

IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICROCHIP TECHNOLOGY INCORPORATED; AND
MICROSEMI CORPORATION
Petitioners

v.

BELL SEMICONDUCTOR, LLC
Patent Owner

Inter Partes Review Case No. IPR2021-00191

Patent No. 7,221,173

**PETITION FOR *INTER PARTES* REVIEW UNDER 35 U.S.C. §§ 311-319 AND
37 C.F.R. § 42**

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Patent Trial and Appeal Board
P.O. Box 1450
Alexandria, VA 22313-1450

November 16, 2020

LIST OF EXHIBITS

1001	Bachman et al., U.S. Patent No. 7,221,173 (“the ’173 patent”)
1002	Prosecution History File Wrapper of the ’173 patent
1003	U.S. Patent Publication No. 2003/0094966 (“ <i>Fang</i> ”)
1004	U.S. Patent No. 6,869,809 (“ <i>Yu</i> ”)
1005	U.S. Patent No. 7,235,412 (“ <i>Mardi</i> ”)
1006	U.S. Patent No. 6,765,228 (“ <i>Lin</i> ”)
1007	U.S. Patent Publication No. 2003/0173667 (“ <i>Yong</i> ”)
1008	Declaration of Dr. Stanley Shanfield, Ph.D.
1009	<i>Curriculum vitae</i> of Dr. Stanley Shanfield, Ph.D.
1010	U.S. Patent No. 5,550,480 (“ <i>Nelson</i> ”)
1011	U.S. Patent No. 6,744,067 (“ <i>Farnworth</i> ”)
1012	U.S. Patent No. 6,597,187 (“ <i>Eldridge</i> ”)
1013	Waizman et al., U.S. Patent No. 6,392,301 (“ <i>Waizman</i> ”)
1014	Hsu et al., U.S. Patent Application Publication 2005/0037601 (“ <i>Hsu</i> ”)

TABLE OF CONTENTS

I.	INTRODUCTORY STATEMENT.....	1
II.	REQUIREMENTS FOR REVIEW UNDER 37 C.F.R. § 42.104	1
A.	Standing Under 37 C.F.R. § 42.104(a).....	1
B.	Challenged Claims and Statutory Grounds Under 37 C.F.R. § 42.104(b)(1)-(2).....	1
C.	Unpatentability of Challenged Claims – 37 C.F.R. § 42.104(b)(4).....	2
D.	Supporting Evidence - 37 C.F.R. § 42.104(b)(5).....	2
III.	LEVEL OF ORDINARY SKILL IN THE ART.....	2
IV.	TECHNOLOGY BACKGROUND.....	3
V.	SUMMARY OF THE '173 PATENT.....	10
A.	The Patent.....	10
B.	Prosecution History	14
VI.	CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(B)(3).....	15
VII.	GROUND 1: CLAIMS 1-10 ARE ANTICIPATED BY <i>MARDI</i>	15
A.	Overview of <i>Mardi</i>	15
B.	Independent Claim 1.....	19
1.	Element 1[preamble] — “an interface assembly for a semiconductor wafer”	19
2.	Element 1[a] — “a flip chip bonding pad including a region for performing a bumping process; and”	20
3.	Element 1[b] — “a test pad integrally constructed with said bonding pad that form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”	22
4.	Element 1[c] — “said test pad being coplanar relative to said flip chip bonding pad and”	23

5.	Element 1[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”	24
C.	Claim 2 — “The interface assembly of claim 1 wherein said test pad may be disposed anywhere along a periphery of said bonding pad.”	27
D.	Claim 3 — “The interface assembly of claim 1 wherein said bonding pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”	28
E.	Claim 4 — “The interface assembly of claim 1 wherein said test pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”	28
F.	Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”	28
G.	Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”	31
H.	Claim 7 — “The interface assembly of claim 1 wherein the region to be bumped is defined by a first opening in a passivation layer.”	32
I.	Claim 8 — “The interface assembly of claim 7 wherein the probe region is defined by a second opening in said passivation layer, said first and second openings being spaced apart from one another.”	35
J.	Independent Claim 9.....	36
1.	Element 9[preamble] — “method for testing a semiconductor wafer prior to performing a flip chip bumping process”	36
2.	Element 9[a] — “providing a flip chip bonding pad having a region for performing said bumping process”	37

3.	Element 9[b] — “integrally constructing a test pad with said bonding pad to form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”	38
4.	Element 9[c] — “disposing said test pad coplanar with said flip chip bonding pad”	38
5.	Element 9[d] — “said test pad including a probe region for performing a wafer test prior to performing said bumping process”	39
K.	Independent Claim 10.....	39
1.	Element 10[preamble] — “an interface assembly for a semiconductor wafer”	39
2.	Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”	39
3.	Element 10[b] — “a test pad integrally constructed with said bonding pad”	39
4.	Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”	39
5.	Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”	40
6.	Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”	40
7.	Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”	40
VIII.	GROUND 2: CLAIMS 1-10 ARE OBVIOUS OVER <i>MARDI</i> IN VEIW OF A POSITA’S KNOWLEDGE	40
A.	Independent Claim 1 (and all dependent claims) — “wafer-level testing”	40

B.	Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”	44
C.	Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”	47
D.	Independent Claim 9 — “wafer test”	49
E.	Independent Claim 10 — “performing wafer-level testing”	49
IX.	GROUND 3: CLAIMS 1-4, 7 AND 9 ARE ANTICIPATED BY <i>LIN</i>	50
A.	Overview of <i>Lin</i>	50
B.	Independent Claim 1.....	51
1.	Element 1[preamble] — “an interface assembly for a semiconductor wafer”	51
2.	Element 1[a] — “a flip chip bonding pad including a region for performing a bumping process; and”	52
3.	Element 1[b] — “a test pad integrally constructed with said bonding pad that form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”	53
4.	Element 1[c] — “said test pad being coplanar relative to said flip chip bonding pad”	54
5.	Element 1[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”	55
C.	Claim 2 — “The interface assembly of claim 1 wherein said test pad may be disposed anywhere along a periphery of said bonding pad.”	56

D.	Claim 3 — “The interface assembly of claim 1 wherein said bonding pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”	57
E.	Claim 4 — “The interface assembly of claim 1 wherein said test pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”	58
F.	Claim 7 — “The interface assembly of claim 1 wherein the region to be bumped is defined by a first opening in a passivation layer.”	58
G.	Independent Claim 9.....	60
1.	Element 9[preamble] — “method for testing a semiconductor wafer prior to performing a flip chip bumping process”	60
2.	Element 9[a] — “providing a flip chip bonding pad having a region for performing said bumping process”	60
3.	Element 9[b] — “integrally constructing a test pad with said bonding pad to form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”	61
4.	Element 9[c] — “disposing said test pad coplanar with said flip chip bonding pad”	61
5.	Element 9[d] — “said test pad including a probe region for performing a wafer test prior to performing said bumping process”	62
X.	GROUND 4: CLAIMS 1-7 AND 9-10 ARE OBVIOUS OVER <i>LIN</i> IN VEW OF POSITA’S KNOWLEDGE	62
A.	Independent Claim 1 (and all dependent claims) — “performing wafer-level testing”	63
B.	Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”	65

A.	Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”	68
B.	Independent Claim 9 — “wafer test”	71
C.	Independent Claim 10.....	71
1.	Element 10[preamble] — “an interface assembly for a semiconductor wafer”	71
2.	Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”	71
3.	Element 10[b] — “a test pad integrally constructed with said bonding pad”	71
4.	Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”	71
5.	Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”	72
6.	Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”	72
7.	Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”	72
D.	Independent Claim 10 — “performing wafer-level testing”	72
XI.	GROUND 5: CLAIMS 5-6 AND 10 ARE OBVIOUS IN VIEW OF <i>LIN</i> AND <i>YONG</i>	72
A.	Overview of <i>Yong</i>	72
B.	Independent Claim 1.....	73
C.	Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”	73

D.	Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”	79
E.	Independent Claim 10.....	81
1.	Element 10[preamble] — “an interface assembly for a semiconductor wafer”	81
2.	Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”	81
3.	Element 10[b] — “a test pad integrally constructed with said bonding pad”	81
4.	Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”	81
5.	Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”	81
6.	Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”	82
7.	Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”	82
XII.	DISCRETIONARY DENIAL IS UNWARRANTED	82
XIII.	CONCLUSION.....	84
XIV.	FEES	84
XV.	MANDATORY NOTICES UNDER 37 C.F.R. § 42.8.....	84
A.	Real Parties-in-Interest Under 37 C.F.R. § 42.8(b)(1).....	84
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2).....	85
C.	Lead and Back-up Counsel Under 37 C.F.R. § 42.8(b)(3)	85
D.	Service Information Under 37 C.F.R. § 42.8(b)(4).....	86

I. INTRODUCTORY STATEMENT

Microchip Technology Incorporated and Microsemi Corporation (“Petitioners”) petition for *Inter Partes* Review (“IPR”) under 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.* of all claims (claims 1-10) of U.S. Patent No. 7,221,173 (“the ’173 patent”) (Ex. 1001), which is currently assigned to Bell Semiconductor, LLC (“Patent Owner”). Because it is reasonably likely that Petitioners will prevail on at least one challenged claim, the PTAB should institute review of the ’173 patent. *See* 35 U.S.C. § 314(a).

II. REQUIREMENTS FOR REVIEW UNDER 37 C.F.R. § 42.104

A. Standing Under 37 C.F.R. § 42.104(a)

Petitioners certify the ’173 patent is eligible for IPR and Petitioners are not barred or estopped from requesting IPR of the ’173 patent.

B. Challenged Claims and Statutory Grounds Under 37 C.F.R. § 42.104(b)(1)-(2)

Petitioners request IPR and cancellation of all claims (claims 1-10) of the ’173 patent on the following grounds.¹

¹ Unless otherwise noted, references to 35 U.S.C. §§ 102 and 103 are to the pre-AIA versions of the Patent Statute.

Ground	Basis	References	Challenged Claims
1	§ 102	<i>Mardi</i>	1-10
2	§ 103	<i>Mardi</i> and knowledge of POSITA	1-10
3	§ 102	<i>Lin</i>	1-4, 7, 9
4	§ 103	<i>Lin</i> and knowledge of POSITA	1-7, 9-10
5	§ 103	<i>Lin</i> , and <i>Yong</i>	5-6, 10

C. Unpatentability of Challenged Claims – 37 C.F.R. § 42.104(b)(4)

An explanation of why claims 1-10 are unpatentable is set forth below.

D. Supporting Evidence - 37 C.F.R. § 42.104(b)(5)

Petitioners rely upon the evidence cited in the List of Exhibits, including the Declaration of Stanley Shanfield, Ph.D. (Ex. 1008).

