *See* Ex. 1004 at 2;25-37 and 4:42-47; Ex. 1003 at ¶ 66.

As to limitation 1.l, this is largely duplicative of limitation 1.d. As shown above with regard to claim limitations 1.b-1.d, Sirinorakul discloses that the solder ball is attached to a contact pad (*e.g.*, bonding pad) of the die, and that after reflow, the bonding pad, the solder ball, the plated attachment area, and the lead finger of the lead frame are electrically connected. *See* Ex. 1003 at ¶ 67.

Finally, with respect to limitation 1.m, as shown in the chart above, Sirinorakul discloses at least partially encapsulating the semiconductor die, the solder ball, and the lead finger with an encapsulant (*e.g.*, molding compound 46). *See* Ex. 1003 at ¶ 68.

Thus, Sirinorakul discloses all the elements and limitations of claim 1 of the '899 patent.

2. Sirinorakul discloses all of the elements of claim 2.

Claim 2 of the '899 patent reads as follows (claim indices added):

2. The method of claim 1, further comprising:
(2.a) attaching the solder ball to a contact pad of the semiconductor die prior to contacting the solder ball with the attachment area of the lead finger; and
(2.b) at least partially encapsulating the semiconductor die, the solder ball, and the lead finger with an encapsulant.

Sirinorakul discloses the limitations of dependent claim 2. *First*, as discussed and shown in the chart above with respect to limitations 1.b-c of claim 1, Sirinorakul discloses a solder ball 42 attached to a contact pad (*e.g.*, bonding pad 16) of the semiconductor die (*e.g.*, chip 14), approaching the lead finger (*e.g.*, leadframe 36), and then undergoing a reflow process once in contact with the attachment area of the lead finger (*e.g.*, plated layer 64). Ex. 1004 at 4:32-35; *see also id.* at Fig. 9A, above. This disclosure shows that the solder ball must necessarily have been *first* attached to the contact pad, *before* coming in contact with the attachment area of the lead finger, because it is "attached" to the contact pad while "approaching" the lead finger. *See* Ex. 1003 at ¶ 71. *Second*, limitation 2.b of claim 2 is identical to limitation 1.m of claim 1, which as shown above, Sirinorakul discloses. *See* Ex. 1003 at ¶ 72.

3. Sirinorakul discloses all elements of claim 3.

Claim 3 of the '899 patent reads as follows (claim indices added):

3. The method of claim 1 wherein forming the attachment area and the non-attachment area includes:
(3.a) depositing a masking material on a surface of the lead finger;
(3.b) patterning the masking material to form an opening corresponding to the attachment area, the opening exposing a first portion of the surface of the lead finger, wherein a second portion of the surface is covered by the masking material;
(3.c) depositing a wetting material on the first portion of the surface of the lead finger through the opening in the masking material;
(3.d) removing the masking material from the surface of the lead finger; and

(3.e)	treating the second portion of the surface of the lead finger such that the second portion is less wettable to the solder ball during reflow than the first portion.

Sirinorakul discloses these limitations of dependent claim 3. As discussed above with regard to claim limitations 1.f-i, Sirinorakul discloses a photoresist process (which was well-known to those of skill in the art at the time of invention), and in any event incorporates Sirinorakul '683, which expressly discloses the steps of the photoresist process. As such (using the terminology of claim 1) Sirinorakul discloses depositing *photoresist* on the surface of a lead finger, patterning the *photoresist* to form an opening corresponding to the attachment area, the opening exposing a first portion of the surface of the lead finger while leaving a second portion of the surface covered by the photoresist, depositing *silver* (Ag) on the first portion of the lead finger through the opening, removing the *photoresist*, and then *oxidizing* the second portion of the lead finger. *See, e.g.*, Ex. 1005 at 4:31-38.

The disclosure of limitations 1.f-i equally discloses all of the limitations of dependent claim 3, because *photoresist* is a type of *masking material*, *silver* is a type of *wetting material*, and *oxidizing* is a manner of *treating* the second portion of the surface of the lead finger. *See* Ex. 1003 at ¶¶ 32-24, 75. And finally, as discussed above with regard to claim limitation 1.a, the treated second portion of the surface of the lead finger, *e.g.*, the oxidized portion, is necessarily less wettable to solder. *See also* Ex. 1003 at ¶¶ 29-31, 76.

4. Sirinorakul discloses all of the elements of claim 4.

Claim 4 of the '899 patent reads as follows (claim indices added):

4. The method of claim 1 wherein forming the attachment area and the non-attachment area includes:
(4.a) depositing a photoresist on a surface of the lead finger containing copper (Cu);
(4.b) patterning the photoresist to form an opening corresponding to the attachment area, the opening exposing a first portion of the surface of the lead finger, wherein a second portion of the surface is covered by the photoresist;
(4.c) depositing silver (Ag) on the first portion of the surface of the lead finger through the opening in the photoresist;
(4.d) removing the photoresist from the second portion of the surface of the lead finger;
(4.e) and oxidizing the second portion of the surface of the lead finger thereby forming copper oxide (CuxO).

Sirinorakul discloses the limitations of dependent claim 4. Except for two minor wording changes, each of claim limitations 4.a-e is *identical* to the corresponding claim limitations 1.f-j. *First*, a portion of claim limitation 4.b, "wherein a second portion of the surface is covered by the photoresist," differs only slightly from the corresponding part of claim limitation 1.g, "a second portion of the surface being covered by the photoresist." *Second*, claim limitation 4.d, "removing the photoresist from the second portion of the surface of the lead finger," differs only slightly from corresponding claim limitation 1.i, "removing the photoresist from the second portion of the surface of the lead finger having the deposited silver." These small changes in no way alter the scope of each element,

which as shown above for claim 1, are disclosed by Sirinorakul. *See* Ex. 1003 at ¶¶ 79-80.

5. Sirinorakul discloses all elements of claim 5.

Claim 5 of the '899 patent reads as follows (claim indices added):

5. The method of claim 1 wherein forming the attachment area and the non-attachment area includes:
(5.a) depositing a wetting material on a first portion of the lead finger; and
(5.b) treating a second portion of the lead finger such that the second portion is less wettable to the solder ball during reflow than the first portion.

Sirinorakul discloses limitation 5.a because it teaches depositing a wetting material (*e.g.*, silver), on a first portion of the lead finger. Ex. 1004 at 3:58-61 ("a relatively small area of the surface of leadframe 36 is plated with a layer 64 of a metal such as silver"). *See* Ex. 1003 at ¶ 82. Further, Sirinorakul discloses limitation 5.b because it teaches treating (*e.g.*, oxidizing) a second portion of the lead finger such that the second portion becomes less wettable to the solder ball during reflow than the first portion. Ex. 1004 at 4:35-37 ("a small area of leadframe 36 is covered by plated layer 64, which is surrounded by oxide layer 66"). As discussed above in section V(A)(1) (*i.e.*, Ground 1–claim 1) with regard to limitation 1.a, the treated second portion of the surface of the lead finger—the oxidized portion—is less wettable to solder during reflow than the first portion (*e.g.*, the portion with deposited silver.) *See* Ex. 1003 at ¶ 83. Therefore, Sirinorakul discloses all of the elements and limitations of claim 5.