III. LEVEL OF ORDINARY SKILL IN THE ART

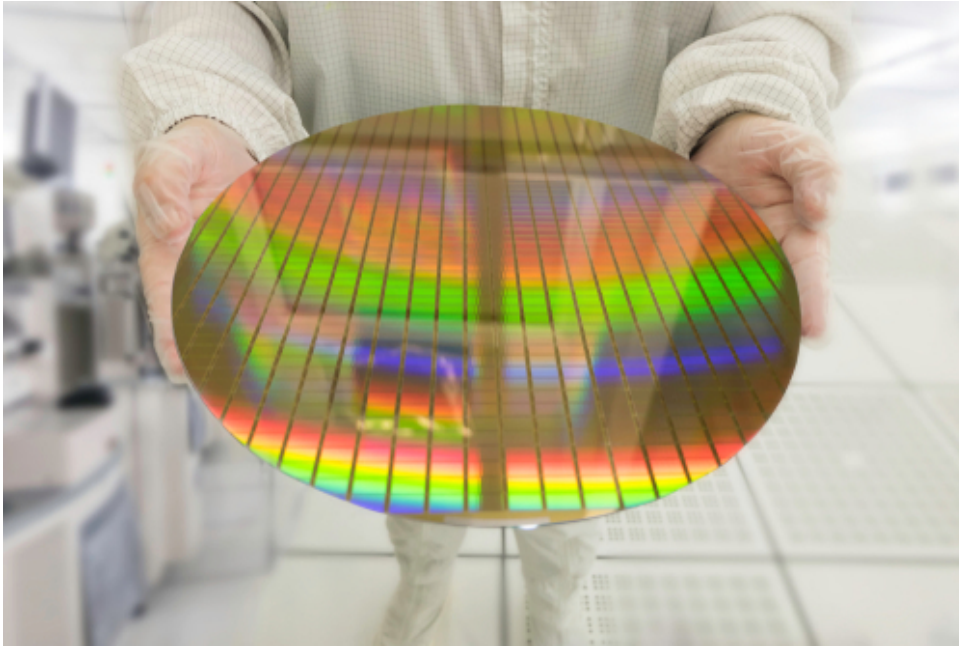
A “person of ordinary skill in the art” (POSITA) at the time of the effective filing date of the ’173 patent would have possessed at least a bachelor’s degree in physics or electrical engineering or a related field as well as at least three (3) years of experience in semiconductor wafer and packaging engineering and development, or alternatively would have an equivalent combination of advanced education and practical experience, such as a master’s or a Ph.D. degree and at least one (1) year

of experience in semiconductor wafer and packaging engineering and development.
Ex. 1008, ¶44.

IV. TECHNOLOGY BACKGROUND

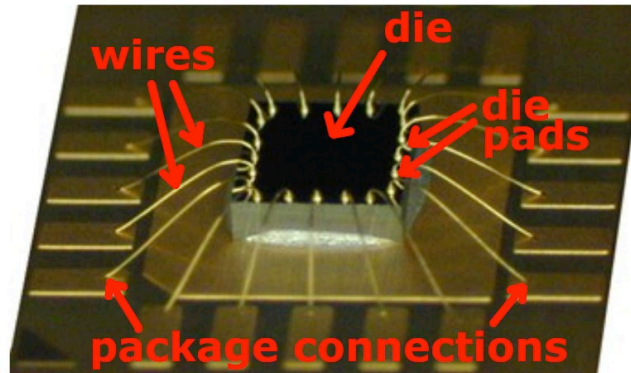
The technology at issue relates to testing flip chip semiconductor wafers prior to soldering bumps to the wafers. Ex. 1001-1, [54] (Title). Semiconductor devices, such as integrated circuit (“IC”) chips, are typically created on a silicon wafer. Ex. 1008, ¶18. A silicon wafer is a thin (usually circular) slice of silicon. *Id.* One wafer can contain tens to hundreds of individual IC chips, also known as “die.” *Id.* The image below shows an example wafer containing a number of ICs (each square is an identical IC):²

² The images in this Technology Background section were copied from the Internet and accurately illustrate the technology described. Ex. 1008, ¶18.

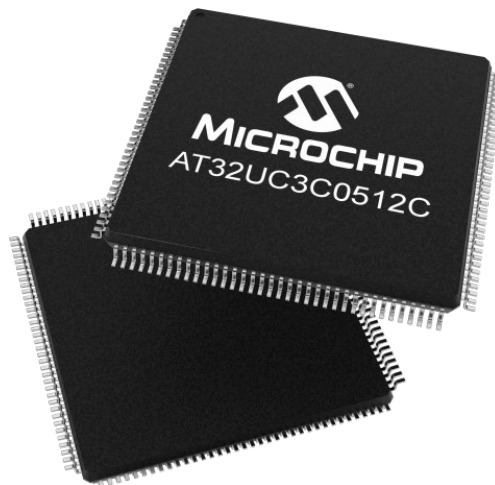


Id. Eventually, each die will be cut from the wafer in a process called “dicing.” The die will then be put into a “package” so that it can be connected to external circuitry such as a circuit board or another IC or wafer. Ex. 1008, ¶19.

One method of packaging a die uses a procedure known as “wire bonding.” Ex. 1008, ¶20. In a wire bonding process, the individual die is patterned with small pads of metal near its edges that serve as the connections to an eventual mechanical package. *Id.* After the die are cut from the wafer, they are electrically connected to their package terminals via wire bonding. *Id.* The image below shows metal wires attaching the pads around the perimeter of the die (“die pads”) to connections on the package (“package connections”):



Id. The package connections eventually lead to pins on the outside of the package, resulting in a final, packaged product like the one depicted below:



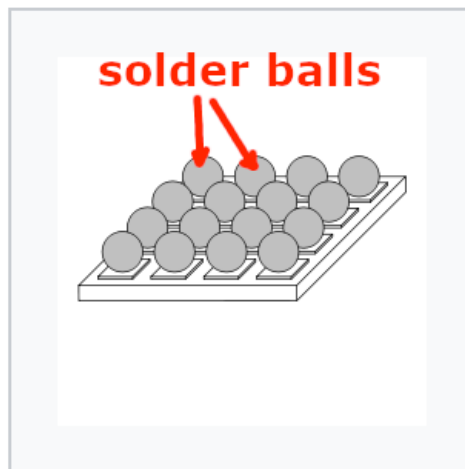
Ex. 1008, ¶21.

“Flip chip” packaging is a packaging technique that was developed in the 1960s. Ex. 1008, ¶22 (citing Aviation Week & Space Technology, Sept. 23, 1963, at 96 (“‘Flip-Chip’ Interconnections—Novel technique for packaging and interconnecting group of semiconductor microcircuit chips, in which 30 to 40 individual circuit function chips are interconnected . . . has been developed by General Electric’s Light Military Electronics Dept....”) (available at

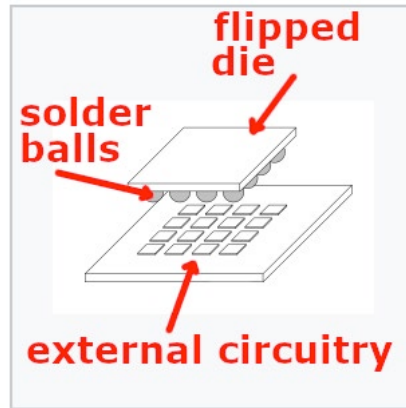
https://archive.org/stream/Aviation_Week_1963-09-23#page/n48/mode/1up) (last accessed Aug. 21, 2020)). For flip chip packaging, the attachment pads—also known as “bond pads”—on the die are metalized to make them more receptive to solder:



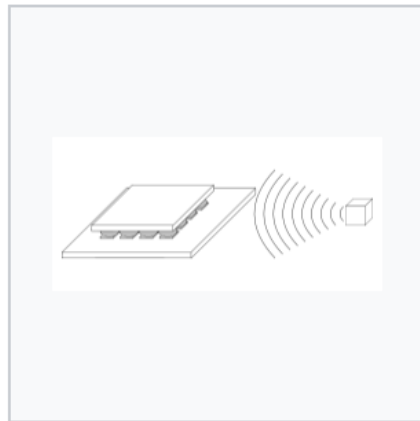
Ex. 1008, ¶23. Then, a small ball (or “bump”) of solder is deposited on each metalized bond pad on the die:



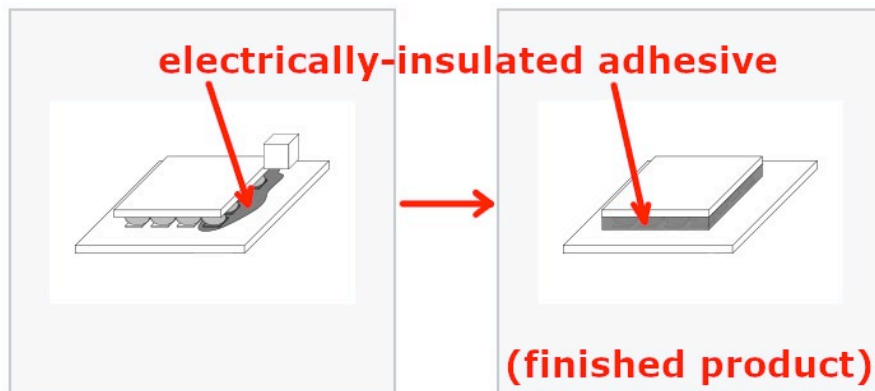
Ex. 1008, ¶24. The die is flipped and positioned so that the solder balls are facing the connectors on the external circuitry:



Ex. 1008, ¶25. The solder balls are then re-melted (typically using hot air):

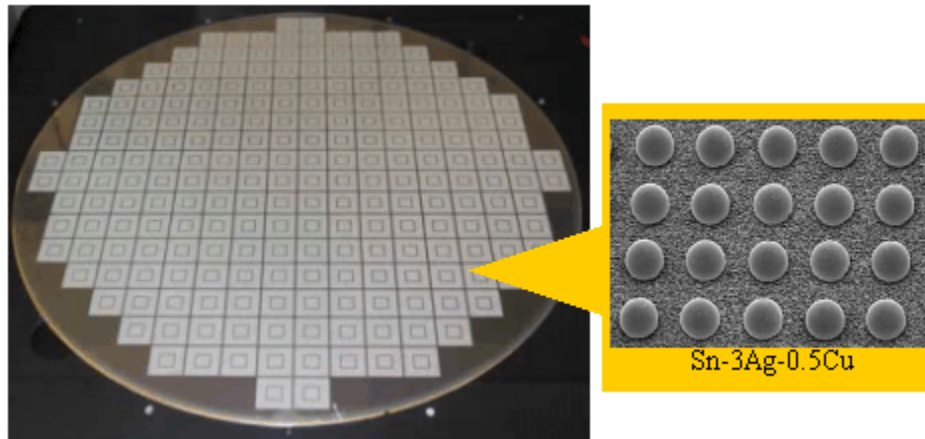


Ex. 1008, ¶26. The mounted die is “underfilled” using an electrically-insulated adhesive:



Ex. 1008, ¶27.

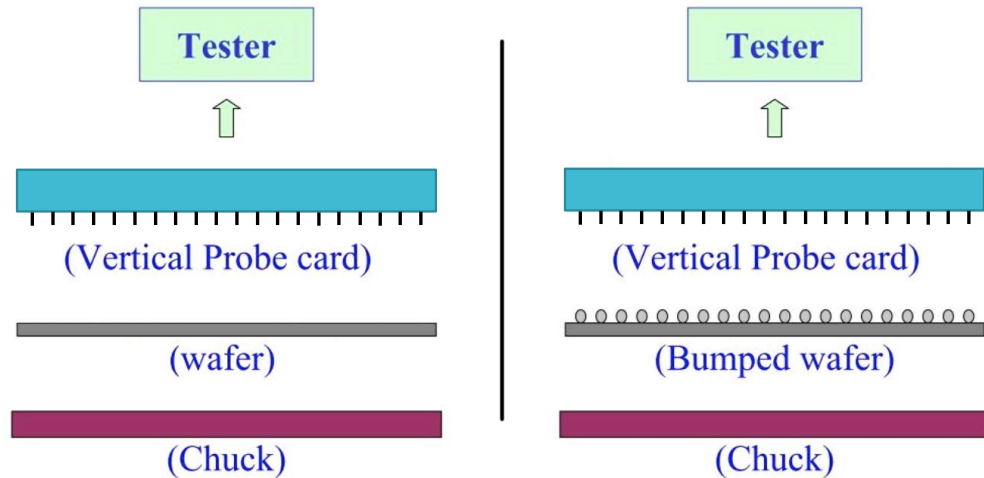
The above description of flip chip packaging leaves out a number of intermediate steps that involve testing of the die on the wafer. Ex. 1008, ¶28. In particular, it is typical that the solder balls/bumps are deposited onto the bond pads on a wafer *before the wafer is diced into individual die*. *Id.* A wafer with solder balls/bumps is shown below:



Id.

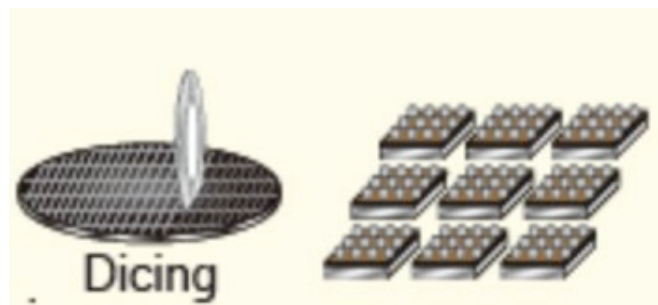
At some point before the wafer is diced into individual die/chips, the functionality of the chips are typically tested to make sure the manufacturing process produced functional chips. Ex. 1008, ¶29. Testing typically involves “probing” the wafer with a machine known as a tester. *Id.* The tester is connected to a “probe card” that includes “probes” that sit on top of the wafer during testing. *Id.* The testing can be done before the wafer is “bumped” (*i.e.*, solder balls deposited) or after, as depicted in the illustrations below. *Id.* During testing, the probes physically touch

either (1) the bond pads on the wafer (without solder balls/bumps) or (2) the solder balls/bumps:



Id. (The “chuck” is a part of the tester that holds the wafer in place during testing.)

After the circuitry in each die on the wafer is tested, and the solder balls/bumps deposited, the wafer is diced into individual die, as described above. Ex. 1008, ¶30. Unnecessary packaging costs are avoided because die that are found not to be functional during testing are discarded after dicing:



Id. Independent of whether wafers incorporate flip chip technology, semiconductor manufacturers are strongly motivated to test die for functionality before any

packaging operation. Ex. 1008, ¶31. A significant fraction of the cost of manufacturing an integrated circuit is associated with the packaging operation itself, *i.e.* die attachment, wiring bonding, encapsulation, etc. *Id.* In the very competitive IC manufacturing environment, testing individual die before packaging is normally an economic necessity. *Id.*

V. SUMMARY OF THE '173 PATENT

A. The Patent

The '173 patent was filed on September 29, 2004 and is titled “Method and Structures for Testing a Semiconductor Wafer Prior to Performing a Flip Chip Bumping Process,” and generally describes separate bonding and testing pads. Ex. 1001-1, [22], [54]. “Flip chip” generally refers to a direct electrical connection of face-down (hence, “flipped”) electronic components to circuit boards via conductive bumps on the chip bond pads. Ex. 1008, ¶32. The '173 patent teaches it was known at the relevant time that a semiconductor device would include a bump region 10 defined by an opening 12 in the passivation layer over a metal bonding pad 8, as shown in Figure 1 and identified as prior art:

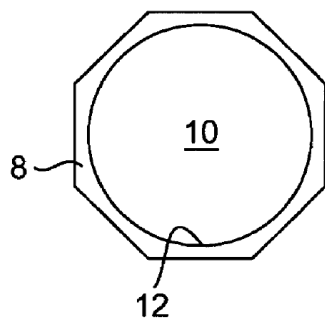
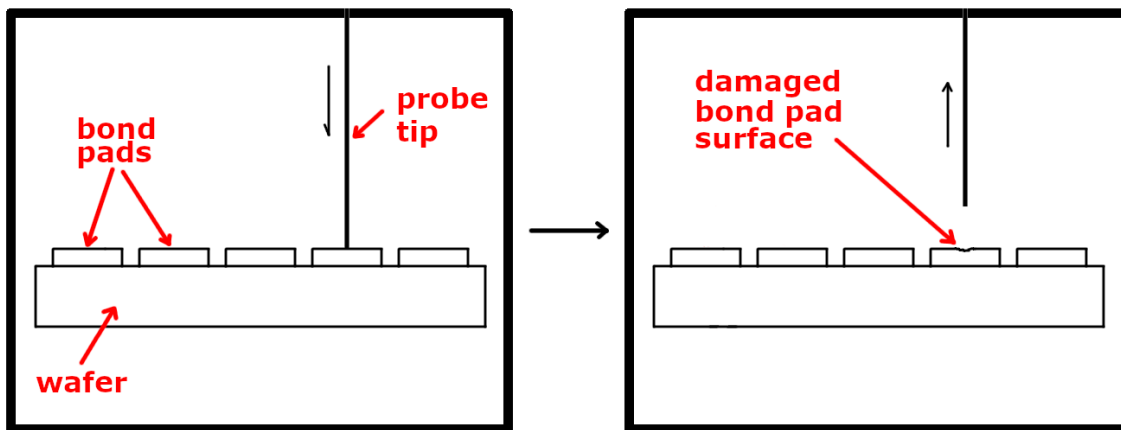


FIG. 1
(PRIOR ART)

Ex. 1008, ¶32; Ex. 1001-4, 1:28-37, 2:50-52; Ex. 1001-2, Fig. 1. It was also known to solder an electrically conductive bump to the bump region 10 to create a “flip chip” assembly. *Id.*

The '173 patent alleges damage to the bump region of the bond pad occurs when a test probe tip contacts the bump region prior to adding the solder bump. Ex. 1008, ¶33; Ex. 1001-4, 1:38-56. The test probe tip gouges the bump region and forms irregularities in the surface, which makes it difficult to adhere or solder the electrically conductive bump to the bump region. Ex. 1008, ¶33; Ex. 1001-4, 1:38-56. The alleged problem is illustrated in the cross-sectional view below:



Ex. 1008, ¶33.

Admitted prior art attempted to address these problems, including using test pads that are physically separate but electrically connected (by interconnect/trace lines) to the bond pad. Ex. 1008, ¶34; Ex. 1001-4, 1:56-60. Because the test pads are physically separate from the bond pads, the probe tip may damage the test pad

without consequence. Ex. 1008, ¶34. The solder bump is placed on the bond pad, not the damaged test pad. *Id.* This type of prior art test pad is discussed in U.S. Patent 6,869,809 (“*Yu*”) (Ex. 1004), which was cited during prosecution of the ’173 patent. Ex. 1001-1, [56]. *Yu*’s Figure 3A shows test pads 208a that are physically separate from bond pads 208, connected by interconnect/trace lines 209:

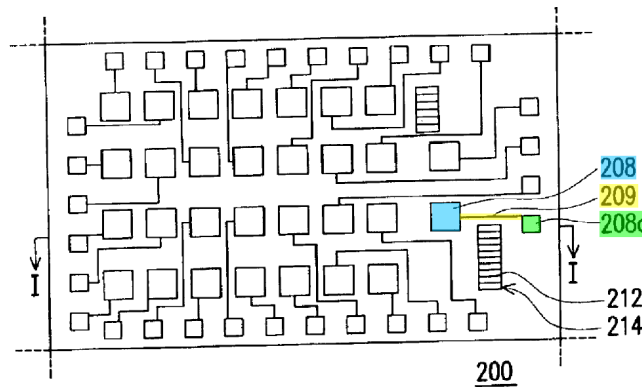


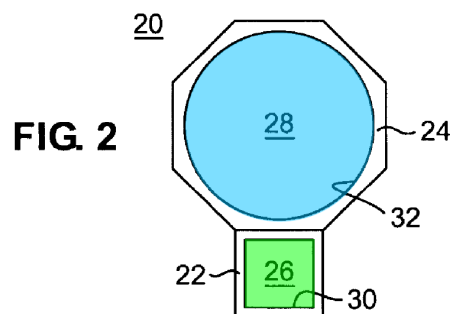
FIG. 3A

Ex. 1004-8, 4:52-55; Ex. 1004-4, Fig. 3A.³ According to the ’173 patent, these interconnect lines between are problematic because (1) they introduce undesirable propagation delays to test signals, and (2) they require “additional processing steps of deposition, pattern and etch.” Ex. 1001-4, 1:62-2:4; Ex. 1008, ¶36.

³ All highlighting, colors, and emphasis added to patent text or figures herein has been added. Any such citations should be understood to include an “(annotated)” and/or “(emphasis added)” parenthetical.

Another admitted prior art testing method involved probing the wafers after the bumping process is performed. Ex. 1001-4, 2:26-27. “[T]his attempt also fails to provide a fully satisfactory solution. For example, this post-bumping probing technique may lead to incremental costs since there is a possibility that the bumping process (that takes valuable time and resources) may have been performed in an already defective wafer....” Ex. 1001-4, 2:27-32; Ex. 1008, ¶37.

The ’173 patent explains “it would be desirable to provide structures and techniques for allowing a semiconductor device or wafer to be tested prior to a bumping process so that wafer level tests can be undertaken without compromising the integrity of the metal bonding pads therein and without introducing delays to signals used for test purposes.” Ex. 1001-4, 2:38-43; Ex. 1008, ¶38. Accordingly, the ’173 patent discloses “a conductive test pad 22 integrally constructed with a conductive bonding pad 24”:



Ex. 1001-5, 3:1-2, and Fig. 2. The bump region 28 and the probe region 26 are exposed through individual openings 32 and 30, respectively, in the passivation

layer. Ex. 1008, ¶39. The '173 patent suggests this configuration is advantageous because:

conductive test pad 22 provides a respective probe region 26 where a probe tip may be placed for performing, for example, wafer level testing. The bonding pad 24 includes a bump region 28 that is no longer subject to mechanical contact with the probe tip and resulting surface irregularities. It is envisioned that since the test pad and bonding pad comprise an integral structure that no longer requires interconnect lines and avoids or substantially reduces propagation delays in test signals passing therethrough, an interface assembly embodying aspects of the present invention should lead to more reliable and accurate test results.