6. Sirinorakul discloses all elements of claim 10.

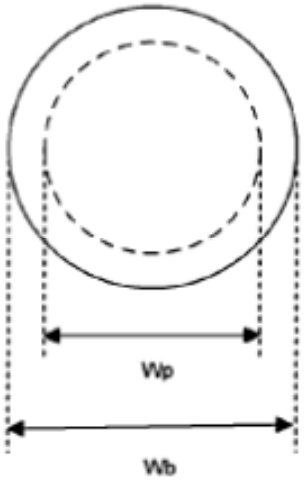
Claim 10 of the '899 patent reads as follows:

10. The method of claim 1 wherein controllably collapsing includes preventing the solder ball from migrating away from the attachment area with the non-attachment area.

As shown above, Sirinorakul discloses the narrower limitation 1.k of claim 1, "preventing the solder ball from migrating away from *the silver in the* attachment area with the *copper oxide in* the non-attachment area." *See* section V(A)(1), above. As such, Sirinorakul equally discloses the broader dependent limitation recited in claim 10, which lacks any limitations on the materials in the attachment and non-attachment areas. *See* Ex. 1003 at ¶ 104.

7. Sirinorakul discloses all of the elements of claim 11.

Claim 11 as disclosed by Sirinorakul
11. A method for fabricating a semiconductor assembly, comprising:
See claim 1 (preamble), above.
(11.a) forming an attachment area and a non-attachment area on a lead finger of a lead frame;
See 1.a in chart for claim 1, above.
(11.b) contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger;
See 1.b in chart for claim 1, above.
(11.c) reflowing the solder ball while the solder ball is in contact with the attachment area of the lead finger; and
See 1.c in chart for claim 1, above.
(11.d) preventing the solder ball from migrating away from the attachment area toward the non-attachment area; and wherein

See 1.k in chart for claim 1, above.
(11.e) the attachment area has a first wettability to the solder ball during reflow; **(11.f) the non-attachment area has a second wettability to the solder ball during reflow; and**
"a relatively small area of the surface of leadframe **36** is plated with a layer **64** of a metal such as silver (Ag) or an alloy" Ex. 1004 at 3:58-61. "leadframe **36** is exposed to a heat treatment to produce an oxide layer **66** in the area that is not covered by plated layer **64**". Ex. 1004 at 4:7-9.
(11.g) preventing the solder ball from migrating includes treating at least one of the attachment area and the non-attachment area such that the second wettability is less than the first wettability for a target amount; [4]
See 11.e and 11.f, above (second wettability less than first wettability). *See* 11.h, below ("target amount" of wettability difference).
(11.h) and the method further includes determining the target amount based on a target degree of migration of the solder ball from the attachment area during reflow;
"A layer **72** of lead-free solder is placed on top of plated layer **64**. As indicated, the width Wp of the plated layer **64** is greater than or equal to 70% of the width Wb of solder ball 42 and less than or equal to Wb—i.e., 0.7 Wb ≤ Wp ≤ Wb. FIG. **9**B shows solder ball **42** during the reflow process. As indicated, solder ball **42** does not spread out significantly beyond the limits of plated layer **64**. FIG. **9**C shows the structure after it has been encapsulated in molding compound **46**. Solder ball **42** remains in a tight configuration and has not spread out. … In this example, the width of solder ball **42** after    Ex. 1004 at Fig. 7D. "FIG. 7D illustrates the relationship between the widths

[4] An August 27, 2013 certificate of correction indicated that the words "first" and "second" had been reversed in the issued patent.

reflow is slightly greater than the width Wp of the plated layer **64**." Ex. 1004 at 4:35-52.	of the plated area and the solder ball, respectively." Ex. 1004 at 3:4-5,
(11.i) and preventing the solder ball from migrating includes at least one of (a) depositing silver (Ag) onto a first portion of the lead finger and (b) oxidizing a second portion of the lead finger.	
See 11.e-f and 1.f-j, above.	

With reference to the claim chart above, Sirinorakul discloses all of the elements of independent claim 11.

i. Limitations 11.a-d and 11.i are identical to limitations of claim 1 or its dependent claims, disclosed by Sirinorakul.

First, many of claim 11's limitations are identical to those of claim 1 or of other dependent claims: the preambles are identical, 11.a is identical to 1.a but for the requirement that the attachment area is more wettable to solder than the non-attachment area (which now appears in limitation 11.g), 11.b is identical to 1.b, 11.c is identical to 1.c, and 11.d is identical to 10a (which as noted above is a broader statement of 1.j). As discussed above with regard to claims 1 and 10, Sirinorakul discloses all of these limitations. *See also* Ex. 1003 at ¶¶ 55-59, 110-114.

With respect to limitation 11.i, Sirinorakul discloses both depositing silver onto a first portion of the lead finger and oxidizing a second portion of the lead

finger, as explained in regard to limitations 1.f-1.j above and 11.e-f below. *See also* Ex. 1003 at ¶¶ 115,117.

ii. Sirinorakul discloses the differing wettabilities of the attachment and non-attachment areas.

With respect to limitations 11.e-g, Sirinorakul discloses that the attachment area has a first wettability to the solder ball during reflow and that the non-attachment area has a second, lesser, wettability to the solder ball during reflow, because it discloses plating the attachment area with silver and oxidizing the non-attachment area. Ex. 1004 at 3:58-61 and 4:7-9. In Sirinorakul, the attachment area (plated metal such as silver) has a first wettability to solder and the non-attachment area (an oxide) has a second, *different and lesser*, wettability to solder, because a metal (having the first wettability) is inherently more wettable to solder than an oxide (having the second wettability), as was well-known in the art at the time of the '899 patent's invention. *See* Ex. 1003 at ¶¶ 29, 115-116.

iii. Sirinorakul discloses an example of the range of target degrees and amounts claimed by the '899 patent in limitations 11.g-h.

Limitation 11.g describes the difference in wettabilities to be a "target amount," which limitation 11.h requires to be determined "based on a target degree of migration of the solder ball from the attachment area during reflow."