Ex. 1001-5, 3:4-14; Ex. 1008, ¶39.

B. Prosecution History

The application for the '173 patent was filed September 29, 2004. Ex. 1001-1, [22]. The '173 patent issued on May 22, 2007. *Id.*, [45]. The prosecution history does not impact the art or arguments of this Petition. Ex. 1008, ¶43.

VI. CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(B)(3)

Unless otherwise noted below, Petitioners submit that terms should be given their plain meaning, but reserve the opportunity to respond to constructions offered by Patent Owner or adopted by the Board.⁴

VII. GROUND 1: CLAIMS 1-10 ARE ANTICIPATED BY *MARDI*

A. Overview of *Mardi*

U.S. Patent No. 7,235,412 (“*Mardi*”) (Ex. 1005), issued to *Mardi et al.* and titled “Semiconductor Component Having Test Pads and Method and Apparatus for Testing Same,” was filed on May 11, 2004 (Ex. 1005-1, [22]), and thus qualifies as §102(e) prior art because it was filed before the ’173 patent’s September 29, 2004 filing date. *Mardi* is directed to testing flip chip semiconductor wafers prior to bump soldering. Ex. 1005-1, [52], [57]; Ex. 1008, ¶48.

⁴ Petitioners do not concede the challenged claims meet all statutory standards. Patentability under §101 or compliance with §112 is not appropriate for IPR, and Petitioners reserve all rights to challenge claims for reasons outside the scope of IPR. Petitioners may advance specific constructions consistent with the plain and ordinary meaning in the related district court proceeding.

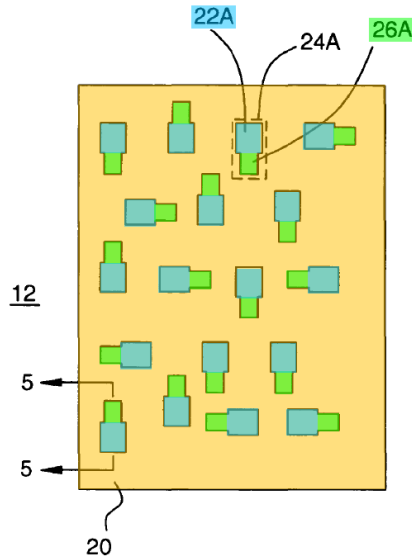


FIG. 4

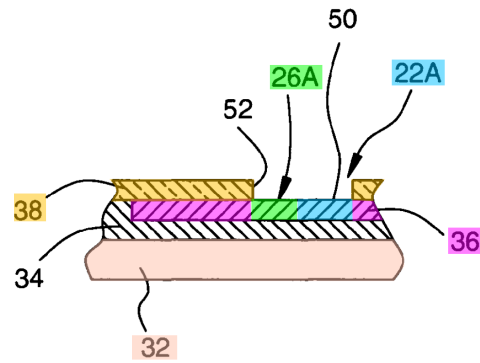
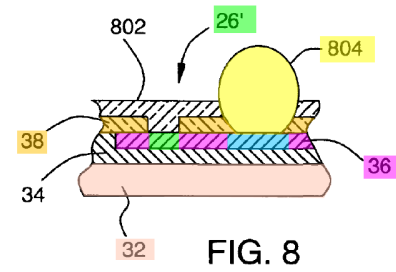
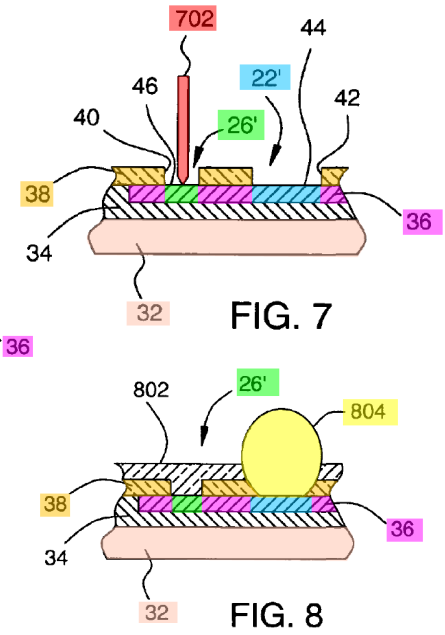
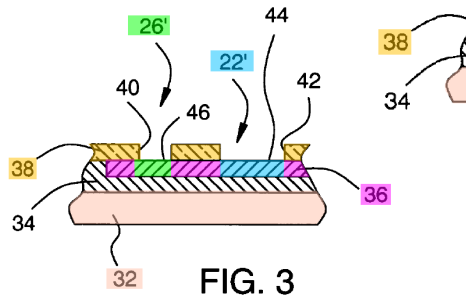
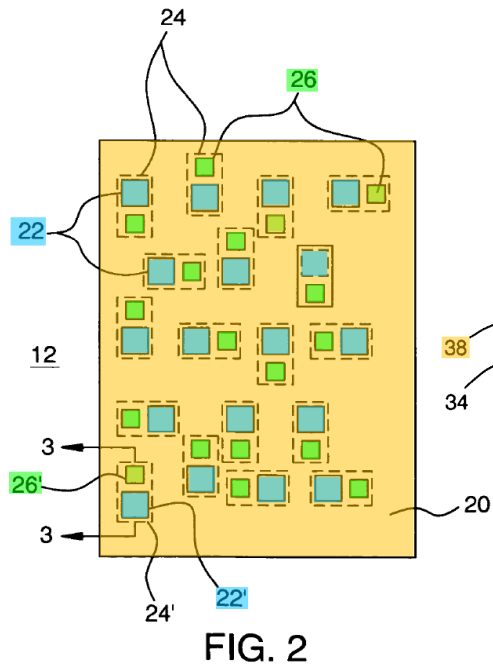


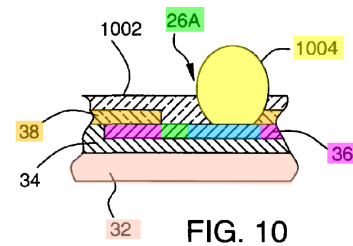
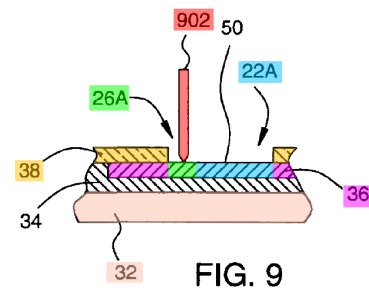
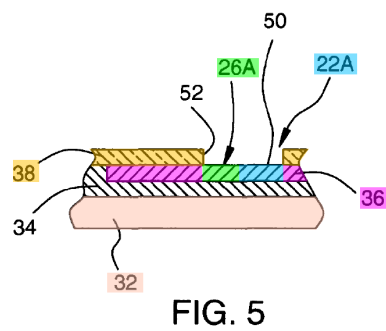
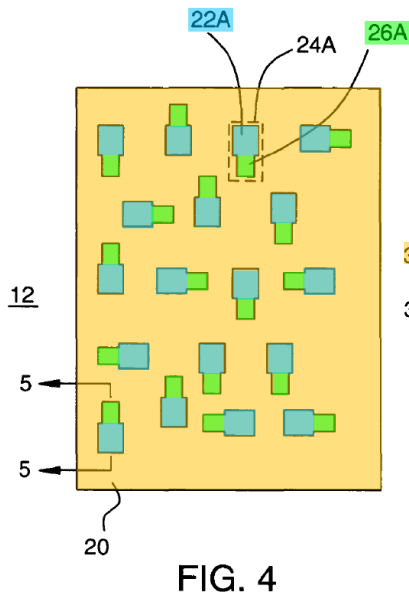
FIG. 5

Ex. 1005-3, Figs. 4-5. *Mardi* discloses **test pads 26A** and **bond pads 22A** are integrated together as “separate regions” of a **top conductor layer 36**. Ex. 1005-8, 5:34-44; Ex. 1008, ¶48. A method for testing flip chip semiconductor wafers is also disclosed, wherein the semiconductors are probe tested via the test pads prior to soldering bumps on the bond pads. Ex. 1005-9, 7:24-36; Ex. 1005-4, Fig. 6; Ex. 1008, ¶48.

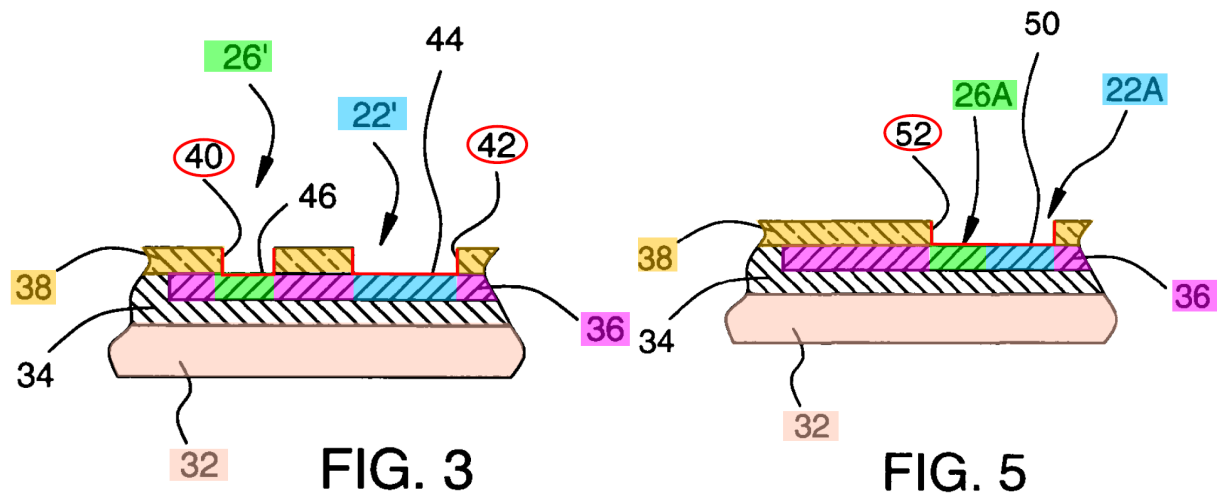
Mardi discloses at least two exemplary embodiments. The first is depicted in Figures 2-3 and 7-8 (“First Mardi Embodiment”):



Ex. 1005-6, 2:53-59; Ex. 1005-7, 3:3-5; Ex. 1005-2, Figs. 2-3; Ex. 1005-5, Figs. 7-8; Ex. 1008, ¶49. The second is depicted in Figures 4-5 and 9-10 (“Second Mardi Embodiment”):



Ex. 1005-6, 2:6-65; Ex. 1005-7, 3:6-8; Ex. 1005-3, Figs. 4-5; Ex. 1005-5, Figs. 9-10; Ex. 1008, ¶49. One difference between the two embodiments is the number of openings in passivation layer 38. In the First Mardi Embodiment, there are separate openings for the test pad and bond pad (“opening 40” and “opening 42”), while the Second Mardi Embodiment only has one opening for both (“opening 52”):



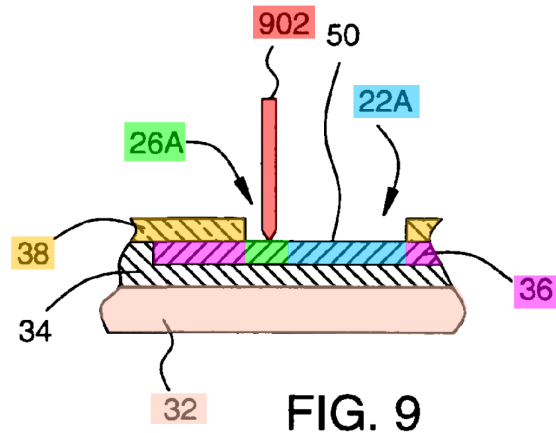
Ex. 1005-7, 4:59-62; Ex. 1005-8, 5:34-35; and Ex. 1005-2 to -3, Figs. 3, 5; Ex. 1008, ¶50.