The '899 patent does not claim any specific range of target degrees of migration or target amounts of wettability difference, thus it is attempting to claim

the full range of any and all of them. *See Falana v. Kent State University,* 669 F.3d 1349, 1355 (Fed. Cir. 2012) (absent limiting language, plain language of claims encompassed entire class of compounds). *See also* Ex. 1003 at ¶ 118. But, as shown in the chart above, Sirinorakul expressly discloses a target degree of migration, that is, the width of a solder ball after reflow is "slightly greater than the width of the plated layer," which in turn is disclosed as a range between 70% and 100% of the width of the solder ball. Ex. 1004 at 4:35-52; Ex. 1003 at ¶ 119. And, the corresponding target amount of wettability difference is the difference in wettability between copper oxide and silver. Ex. 1003 at ¶ 119. Thus, Sirinorakul discloses at least one target degree of migration and correspondingly determined target amount of wettability difference, and so it anticipates under section 102. *See, e.g., In re Slayter*, 276 F.2d 408, 411 (C.C.P.A. 1960) ("A generic claim cannot be allowed to an applicant if the prior art discloses a species falling within the claimed genus."); *see also* MPEP § 2131.02 ("The species in that case will anticipate the genus").

iv. The '899 patent claims, in 11.g-h, the scientific principle for functionality disclosed in the prior art.

As an additional and alternative reason for why Sirirnorakul anticipates claim 11, the limitation of "determining the target amount [of wettability difference] based on a target degree of migration of the solder ball" is an attempt to

claim the scientific principle for functionality disclosed in the prior art. The '899 patent's specification states:

> As discussed above, the attachment area 112 is generally wettable while the non-attachment area 113 is generally non-wettable to the electrical couplers 104. *Without being bound by theory, it is believed that the wettability differential between the attachment area 112 and the non-attachment area 113 can at least limit or substantially eliminate migration or spreading of the reflowed electrical couplers 104.* It is believed that the reflowed electrical couplers 104 may not readily bond to the non-attachment area 113 due to a lack of surface contact. As a result, the reflowed electrical couplers 104 tend to be confined in the attachment area 112.
>
> In certain embodiments, a wettability differential between the attachment area 112 and the non-attachment area 113 may be adjusted based on a target degree of migration of the reflowed electrical couplers 104. *In general, it is believed that the larger the wettability differential, the smaller the degree of migration, and vice versa.*

Ex. 1001 at 4:16-32 (emphasis added); Ex. 1003 at 121. But this relationship between wettabilities and solder migration, and the resulting functionality, is inherent in Sirinorakul's disclosures and teachings, as discussed above. *See* Ex. 1003 at ¶ 123. All that the '899 patent attempts to add is a scientific explanation for the functionality disclosed in the prior art (Ex. 1003 at ¶ 122), which is unpatentable under 35 U.S.C. § 102. *See Atlas Powder Co. v. Ireco Inc.*, 190 F.3d 1342, 1347, 51 USPQ2d 1943, 1947 (Fed. Cir. 1999) ("[T]he discovery … of a

scientific explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer."); *Toro Co. v. Deere & Co.*, 355 F.3d 1313, 1320, 69 U.S.P.Q.2d 1584, 1590 (Fed. Cir. 2004) ("[T]he fact that a characteristic is a necessary feature or result of a prior-art embodiment (that is itself sufficiently described and enabled) is enough for inherent anticipation, even if that fact was unknown at the time of the prior invention.").

B. Ground 2: Claims 6-7 and 11 are obvious under 35 U.S.C. § 103(a) over Sirinorakul.

1. Claim 6: It would have been obvious to one of ordinary skill to use a masking process to define the non-attachment area rather than the attachment area.

Claim 6 of the '899 patent reads as follows:

6. The method of claim 1 wherein forming the attachment area and the non-attachment area includes:
depositing a masking material on a surface of the lead finger;
removing a portion of the masking material, a remaining portion of the masking material covering a first portion of the surface of the lead finger, wherein a second portion of the surface of the lead finger is exposed through the masking material;
treating the second portion of the surface of the lead finger such that the second portion is less wettable to the solder ball during reflow than the first portion; and
thereafter, removing the remaining portion of the masking material from the lead finger.

This claim recites depositing a masking material on the surface of a lead finger, much in the same way as claimed in dependent claim 3. But instead of exposing a <u>first</u> portion and depositing a wetting material as in claim 3, here a

second portion is exposed and treated to be less wettable to solder than the first portion of the lead finger. In other words, claim 3 claims use of a masking process to form the *attachment area*, and dependent claim 6 claims use of a masking process to form the *non-attachment area*. *See* Ex. 1003 at ¶¶ 85-86.

As explained above in section V(A)(3) (*i.e.*, Ground 1, claim 3), Sirinorakul discloses using the well-known prior art photoresist masking process to form the attachment area by masking off and plating the exposed attachment area with silver. It would have been obvious and well within the capability of one of ordinary skill in the art to use the same well-known photoresist process to create the non-attachment area by masking off and oxizing the exposed non-attachment area. *See KSR*, 550 U.S. at 417 (2007); MPEP § 2141(I). Ex. 1003 at ¶ 87. And regardless, as shown below in section V(C)(1), Eslamy explicitly discloses forming the non-attachment area by masking and oxidixing.

2. Claim 7: Sirinorakul discloses oxidizing the non-attachment area.

Claim 7 of the '899 patent reads as follows:

7. The method of claim 6 wherein treating the second portion includes oxidizing the second portion of the surface of the lead finger.

Sirinorakul discloses treating the second portion of the surface of the lead finger by oxidizing it. *See* Ex. 1004 at 4:7-9 ("leadframe 36 is exposed to a heat treatment to produce an oxide layer 66 in the area that is not covered by plated

layer 64".) Because, as shown above, claim 6 is obvious under section 103 over Sirinorakul, and Sirinorakul also discloses the additional limitation of claim 7, claim 7 is similarly obvious. *See* Ex. 1003 at ¶ 93.

3. Claim 11: Determining a target amount of wettability difference based on a target degree of migration requires only routine experimentation and is not inventive.

As shown above in Ground 1 with regard to limitations 11.g-h, the '899 patent claims the result of applying the scientific principle underlying the disclosure of Sirinorakul—that the wettability difference between two neighboring regions will limit or prevent solder from migrating from the more wettable to the less wettable region.

To the extent that this property is not inherent in Sirinorakul's disclosure (so that Sirinorakul would anticipate claim 11), determining the optimum value, *i.e.*, the target wettability difference based on a target degree of migration would have been obvious to one of ordinary skill in the art. "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 105 U.S.P.Q. 223, 220 F.2d 454, 456 (C.C.P.A. 1955). *First*, Sirinorakul discloses the general conditions of the claim—that a relationship exists between wettability and degree of solder migration. Ex. 1003 at ¶ 124. And *second*, determining the optimum ("target") amount of wettability difference is not inventive, and thus not patentable, because,

as Dr. Baker explains, it would require only routine experimentation by one of ordinary skill in the art. Ex. 1003 at ¶ 125.

C. Ground 3: Claims 6-7 are obvious under 35 U.S.C. § 103(a) over Sirinorakul in view of Eslamy.

1. Eslamy discloses the additional limitations of claim 6

To the extent that, as argued in section V(B)(1) (*i.e.*, Ground 2, claim 6) above, it would not have been obvious to one of ordinary skill in the art to use a masking process disclosed in Sirinorakul to treat the non-attachment area rather than the attachment area, Eslamy discloses using the well-known prior art masking process to treat (*e.g.*, oxidize) a portion of the lead finger to make it less wettable to solder during reflow:

> "FIG. 2 shows a simplified cross-sectional view of one embodiment of the present invention. In FIG. 2, lead 208 is provided having portion 208*a* of its surface oxidized (for example Brown Oxide), and other portions 208*b* substantially free of oxide. *Such oxidation of only portions of the lead may be accomplished by masking selected portions, followed by exposure of unmasked portions to an oxidizing ambient.*"

Ex. 1006 at 2:41-47 (emphasis added). *See also* Ex. 1006 at Fig. 2 (annotated):

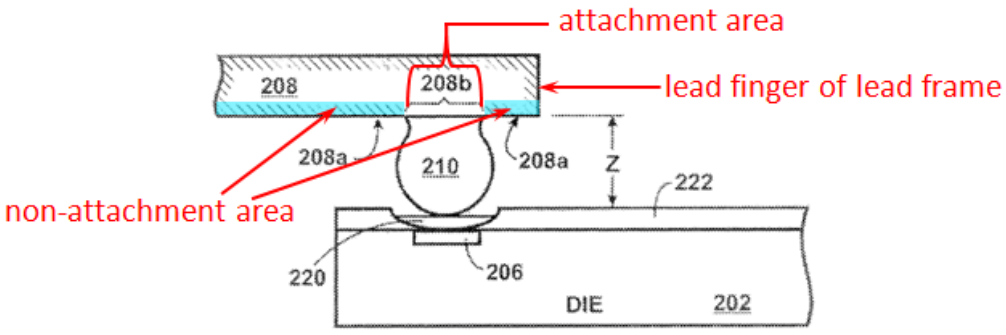


FIGURE 2

As shown above in section V(A)(1)(*i.e.*, Ground 1, claim 1) with regard to limitations 1.f-i, and in sections V(A)(3-4) (*i.e.*, Ground 1, claims 3-4) Sirinorakul inherently discloses the prior-art photoresist masking process. Here, Eslamy expressly teaches using a masking process to mask selected portions (*i.e.*, the area where the solder ball is to attach) while treating (*e.g.*, oxidizing) the exposed portion of the surface of the lead finger. Ex. 1006 at 2:41-47. And as explained earlier, an oxidized region is inherently less wettable to solder than a metal region. Thus, the combination of Sirinorakul and Eslamy—incorporating Eslamy's teachings into Sirinorakul's process—discloses all the additional limitations of claim 6. *See* Ex. 1003 at ¶¶ 88-89.

One of ordinary skill in the art would have been motivated to combine Eslamy with Sirinorakul because both references are in the same field—"flip-chip" semiconductor packaging—and both are directed at solving the same problem, *e.g.*, "preventing the solder from spreading out during reflow" according to Sirinorakul (Ex. 1004 at Abstract) or "avoiding deformation in the shape of a solder

connection" according to Eslamy (Ex. 1006 at Abstract). And treating Sirinorakul's leadframe in the manner taught by Eslamy is merely using a combination of known prior art elements and techniques to yield predictable results. *See* Ex. 1003 at ¶ 90; *see also KSR*, 550 U.S. at 401; MPEP § 2143(I) A.

2. Both Sirinorakul and Eslamy disclose the additional limitation—oxidizing part of the surface— of claim 7.

As shown above and in section V(B)(2)(*i.e.*, Ground 2, claim 7), both Eslamy and Sirinorakul disclose treating the second portion of the lead finger by oxidizing it. Thus, because claim 6 is obvious over Sirinorakul in view of Eslamy, claim 7 (which depends from claim 6) is also obvious because both references disclose the additional limitation. *See* Ex. 1003 at ¶ 94.

D. Ground 4: Claim 8 is obvious under 35 U.S.C. § 103(a) over Sirinorakul in view of Khor.

1. Khor discloses the additional elements of claim 8.

Khor discloses using the well-known prior art stencil-printing process to print a wetting material (*e.g.*, solder) onto the surface of a lead frame through stencil openings generally corresponding to the attachment area (*e.g.*, openings designed and adapted to match with solder bump locations on the die):

> "Solder element, preferably eutectic solder paste, is then deposited onto the lead finger of the lead frame (12) using preferably, stencil printing process to form solder element layers (14). Stencils opening (not shown) are designed and adapted to match with solder bumps locations formed on the semiconductor die."

Ex. 1008 at 3:66-4:4; *see also* Ex. 1008 at Fig 2:

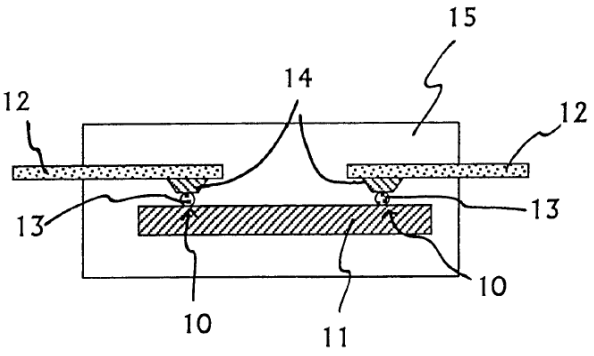


Figure 2

One of ordinary skill in the art would understand that using a stencil printing process necessarily requires placing a stencil proximate to the surface to be printed, and requires that the stencil have openings corresponding to the areas where the desired material should be printed. Ex. 1003 at ¶ 100. And using stencil printing to form an attachment area on the surface of a lead finger, as taught by Khor, is nothing more than a combination of familiar elements according to known methods that yields predictable results and, therefore, is obvious. Ex. 1003 at ¶ 101. *See KSR*, 550 U.S. at 401.

E. Ground 5: Claim 11 is anticipated under 35 U.S.C. § 102(b) by Greenwood.

1. Greenwood discloses all the elements of claim 11.

Claim 11 as disclosed by Greenwood
11. A method for fabricating a semiconductor assembly, comprising:
"The present invention relates generally to the packaging of electronic components. More particularly, the present invention relates to a method of fabricating a leadframe and a leadframe package." Ex. 1007 at 1:7-10. *See also* Ex. 1007 at Fig 6 (reproduced below) and 7:41-8:9 (diagram and description of a process for fabricating a semiconductor assembly in accordance

with an embodiment of the invention).

(11.a) forming an attachment area and a non-attachment area on a lead finger of a lead frame;

"Referring to FIGS. 1A and 1B together, laser **100** is fired at wettable region **102** of leadframe **104** resulting in the formation of a non wettable barrier **106**. More particularly, laser **100** modifies wettable region **102** to be non wettable barrier **106**.

. . .