B. Independent Claim 1⁵

1. Element 1[preamble] — “an interface assembly for a semiconductor wafer”

To the extent the preamble is limiting, *Mardi* discloses this element. Ex. 1008, ¶¶53-55. *Mardi* teaches a semiconductor wafer with bond pads and test pad interfaces (“interface assembly”) for testing the semiconductor wafer prior to soldering balls to the bond pads. Ex. 1005-1, [57] (“A semiconductor component having **test pads** and a method and apparatus for testing the same is described.”). The “invention relates to testing a semiconductor component” (Ex. 1005-6, 1:62-63), and “[t]he semiconductor component 11 comprises a substrate 10 ... [which] may be a wafer....” Ex. 1005-7, 3:18-23. The **test pad** provides an “interface assembly” whereby a **probe element 902** may be brought into contact with the **test pad 26A** to interface with the semiconductor wafer. Ex. 1008, ¶55.

⁵ The mapping of claim elements 1[preamble]-[d] is directed at the Second Mardi Embodiment found in Figures 4-5 and 9-10. That mapping applies equally to the First Mardi Embodiment shown in Figures 2-3 and 7-8. Ex. 1008, ¶ 65.1.



Ex. 1005-5, Fig. 9. “In this manner, the die or dice of the substrate may be tested or ‘burned-in’ before further processing (e.g., bumping, packaging, etc.).” Ex. 1005-8, 6:21-23; Ex. 1008, ¶55.

2. Element 1[a] — “a flip chip bonding pad including a region for performing a bumping process; and”

Mardi discloses this element. Ex. 1008, ¶¶56-57. In *Mardi*, “bond pad 22A” corresponds to the claimed “flip chip bonding pad including a region for performing a bumping process.”

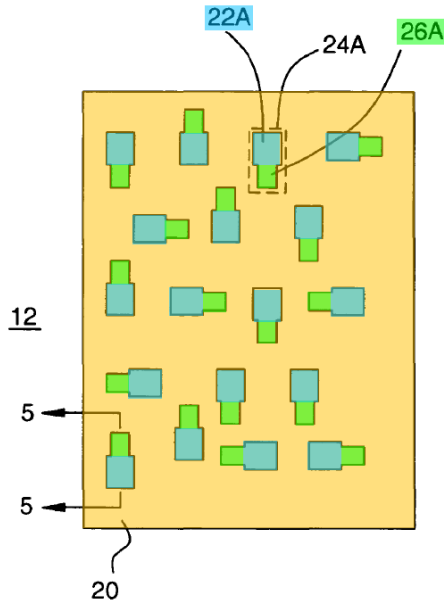


FIG. 4

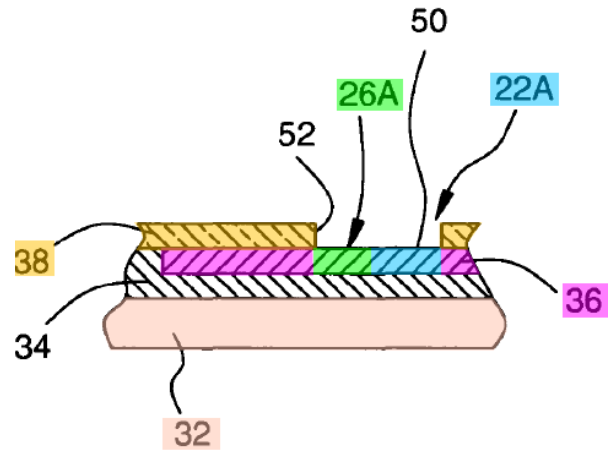


FIG. 5

Ex. 1005-3, Figs. 4-5. The “test/bond pad pair 24A” is a flip chip bonding pad. Ex. 1005-8, 5:5-11 (“bond pads 22 are adapted to support bumped contacts (e.g., solder balls) for providing external electrical connections for the semiconductor die 12. Once the bumped contacts are in place, the semiconductor die 12 may be ‘flip chip’ mounted (i.e., circuit-side down) to mating electrodes on a supporting substrate, such as a circuit board or lead-frame.”)

The **bond pad 22A** includes a region for performing a bumping process because “bond pads 22 are adapted to support bumped contacts (e.g., solder balls) for providing external electrical connections for the semiconductor die 12.” Ex. 1005-8, 5:5-11; *see also* Ex. 1005-8, 5:26-33 (“With simultaneous reference to FIGS. 4 and 5, in the present embodiment, the semiconductor die 12 includes a pattern of test/bond pad pairs 24A embedded within the die passivation layer 38.

Each of the test/bond pad pairs 24A comprises a die contact portion (‘bond pad 22A’) in electrical communication with a test contact portion (‘test pad 26A’). FIG. 5 shows a cross-section of one of the test/bond pad pairs 24A.” Ex. 1008, ¶57.

3. Element 1[b] — “a test pad integrally constructed with said bonding pad that form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”

Mardi discloses this element. Ex. 1008, ¶¶58-61. The “test pad 26A” in *Mardi* corresponds to the claimed “test pad.”

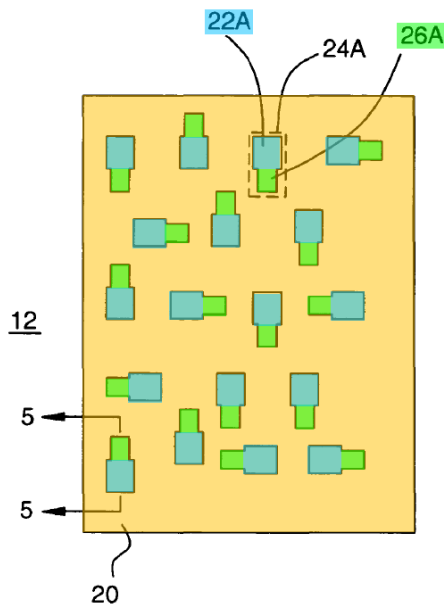


FIG. 4

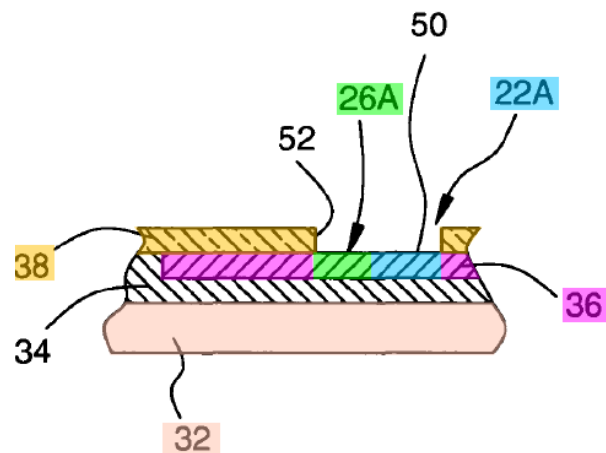


FIG. 5

Ex. 1005-3, Figs. 4-5.

Further, the “bond pad 22A” and the “test pad 26A” are integrally constructed as an integral conductive structure, as claimed. Ex. 1005-8, 5:29-33 (“the semiconductor die 12 includes a pattern of test/bond pad pairs 24A embedded

within the die passivation layer 38. Each of the test/bond pad pairs 24A comprises a die contact portion (**‘bond pad 22A’**) in electrical communication with a test contact portion (**‘test pad 26A’**). FIG. 5 shows a cross-section of one of the test/bond pad pairs 24A.”) Ex. 1008, ¶59.

There are no interconnect testing lines between the **test pad 26A** and the **bond pad 22A**. Ex. 1005-8, 5:34-44 (“The top conductor layer 36 electrically couples the **bond pad 22A** with the **test pad 26A**. The **test pad 26A** may be considered as an ‘extended test pad’ with respect to the **bond pad 22A**.”) The integral nature of the test/bond pad pairs 24A is evident from (1) the shape of element 24A in Figure 4, and (2) the fact that the **bond pad 22A** and the **test pad 26A** are merely “separate regions of the section 50 of the top conductor layer 36” (shown in Fig. 5). Ex. 1005-8, 5:39-44; Ex. 1005-3, Fig. 4; Ex. 1008, ¶¶60-61.

4. Element 1[c] — “said test pad being coplanar relative to said flip chip bonding pad and”

Mardi discloses this element. Ex. 1008, ¶62. In *Mardi*, **test pad 26A** is coplanar with the **bond pad 22A** because they are merely “regions” of the same conductor layer.

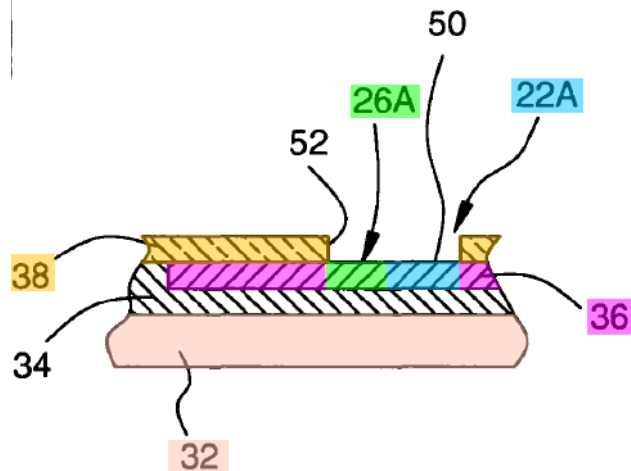
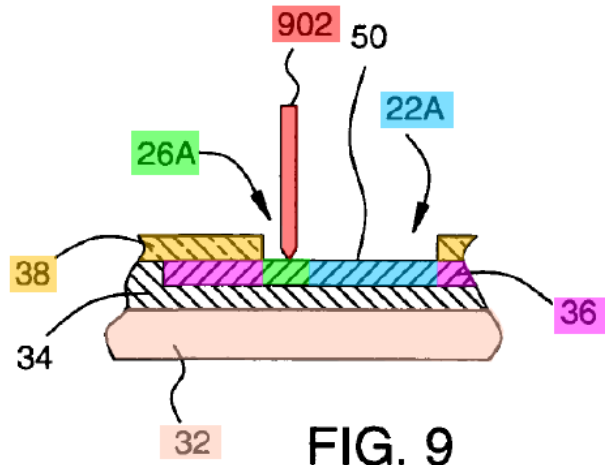


FIG. 5

Ex. 1005-3, Fig. 5; Ex. 1005-8, 5:34-44 (“In the present embodiment, each of the test/bond pad pairs 24A is located in an opening 52 of the passivation layer 38 and comprises a section 50 of the top conductor layer 36. A first portion of the section 50 defines the **bond pad 22A**, and a second portion of the section 50 defines the **test pad 26A**. That is, the **bond pad 22A** and the **test pad 26A** comprise separate regions of the section 50 of the top conductor layer 36.”)