Non wettable barrier **106** defines a wettable pad **108**, sometimes called a flip chip pad, of leadframe **104**. In one embodiment, leadframe **104** is formed of a wettable material such as copper. Laser **100** selectively modifies, e.g., oxidized [sic], wettable region **102** of leadframe **104** to form non wettable barrier **106**, which defines wettable pad **108**." Ex. 1007 at 3:26-39.

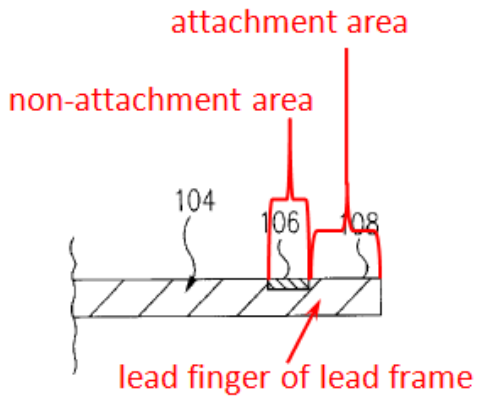


FIG. 1B

Ex. 1007 at Fig. 1B (annotated).

"Wettable pads **108** are wettable, sometimes called solder wettable, i.e., have the ability to be wet with molten solder." Ex. 1007 at 5:6-8.

"In contrast to wettable pads **108** and wettable lead surfaces **310**, non wettable barriers **106** are not wettable, i.e., do not have the ability to be wet with molten solder." Ex. 1007 at 5:15-18.

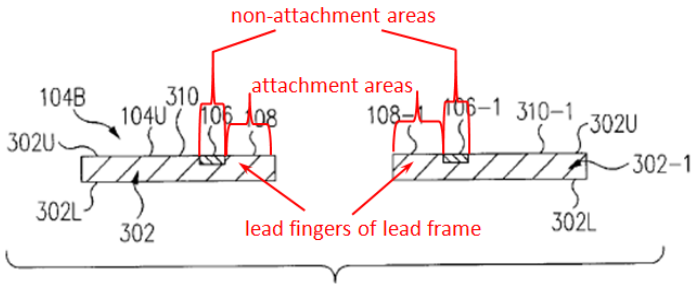


FIG. 4A

Ex. 1007 at Fig. 4A (annotated).

(11.b) contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger;

See Ex. 1007 at 7:10-40 (describing Fig. 5 as a package formed with the leadframe of Fig. 4A) and related text at 7:41-8:9:

"solder balls are formed on the bond pads of dies, i.e., electronic components **502**"

Ex. 1007 at 7:51-52.

"Electronic component **502** is then flip chip placed on leadframe **104**B such that the solder balls (not shown) on bond pads **504** are in abutting contact with wettable pads **108** in a Flip Chip Place Die on Leadframe Operation **612**. The assembly is then heated to reflow the solder balls and form bumps **506** in a Reflow Operation **614**."

Ex. 1007 at 7:59-64.

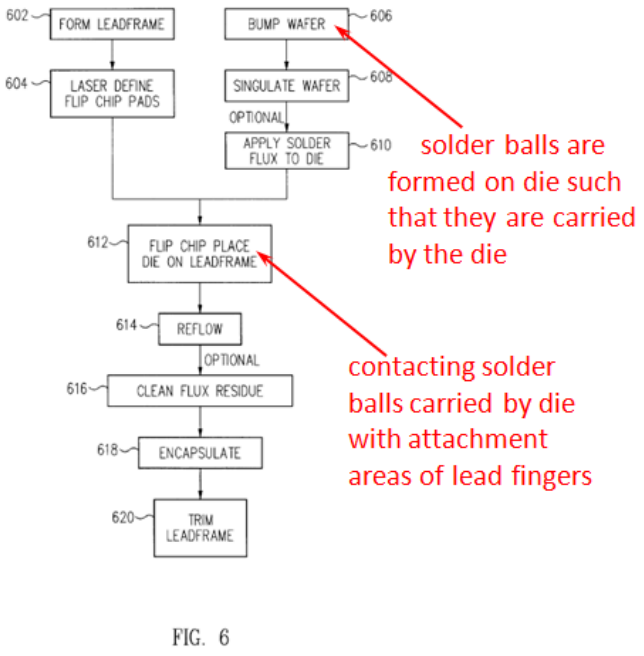


FIG. 6

Ex. 1007 at Fig. 6 (annotated).

(11.c) reflowing the solder ball while the solder ball is in contact with the attachment area of the lead finger; and

"The assembly is then heated to reflow the solder balls and form bumps **506** in a Reflow Operation **614**." Ex. 1007 at 7:62-64.

(11.d) preventing the solder ball from migrating away from the attachment area toward the non-attachment area; and wherein:

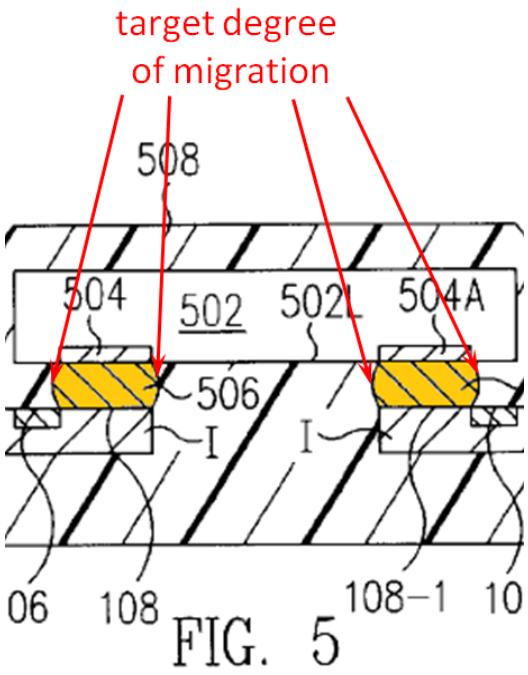
"Advantageously, non wettable barriers **106** prevent bumps **506** from running on to and contacting wettable lead surfaces **310**. Stated another way, non wettable barriers **106** insure [sic] that bumps **506** only contact wettable pads **108**." Ex. 1007 at 7:28-32.

"Advantageously, bumps **506** are confined to wettable pads 108 by non wettable barriers **106**" Ex. 1007 at 7:64-66.

(11.e) the attachment area has a first wettability to the solder ball during reflow;

(11.f) the non-attachment area has a second wettability to the solder ball during reflow; and

(11.g) preventing the solder ball from migrating includes treating at least one of the attachment area and the non-attachment area such that the second

wettability is less than the first wettability for a target amount;
"Generally, wettable pads **108** and wettable lead surfaces **310** have a greater wetability [sic] than non wettable barriers **106**." Ex. 1007 at 5:19-21. *See* 11.a, above (treating the non-attachment area with a laser). *See* 11.h, below (target amount of wettability).
(11.h) and the method further includes determining the target amount based on a target degree of migration of the solder ball from the attachment area during reflow;
"Non wettable barrier **106** defines a wettable pad **108**, sometimes called a flip chip pad, of leadframe **104**. In one embodiment, leadframe **104** is formed of a wettable material such as copper. Laser **100** selectively modifies, e.g., oxidized [sic], wettable region **102** of leadframe **104** to form non wettable barrier **106**, which defines wettable pad **108**." Ex. 1007 at 3:34-39. "Advantageously, non wettable barriers **106** prevent bumps **506** from running on to and contacting wettable lead surfaces **310**. Stated another way, non wettable barriers **106** insure [sic] that bumps **506** only contact wettable pads **108**. In this manner, bumps **506** are formed with a repeatable height, shorting of leads **302** is prevented, and formation of an open circuit between leads **302** and bond pads **504** is prevented." Ex. 1007 at 7:28-34.  Ex. 1007 at Fig. 5 (enlarged, excerpted, and annotated).
(11.i) and preventing the solder ball from migrating includes at least one of **(a) depositing silver (Ag) onto a first portion of the lead finger and** **(b) oxidizing a second portion of the lead finger.**
"More particularly, laser **100** selectively heats wettable regions of leadframe **104**B. The heated copper of leads **302** and, more particularly, wettable regions **102**, reacts with the oxygen in the air to form oxidized copper, this oxidized copper forming non wettable barriers **106**." Ex. 1007 at 6:3-8.

With reference to the claim chart above, Greenwood discloses all of the elements and limitations of claim 11. As an initial matter, to the extent that the preamble is a limitation, the citations in the chart above show that Greenwood is directed to a particular "flip-chip on leadframe fabrication method," which is a "method for fabricating a semiconductor assembly," as called for by claim 11's preamble. Ex. 1003 at ¶ 127.

i. Greenwood expressly discloses limitations 11.a-g, and 11.i.

With respect to limitation 11.a, Greenwood discloses forming an attachment area (*e.g.*, wettable pad 108) and a non-attachment area (*e.g.*, non wettable barrier 106) on a lead finger of a lead frame by using a laser to oxidize a portion of the leadframe and make it non-wettable. Ex. 1003 at ¶ 128.

With respect to limitation 11.b, Greenwood discloses contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger. Greenwood discloses that solder balls are first formed on the bond pads of the dies, and then the die (carrying the balls) is "flip chip placed" on the leadframe, bringing the balls into "abutting contact" with the wettable pads, which are the attachment areas of the lead fingers. Ex. 1003 at ¶ 129. Greenwood also shows the process in Fig. 6, reproduced above. One of ordinary skill would understand that step 606—"bump wafer"—means to apply solder balls to the die. Ex. 1003 at ¶ 39. And similarly, step 612—"flip chip place die on leadframe"—would be understood by

one of ordinary skill in the art to mean bringing the solder balls into contact with the leadframe. Ex. 1003 at ¶ 39.

With respect to limitation 11.c, Greenwood discloses reflowing the solder ball while the solder ball is in contact with the attachment area of the lead finger by disclosing that the assembly is heated to reflow the solder balls. Ex. 1007 at 7:62-64; Ex. 1003 at ¶ 130.

With respect to limitation 11.d, Greenwood as cited above discloses preventing the solder ball from migrating away from the attachment area toward the non-attachment area, explaining that the non-wettable barriers 106 (the non-attachment areas) prevent bumps 506 (the solder balls) from running on to and contacting lead surfaces 310 and that the bumps are "confined" to the wettable pads by the non-wettable barriers. Ex. 1007 at 7:28-32,7:64-66; Ex. 1003 at ¶ 131.

With respect to limitations 11.e-g, Greenwood discloses that the attachment area has a first wettability to the solder ball during reflow, that the non-attachment area has a second wettability to the solder ball during reflow, and that the second wettability is less than the first wettability, teaching specifically that wettable pads 108 (the attachment areas) have a greater wettability than non wettable barriers 106 (the non-attachment areas). Ex. 1007 at 5:19-21. It necessarily follows that if the wettability of one area is greater than that of another, the wettabilities must be *different* (*i.e.*, "first" and "second" wettabilities). *See* Ex. 1003 at ¶ 132.

With respect to limitation 11.i, Greenwood discloses oxidizing a second portion of the lead finger by heating it with a laser so that it reacts with oxygen to form copper oxide. Ex. 1007 at 6:3-8; Ex. 1003 at ¶ 133. Limitation 11.i calls for either depositing silver on one portion of the lead finger or oxidizing another portion; Greenwood's disclosure of oxidation anticipates this limitation. *See Brown v. 3M*, 265 F.3d 1349, 1351, 60 USPQ2d 1375, 1376 (Fed. Cir. 2001) ("When a claim covers several structures or compositions, either generically or as alternatives, the claim is deemed anticipated if any of the structures or compositions within the scope of the claim is known in the prior art.")

ii. Greenwood anticipates claim 11 by disclosing an example of the claimed range of target degrees and target amounts.

Limitation 11.g describes the difference in wettabilities to be a "target amount," which limitation 11.h requires to be determined "based on a target degree of migration of the solder ball from the attachment area during reflow."

As shown in the chart above, Greenwood expressly discloses a target degree of migration, that is, the width of the solder ball after reflow is slightly greater than the width of the wettable pad (*e.g.*, as shown in Fig. 5). And, the corresponding target amount of wettability difference is, for example, the difference in wettability between copper and copper oxide. Ex. 1007 at 3:34-39; Ex. 1003 at ¶ 135.

The ’899 patent does not claim a specific range of target degrees of migration or target amounts of wettability difference. Thus, it claims the full range of any and all of them. *See Falana,* 669 F.3d at 1355 (non-specific claim language encompassed entire class of compounds). Because Greenwood discloses at least one target degree of migration and a correspondingly determined target amount of wettability difference, it anticipates under section 102. *See In re Slayter*, 276 F.2d at 411, 125 U.S.P.Q. at 347; MPEP § 2131.02. *See also* Ex. 1003 at ¶ 134, 136.

iii. The ’899 patent merely attempts to explain the scientific principle for functionality disclosed in the prior art.

As explained above in section V(A)(7) (*i.e.*, Ground 1, claim 11—anticipation), the ’899 patent’s specification attempts to support limitations 11.g-h by citing to the scientific principle that there is a relationship between the amount of wettability difference of two adjacent regions and the degree of solder migration from the more wettable to the less wettable region. But this relationship and functionality are inherent, and therefore are necessarily disclosed by Greenwood. Ex. 1003 at ¶¶ 137-138. So all that the ’899 patent purports to add is a scientific explanation for the functionality disclosed in the prior art, and as such, is unpatentable under 35 U.S.C. § 102. *See* section V(A)(7)(iv), above (citing *Atlas Powder*, 190 F.3d at 1347; *Toro*, 355 F.3d at 1320).