5. Element 1[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”

Mardi discloses this element. Ex. 1008, ¶¶63-65. Figure 9 illustrates that **test pad 26A** is a probe region during wafer-level testing because “a **probe element 902** is in contact with the portion of the conductor section 50 that defines the **test pad 26A**.” Ex. 1005-9, 7:31-32.



Ex. 1005-5, Fig. 9. Further, “the **test pad 26A** may be used to test the semiconductor die 12 *before the semiconductor die 12 is bumped* [*i.e.* the ‘bumping process’] and without contacting the **bond pad 22A**.” Ex. 1005-8, 5:54-56.

Figure 6 confirms the test pad’s probe region is for performing wafer-level testing prior to performing the bumping process:

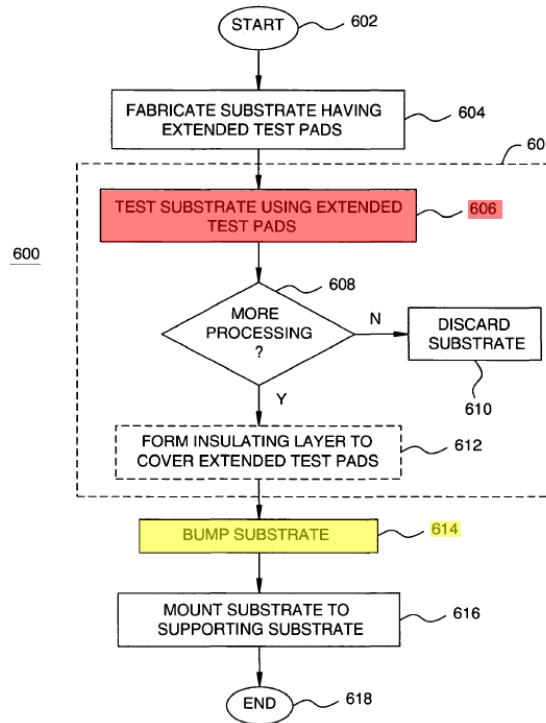
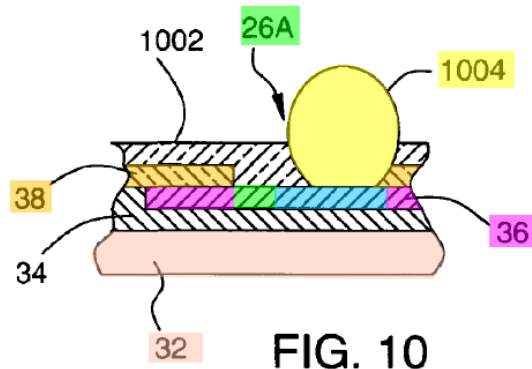


FIG. 6

Ex. 1005-4, Fig. 6. Test pads are fabricated in step 604, the substrate is tested using the probe regions at step 606 (“wafer-level testing”), and the “bumping process” is performed later in step 614. Ex. 1005-9, 7:24-36 (“... FIG. 5 depicts a cross-section of the test/bond pad pair 24A after *fabrication at step 604*. FIG. 9 depicts a cross-section of the test/bond pad pair 24A during the *testing at step 606*. Notably, a **probe element 902** is in contact with the portion of the conductor section 50 that defines the **test pad 26A**. The **probe element 902** does not contact the portion of the conductor section 50 that defines the **bond pad 22A**. Thus, damage to the **bond pad 22A** is avoided during the testing at step 606.”); Ex. 1005-8, 6:51-55 (“At *step 614*,

the semiconductor substrate is bumped ... using a conventional bumping process.”).



Ex. 1005-5, Fig. 10. Figure 10 shows “a bumped contact 1004 formed in electrical communication with the **bump pad 22A**.” Ex. 1008, ¶¶64-65.

C. Claim 2 — “The interface assembly of claim 1 wherein said test pad may be disposed anywhere along a periphery of said bonding pad.”

Mardi discloses this claim. Ex. 1008, ¶66. *Mardi* explains the test pad in the First *Mardi* Embodiment may be anywhere along the periphery of the bonding pad. Ex. 1005-7, 4:30-33 (“Illustratively, the test pad 26' may be disposed at any point around the perimeter of the bond pad 22'....”) Likewise, *Mardi* explains the test pad in the Second *Mardi* Embodiment may anywhere along the periphery of the bond pad because “[t]he shapes and sizes of the bond pad 22A and the test pad 26A may be selected substantially as described above with respect to FIGS. 2 and 3,” *i.e.*, the First *Mardi* Embodiment. Ex. 1005-8, 5:48-50.

D. Claim 3 — “The interface assembly of claim 1 wherein said bonding pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”

Mardi discloses this claim. Ex. 1008, ¶67. *Mardi* expressly describes polygonal and circular shaped bonding pads: “The bond pad 22A and the test pads 26 may be generally square as illustrated in FIG. 2, or may have other shapes known in the art (e.g., other polygonal or elliptical shapes).” Ex. 1005-7, 4:6-8.

E. Claim 4 — “The interface assembly of claim 1 wherein said test pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”

Mardi discloses this claim. Ex. 1008, ¶68. *Mardi* expressly describes polygonal and circular shaped test pads: “The bond pad 22A and the test pads 26 may be generally square as illustrated in FIG. 2, or may have other shapes known in the art (e.g., other polygonal or elliptical shapes).” Ex. 1005-7, 4:6-8.

F. Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”

Mardi discloses this claim. Ex. 1008, ¶¶69-72. The **top conductor layer 36** of *Mardi* corresponds to the claimed “first metal redistribution layer.”

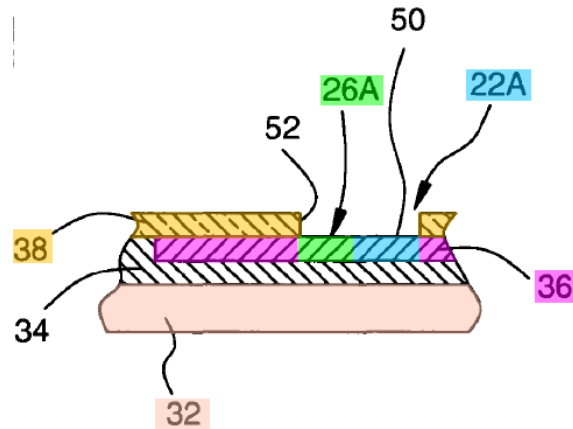


FIG. 5

Ex. 1005-3, Fig. 5. The **test pad 26A** and the **bond pad 22A** are electrically connected to the **top conductor layer 36** because they are a section of that layer. See Ex. 1005-8, 5:34-41 (“each of the test/bond pad pairs 24A [*i.e.*, **test pad 26A** and **bond pad 22A**] . . . comprises a section 50 of the **top conductor layer 36**”). As illustrated and described, **top conductor layer 36** is a redistribution layer because it provides electrical communication between the **test pad 26A** and **bond pad 22A** and various semiconductor devices (semiconductor circuits) within the semiconductor. Ex. 1005-7, 4:36-39 (**top conductor layer 36** is “in electrical communication with the various semiconductor devices (semiconductor circuits) within the **semiconductor portion 32**.”) Ex. 1008, ¶69.

As shown in Figure 5, the **top conductor layer 36** extends under the **passivation layer 38** for some distance beyond the **test pad 26A** and **bond pad 22A**, which is typical for a “redistribution layer.” The extending “redistribution layer” portion of the **top conductor layer 36** is coplanar with the **test pad 26A** and **bond**

pad 22A because all are part of the same “top conductor layer 36.” Ex. 1005-8, 5:34-36; Ex. 1008, ¶70.

Further, a conductor layer within the internal conductor portion 34 may also correspond to the “first metal redistribution layer” because “internal conductor portion 34 compris[es] one or more internal conductor layers between the substrate portion 32 and the top conductor layer 36.” Ex. 1005-7, 4:39-42. As illustrated in Figure 5, the uppermost portion of conductor portion 34 is coplanar with the test pad 26A and bond pad 22A. That portion would be electrically connected to other metal layers using vias: “all of the conductor layers may be separated by respective insulating layers, and may be connected to each other using vias (not shown for simplicity).” Ex. 1005-8, 5:42-45; Ex. 1005-3, Fig. 5; Ex. 1008, ¶71.

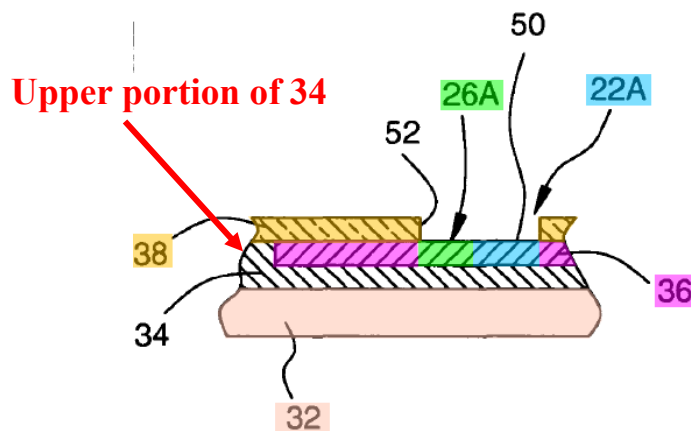


FIG. 5

Similarly, all of the test/bond pad pairs 24' (Figure 2) and 24A (Figure 4) are on the same plane because the “the bond pads 22 and the test pads 26 [are] disposed below the level of the die passivation layer 38.” Ex. 1005-7, 4:1-5. Thus, other

test/bond pad pairs are part of the same “redistribution layer” and are coplanar with the **test pad 26A** and **bond pad 22A**. Ex. 1008, ¶72.

G. Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”

Mardi discloses this claim. Ex. 1008, ¶¶73-75. *Mardi* expressly discloses vias are used to connect “redistribution layers” at different planes within the semiconductor. As noted above with respect to claim 5, the **top conductor layer 36** and/or the uppermost conductor layer within the internal conductor portion 34 correspond to a “redistribution layer” as claimed. Ex. 1005-8, 4:36-39.