F. Ground 6: Claim 11 is obvious under 35 U.S.C. § 103(a) over Greenwood.

1. Determining a target amount of wettability difference based on a target degree of migration requires only routine experimentation and is not inventive.

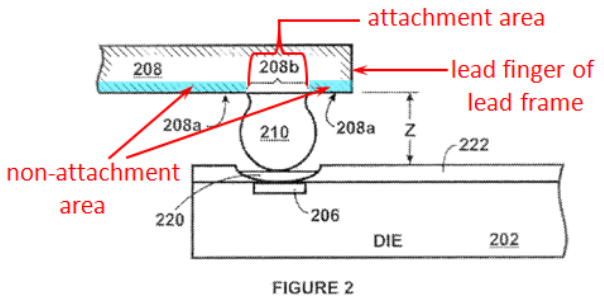
As shown above in Ground 5, Greenwood expressly discloses limitations 11.a-11.f and 11.i of claim 11. To the extent that Greenwood does not expressly or inherently disclose limitations 11.g and 11.h, these limitations—which require determining a target amount of wettability difference based on a target degree of solder migration—are, alternatively, obvious over Greenwood, for the same reasons that they are obvious over Sirinorakul (*see* Ground 2, above).[5] As Dr. Baker explains, Greenwood discloses the general conditions of the claim—that there is a relationship between wettability difference and degree of solder migration. Ex. 1003 at ¶ 139. Moreover, determining the optimum ("target") amount of wettability difference is not inventive, and thus not patentable, because it requires only routine experimentation by an ordinarily skilled artisan. Ex. 1003 at ¶ 140. *See In re Aller*, 105 U.S.P.Q. 223, 220 F.2d at 456 ("[W]here the general

[5] Although the *rationale* for these limitations being obvious over Greenwood is the same as for Sirinorakul, Greenwood is not redundant of Sirinorakul because it discloses the limitations of claim 11 in a different way than does Sirinorakul.

conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.").

G. Ground 7: Claim 11 is anticipated under 35 U.S.C. § 102(b) by Eslamy.

1. Eslamy discloses all of the elements of claim 11.

Claim 11 as disclosed by Eslamy
11. A method for fabricating a semiconductor assembly, comprising:
Ex. 1006 at Abstract; *id.* at 2:29-33 ("Embodiments in accordance with the present invention relate to techniques, employed alone or in combination, which avoid the problems of deformation in the shape of a solder connection in a flip chip package, resulting from solder reflow."); *id*. at claims 1-19, *e.g.* claim 1 ("A method of fabricating a package for a semiconductor device, the method comprising …").
(11.a) forming an attachment area and a non-attachment area on a lead finger of a lead frame;
"a solder-repellent surface is formed on the surface of the lead adjacent to the surface expected to be in contact with the solder connection." Ex. 1006 at 2:34-36. "In FIG. **2**, lead **208** is provided having portion **208***a* of its surface oxidized (for example Brown Oxide), and other portions **208***b* substantially free of oxide." Ex. 1006 at 2:41-44.  FIGURE 2 Ex. 1006 at Fig. 2 (annotated).
(11.b) contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger;
"Solder ball **210** is provided attached to pad **206** present on the top surface of the die." Ex. 1006 at 2:48-49. "In the step of attaching the lead **208** to the die via the solder contact, the solder ball is heated to above its reflow temperature." Ex. 1006 at 2:55-57. *See also* Ex. 1006 at Fig. 2, above.
(11.c) reflowing the solder ball while the solder ball is in contact with the

attachment area of the lead finger; and
"In the step of attaching the lead **208** to the die via the solder contact, the solder ball is heated to above its reflow temperature." Ex. 1006 at 2:55-57.
(11.d) preventing the solder ball from migrating away from the attachment area toward the non-attachment area; and wherein:
"In certain embodiments, a solder-repellent surface is formed on the surface of the lead adjacent to the surface expected to be in contact with the solder connection. This solder-repellent surface constrains reflow of the solder and thereby maintains the requisite vertical spacing between the lead and the die." Ex. 1006 at 2:34-39. "As shown in FIG. **2**, however, the presence of the oxidized lead portions **208***a* adjacent to the oxide-free lead portion **208***b* in contact with the solder, serve to restrain the flow of heated solder. In particular, the non-wettable character of the oxide inhibits the spread of the molten solder. Thus, while the portions of the solder distal from the lead may bulge, the solder proximate to the lead is constrained from flowing, and thereby allows the solder to substantially maintain its vertical profile." Ex. 1006 at 2:57-65.
(11.e) the attachment area has a first wettability to the solder ball during reflow; **(11.f) the non-attachment area has a second wettability to the solder ball during reflow; and** **(11.g) preventing the solder ball from migrating includes treating at least one of the attachment area and the non-attachment area such that the second wettability is less than the first wettability for a target amount;**
Ex. 1006 at 2:34-39 (*see* 11.d, above). Ex. 1006 at 2:40-46 (*see* 11.a, above). Ex. 1006 at 2:57-65 (*see* 11.d, above). "While the particular embodiment just described utilizes a bare Cu surface to receive the solder, this is not required by the present invention. In accordance with alternative embodiments, the surface that is configured to receive the solder may comprise a plated metal such as silver, or a stack of plated stack of metal such as Ni/Au or Ni/Pd/Au. In such embodiments, the wettability of the plated metal/metal stack may allow only a native oxide layer (rather than an intentionally grown Brown Oxide layer) to contain the flow of solder in the desired manner." Ex. 1006 at 3:9-18. *See* 11.h, below (target amount).
(11.h) and the method further includes determining the target amount based on a target degree of migration of the solder ball from the attachment area

during reflow;
Ex. 1006 at 2:57-65 (*see* 11.d, above). Ex. 1006 at 3:9-18 (*see* 11.e-g, above).
(11.i) and preventing the solder ball from migrating includes at least one of **(a) depositing silver (Ag) onto a first portion of the lead finger and** **(b) oxidizing a second portion of the lead finger.**
"In accordance with alternative embodiments, the surface that is configured to receive the solder may comprise a plated metal such as silver." Ex. 1006 at 3:9-11. "lead **208** is provided having portion **208***a* of its surface oxidized (for example Brown Oxide), and other portions **208***b* substantially free of oxide." Ex. 1006 at 2:41-44.

With reference to the claim chart above, Eslamy discloses all of the elements and limitations of claim 11. As an initial matter, to the extent that the preamble is a limitation, the citations in the chart above show that Eslamy is directed to, for example, a "method of fabricating a package for a semiconductor device" which is a "method for fabricating a semiconductor assembly" as required by claim 11's preamble. *See* Ex. 1003 at ¶ 142.

i. Eslamy expressly discloses limitations 11.a-g, and 11.i.

With respect to limitation 11.a, Eslamy discloses forming an attachment area (*e.g.*, portion 208*b*) and a non-attachment area (*e.g.*, solder-repellent portion 208*a*) on a lead finger (*e.g.*, lead 208) of a lead frame. Ex. 1003 at ¶ 143.

With respect to limitation 11.b, Eslamy discloses contacting a solder ball carried by a semiconductor die with the attachment area of the lead finger, stating that the solder ball is attached to a pad on the top surface of the die, (Ex. 1006 at

2:48-49) and then attached to the leadframe (Ex. 1006 at 2:55-57). *See* Ex. 1003 at ¶ 144.

With respect to limitation 11.c, Eslamy discloses reflowing the solder ball while the solder ball is in contact with the attachment area of the lead finger by heating the solder ball to "above its reflow temperature." Ex. 1005 at 2:55-57; *see also* Ex. 1003 at ¶ 145.

With respect to limitation 11.d, Eslamy discloses preventing the solder ball from migrating away from the attachment area toward the non-attachment area, explaining that the solder-repellent surface (the non-attachment area) constrains reflow of the solder (Ex. 1006 at 2:34-39) and that the oxidized lead portions adjacent to the oxide-free lead portions "restrain the flow of heated solder" so that "while portions of the solder … may bulge, the solder proximate to the lead is prevented from flowing" and the solder "substantially maintain[s] its vertical profile." Ex. 1006 at 2:57-65; *see also* Ex. 1003 at ¶ 146.

With respect to limitations 11.e-g, Eslamy discloses an attachment area (*e.g.*, a non-oxidized area, or a plated metal such as silver) and a non-attachment area (*e.g.*, an oxidized area, including a "native oxide layer" and an "intentionally grown Brown Oxide layer"). It is inherent in this disclosure that the attachment area (*e.g.*, plated silver, or a region substantially free of oxide) has a first wettability to solder and the non-attachment area (an oxidized region, which

Eslamy describes as a solder-*repellent* surface) has a second wettability, which is less than the first wettability. *See* Ex. 1003 at ¶ 29. A plated metal surface, or a metal surface substantially free of oxide (having the first wettability) is inherently more wettable to solder than an oxidized surface (having the second wettability), as was well-known in the art at the time of the '899 patent's filing. Ex. 1003 at ¶¶ 147-148. And intentionally growing Brown Oxide or plating silver are examples of treating the attachment or non-attachment areas so as to make the wettability of the non-attachment area less than that of the attachment area.

With respect to limitation 11.i, Eslamy discloses both depositing silver (Ag) onto a first portion of the lead finger (Ex. 1006 at 3:9-11) and oxidizing a second portion of the lead finger. Ex. 1006 at 2:41-44; *see also* Ex. 1003 at ¶ 149.

ii. Eslamy anticipates claim 11 by disclosing an example of the claimed range of target degrees and target amounts.

Limitation 11.g describes the difference in wettabilities to be a "target amount," which limitation 11.h requires to be determined "based on a target degree of migration of the solder ball from the attachment area during reflow."

As shown in the chart above, Eslamy discloses a target degree of migration, stating that "portions of the solder distal from the lead may bulge" but "the solder proximate to the lead is constrained from flowing and … substantially maintain[s] its vertical profile." Ex. 1006 at 2:62-65. And, the corresponding target amount of

wettability difference is, for example, the difference in wettability between copper and an oxide such as Brown oxide or the difference in wettability between plated silver (or gold) and a native oxide. Ex. 1006 at 3:9-18; Ex. 1003 at ¶ 151.

The '899 patent does not claim a specific range of target degrees of migration or target amounts of wettability difference. Thus, it claims the full range of any and all of them. *See Falana,* 669 F.3d at 1355 (non-specific claim language encompassed entire class of compounds). Because Eslamy discloses at least one target degree of migration and correspondingly determined target amount of wettability difference, it anticipates under section 102. *See In re Slayter*, 276 F.2d at 411, 125 U.S.P.Q. at 347; MPEP § 2131.02; *see also* Ex. 1003 at ¶¶ 150, 152.

iii. The '899 patent merely attempts to explain the scientific principle for functionality disclosed in the prior art.

As explained above in section V(A)(7) (*i.e.*, Ground 1, claim 11—anticipation), the '899 patent's specification attempts to support limitations 11.g-h by citing to the scientific principle that there is a relationship between the amount of wettability difference of two adjacent regions and the degree of solder migration from the more wettable to the less wettable region. But this relationship and functionality is inherent and necessarily disclosed by Eslamy. Ex. 1003 at ¶ 154. So all that the '899 patent purports to add is a scientific explanation for the functionality disclosed in the prior art, and as such, is unpatentable under 35

U.S.C. § 102. *See* section V(A)(7)(iv), above (citing *Atlas Powder Co.*, 190 F.3d at 1347; *Toro Co.*, 355 F.3d at 1320).

H. Ground 8: Claim 11 is obvious under 35 U.S.C. § 103(a) over Eslamy.

1. Determining a target amount of wettability difference based on a target degree of migration requires only routine experimentation and is not inventive.

As shown above in Ground 7, Eslamy expressly discloses limitations 11.a-11.f and 11.i of claim 11. To the extent that Eslamy does not expressly or inherently disclose limitations 11.g and 11.h, these limitations—which require determining a target amount of wettability difference based on a target degree of solder migration—are obvious over Eslamy for the same reasons that they are obvious over Sirinorakul (*see* Ground 2, above).[6] *First,* as Dr. Baker explains, Eslamy discloses the general conditions of the claim—that there is a relationship between wettability difference and degree of solder migration from one region to another. Ex. 1003 at ¶ 155. And *second*, determining the optimum ("target") amount of wettability difference is not inventive, and thus not patentable, because it requires only routine experimentation by an ordinarily skilled artisan. Ex. 1003

[6] Although the *rationale* for these limitations being obvious over Eslamy is the same as for Sirinorakul, Eslamy is not redundant of Sirinorakul because it discloses the limitations of claim 11 in a different way than does Sirinorakul.

at ¶ 156. *See In re Aller*, 105 U.S.P.Q. 223, 220 F.2d at 456 ("[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.").

VI. CONCLUSION

In light of the above, it is respectfully submitted that the claims 1-8 and 10-11 of the '899 patent are unpatentable under pre-AIA 35 U.S.C. §§ 102 and 103. Petitioner respectfully requests that an *inter partes* review be instituted and the subject claims cancelled.

Date: February 24, 2015

Respectfully submitted,

By /Andrew J. Gray IV/

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CERTIFICATE OF SERVI CE

The undersigned hereby certifies that a copy of the foregoing Petition for *inter partes* review of United States Patent No. 8,361,899 and all exhibits and other documents filed together with the petition were served on February 25, 2015 via FIRST CLASS MAIL on the attorney of record for the Patent Owner at the current correspondence address on file with the PTO:

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A copy of the foregoing Petition, exhibits and all other documents filed together with the petition were also served on February 24, 2015 via FedEx to MPS's counsel in the Northern District of California proceedings:

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The foregoing Petition, exhibits and documents were also served by email to:

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