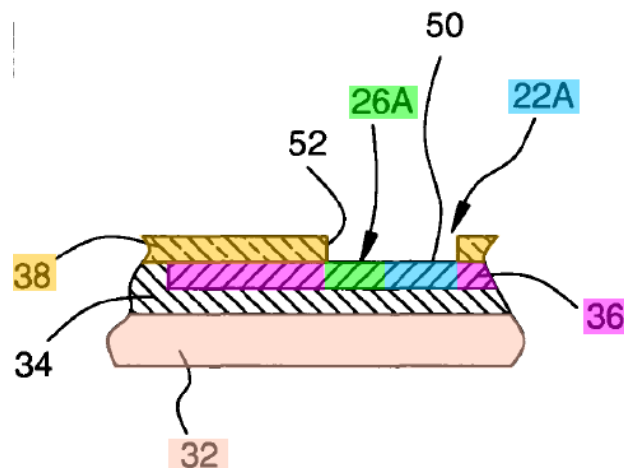


FIG. 5

Ex. 1005-3, Fig. 5.

Lower conductor layers in the “internal conductor portion 34” of *Mardi* correspond to the claimed “second redistribution layer” because portion 34 includes “one or more internal conductor layers between the **substrate portion 32** and the

top conductor layer 36” (Ex. 1005-7, 4:39-42) and it “may be in electrical communication with the **top conductor layer 36** and the semiconductor devices/circuits within the **semiconductor portion 32**.” Ex. 1005-7, 4:45-48; Ex. 1008, ¶74.

Mardi teaches these “redistribution layers” may be connected by vias: “all of the conductor layers may be separated by respective insulating layers, and may be connected to each other using vias (not shown for simplicity).” Ex. 1005-7, 4:42-45. Because *Mardi* discloses there are insulating layers separating all of the conductor layers (including **top conductor layer 36** and any conductor layer(s) inside internal conductor portion 34), *Mardi* expressly discloses the conductor layers are disposed in different planes. Ex. 1008, ¶75.

H. Claim 7 — “The interface assembly of claim 1 wherein the region to be bumped is defined by a first opening in a passivation layer.”

Mardi discloses this claim. Ex. 1008, ¶¶76-80. In the First *Mardi* Embodiment, the “**opening 42**” is the claimed “first opening”:

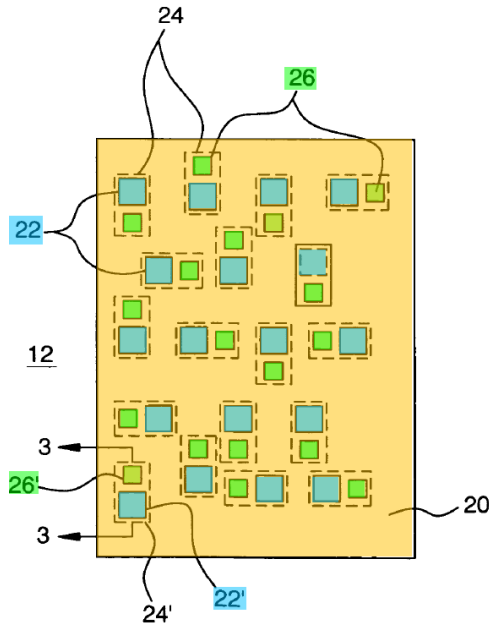


FIG. 2

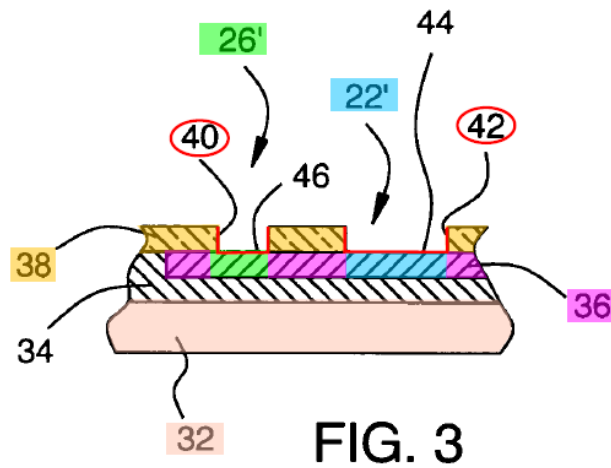


FIG. 3

Ex. 1005-2 to -3, Figs. 2-3. “The **passivation layer 38** is formed over the top conductor layer 36. Each of the **bond pads 22** is located in an **opening 42** of the **passivation layer 38** and comprises a portion 44 of the top conductor layer 36.” Ex. 1005-7, 4:58-63; Ex. 1008, ¶76.

The **bond pad 22** is defined by the **opening 42** in the **passivation layer 38** as claimed because the bond pad is the region to be bumped. Ex. 1005-8, 5:5-7 (“The bond pads 22 are adapted to support bumped contacts (e.g., solder balls) for providing external electrical connections for the semiconductor die 12.”) Ex. 1008, ¶77.

In the Second Mardi Embodiment, the “**opening 52**” is the claimed “first opening”:

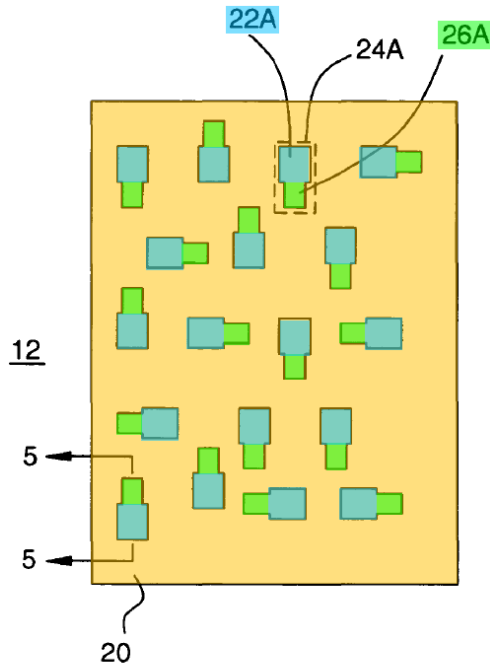


FIG. 4

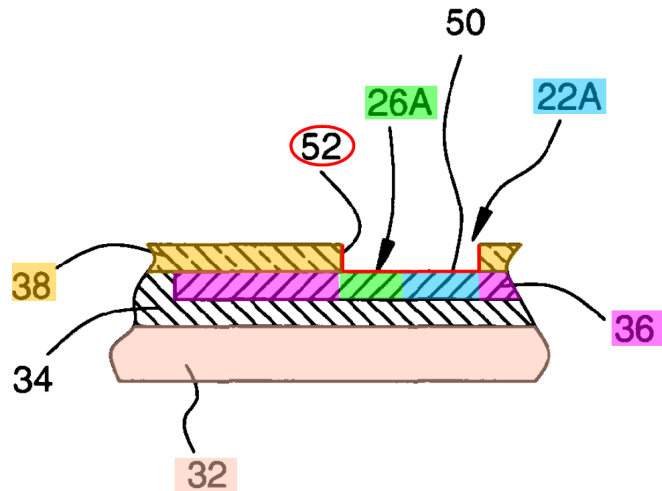


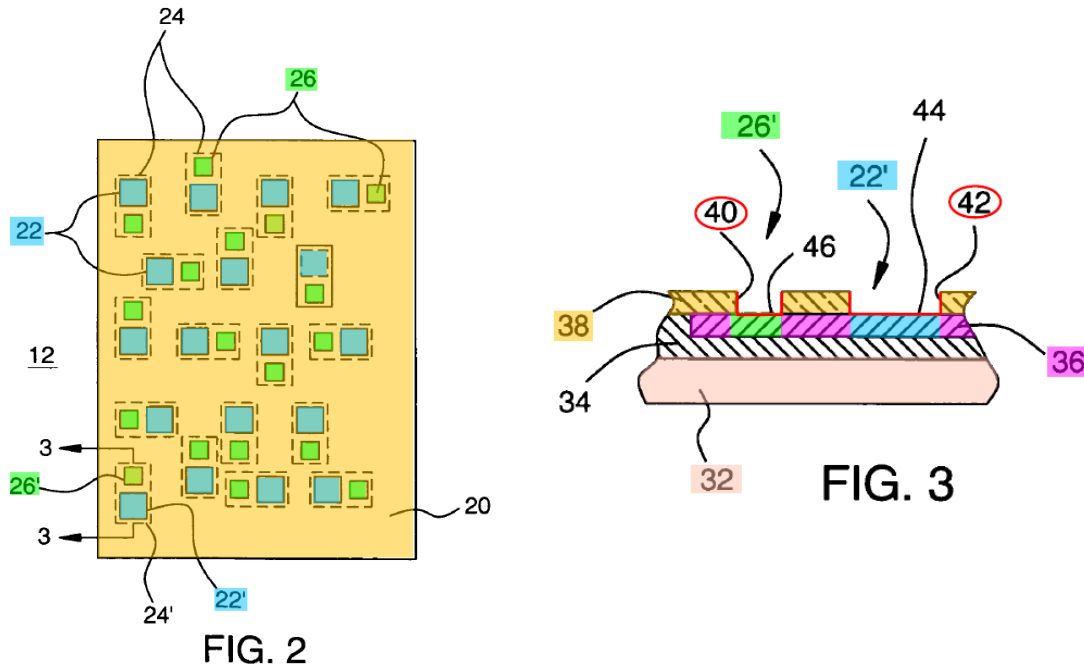
FIG. 5

Ex. 1005-3, Figs. 4-5. “[E]ach of the test/bond pad pairs 24A is located in an **opening 52** of the **passivation layer 38** and comprises a section 50 of the top conductor layer 36. A first portion of the section 50 defines the **bond pad 22A**, and a second portion of the section 50 defines the **test pad 26A**.” Ex. 1005-8, 5:34-38; Ex. 1008, ¶78.

The **bond pad 22A** is defined by the **opening 52** in the passivation layer 38 as claimed because the bond pad is the region to be bumped. Ex. 1005-8, 5:5-7 (“The bond pads 22 are adapted to support bumped contacts (e.g., solder balls) for providing external electrical connections for the semiconductor die 12.”) Ex. 1008, ¶¶79-80.

I. Claim 8 — “The interface assembly of claim 7 wherein the probe region is defined by a second opening in said passivation layer, said first and second openings being spaced apart from one another.”

Mardi discloses this claim. Ex. 1008, ¶¶81-82. In the First *Mardi* Embodiment, the “**opening 40**” corresponds to the claimed “second opening”:



Ex. 1005-2, Figs. 2-3; Ex. 1008, ¶81. “The **passivation layer 38** is formed over the top conductor layer 36. Each of the **bond pads 22** is located in an **opening 42** of the **passivation layer 38** and comprises a portion 44 of the top conductor layer 36. Each of the **test pads 26** is located in an **opening 40** of the **passivation layer 38** and comprises a portion 46 of the top conductor layer 36.” Ex. 1005-7, 4:58-63.

Thus, in the **passivation layer 38**, the **bond pad 22'** is defined by the **opening 42** and the **test pad 26'** is defined by the **opening 40**, as claimed because the test

pad is used as a probe region. Ex. 1005-9, 7:10-13 (“Notably, a probe element 702 is in contact with the portion 46 of the **top metal layer 36** defining the **test pad 26**’.

The probe element 702 does not contact the portion 44 of the **top metal layer 36** defining the **bond pad 22**’.”) Ex. 1008, ¶82.

J. Independent Claim 9

1. Element 9[preamble] — “method for testing a semiconductor wafer prior to performing a flip chip bumping process”

To the extent the preamble is limiting, *Mardi* discloses this element. Ex. 1008, ¶¶83-84. *Mardi* discloses a method for testing a wafer prior to performing a flip chip bumping process so as not to damage the bond pad: “Fig. 6 is a flow diagram depicting ... a process for fabricating an integrated circuit including a semiconductor component testing process” Ex. 1005-6, 2:66-3:2.

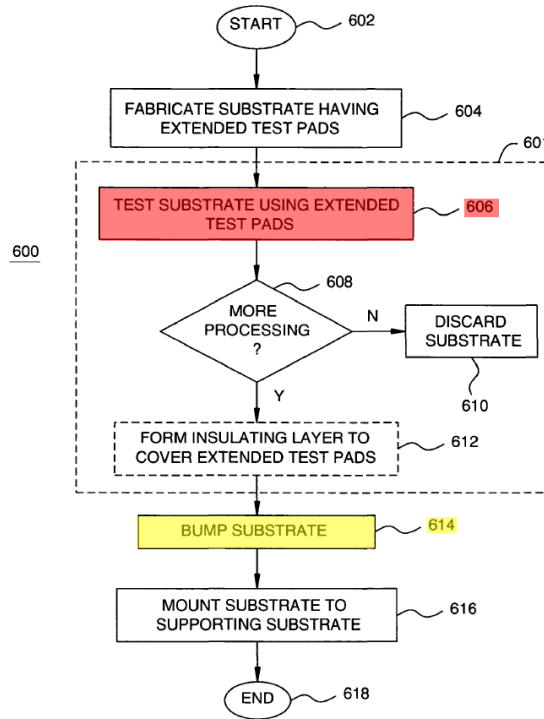


FIG. 6

Ex. 1005-4, Fig. 6. Testing occurs at step 606, and a flip chip bumping process occurs later at step 614. Ex. 1005-9, 7:24-36 (“damage to the bond pad 22A is avoided during the testing at step 606”); Ex. 1005-8, 6:51-55 (“At step 614, the semiconductor substrate is bumped. That is, bumped contacts (e.g., solder balls) are formed on the substrate in electrical communication with the bump pads using a conventional bumping process.”) Ex. 1008, ¶84.

2. Element 9[a] — “providing a flip chip bonding pad having a region for performing said bumping process”

Mardi discloses this element. Ex. 1008, ¶85. *Mardi* discloses “a flip chip bonding pad having a region for performing said bumping process” as shown for element 1[a] above. To the extent the method claim step of “providing” this

structural feature requires additional disclosure, *Mardi* discloses “providing” such a structure via fabrication in step 604 of the Figure 6 method: “The semiconductor substrate 10 fabricated at step 604 is then tested in accordance with the test process 601.” Ex. 1005-8, 6:10-12.

3. Element 9[b] — “integrally constructing a test pad with said bonding pad to form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”

Mardi discloses this element. Ex. 1008, ¶86. *Mardi* discloses this element as shown for element 1[b] above. To the extent the method claim step of “integrally constructing” this structural feature requires additional disclosure, *Mardi* discloses “integrally constructing” such a structure via fabrication in step 604 of the Figure 6 method: “The semiconductor substrate 10 fabricated at step 604 is then tested in accordance with the test process 601.” Ex. 1005-8, 6:10-12.

4. Element 9[c] — “disposing said test pad coplanar with said flip chip bonding pad”

Mardi discloses this element. Ex. 1008, ¶87. *Mardi* discloses this element as shown for element 1[c] above. To the extent the method claim step of “disposing” this structural feature requires additional disclosure, *Mardi* discloses “disposing” such a structure via fabrication in step 604 of the Figure 6 method: “The semiconductor substrate 10 fabricated at step 604 is then tested in accordance with the test process 601.” Ex. 1005-8, 6:10-12.

5. Element 9[d] — “said test pad including a probe region for performing a wafer test prior to performing said bumping process”

Mardi discloses this element. Ex. 1008, ¶88. *Mardi* discloses this element as shown for element 1[d] above. To the extent the method claim step of “disposing” this structural feature requires additional disclosure, *Mardi* discloses “disposing” such a structure via fabrication in step 604 of the Figure 6 method: “The semiconductor substrate 10 fabricated at step 604 is then tested in accordance with the test process 601.” Ex. 1005-8, 6:10-12.

K. Independent Claim 10

1. Element 10[preamble] — “an interface assembly for a semiconductor wafer”

Mardi teaches this element as shown for element 1[preamble] above. Ex. 1008, ¶89.

2. Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”

Mardi teaches this element as shown for element 1[a] above. Ex. 1008, ¶90.

3. Element 10[b] — “a test pad integrally constructed with said bonding pad”

Mardi teaches this element as shown for element 1[b] above. Ex. 1008, ¶91.

4. Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”

Mardi teaches this element as shown for element 1[c] above. Ex. 1008, ¶92.

5. **Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”**

Mardi teaches this element as shown for element 1[d] above. Ex. 1008, ¶93.

6. **Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”**

Mardi teaches this element as shown for claim 5 above. Ex. 1008, ¶94.

7. **Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”**

Mardi teaches this element as shown for claim 6 above. Ex. 1008, ¶95.

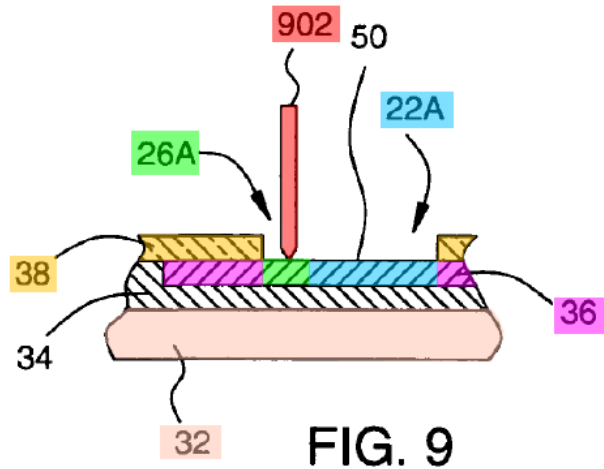
VIII. GROUND 2: CLAIMS 1-10 ARE OBVIOUS OVER *MARDI* IN VIEW OF A POSITA’S KNOWLEDGE

As addressed in Ground 1, *Mardi* fully discloses all elements of claims 1-10.

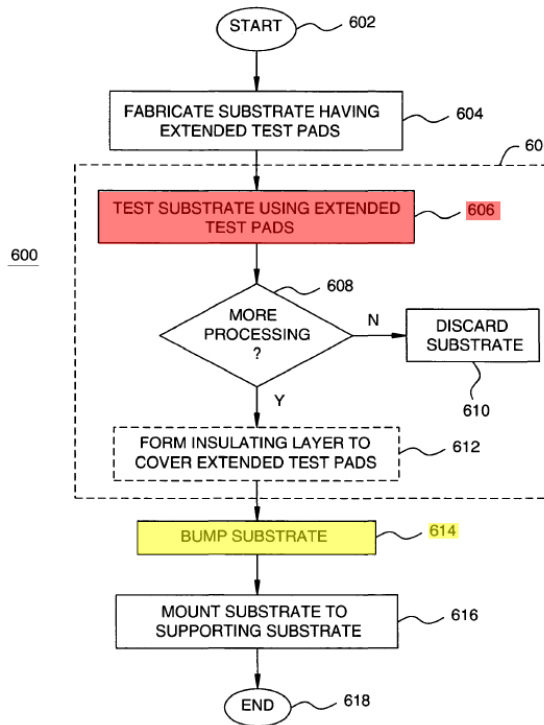
Alternatively, it would have been obvious to a POSITA to modify *Mardi* in view of the POSITA’s knowledge to achieve the features of claims 1-10. Ex. 1008, ¶96.

A. Independent Claim 1 (and all dependent claims) — “wafer-level testing”

As discussed for claim 1, *supra*, with reference to Figures 6 and 9, *Mardi* discloses “performing wafer-level testing prior to performing said bumping process.” Ex. 1001-5, 4:6-8. First, Figure 9 illustrates testing with a **probe element 902**.



Ex. 1005-5, Fig. 9. Second, Figure 6 shows testing *before* the bumping process. Ex. 1005-8, 5:54-56.



Ex. 1005-4, Fig. 6; Ex. 1008, ¶97.

Further, *Mardi* confirms Figures 6 and 9 show “wafer-level testing.” In particular, *Mardi* says “the term ‘semiconductor component’ is meant to encompass a substrate having multiple semiconductor dice” (Ex. 1005-7, 3:30-32), as shown in Figure 1.

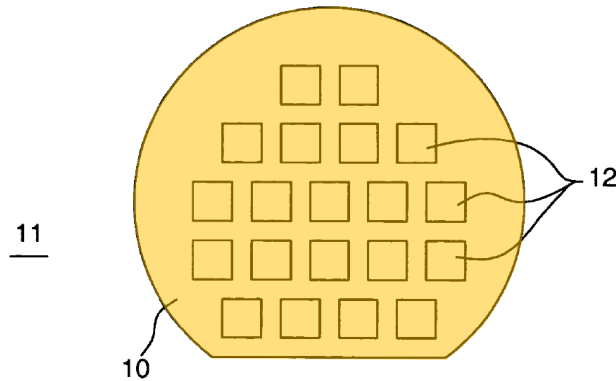


FIG. 1

Ex. 1005-2, Fig. 1; Ex. 1008, ¶98. A POSITA understands a “substrate having multiple semiconductor dice” is a wafer. Ex. 1008, ¶99. Relative to Figure 6, *Mardi* says “the process 600 is described with respect to a semiconductor component comprising a substrate with a plurality of semiconductor dice,” *i.e.*, a wafer. Ex. 1005-8, 5:65-67. *Mardi* teaches process 600 relates to a wafer that is singulated or diced at the mounting step 616. Ex. 1005-9, 7:1-2 (“If the substrate includes multiple dice, the dice are singulated (*i.e.*, diced) before mounting.”) Thus, *Mardi* teaches “wafer-level testing.” Ex. 1008, ¶99.

Alternatively, a POSITA would have found it obvious to use *Mardi*’s process for “wafer-level testing” because POSITAs knew that wafer-level testing (as opposed to testing one chip at a time) reduces manufacturing costs and

manufacturing time. U.S. Patent No. 5,550,480 to Nelson *et al.* was filed in 1994 (over 10 years before the '173 patent), and shows that a POSITA would have knowledge of the benefits of testing semiconductor devices at the wafer level:

Generally, integrated devices are fabricated in a thin flat substrate material commonly referred to as a semiconductor wafer. After fabrication, the integrated devices in the semiconductor wafer are tested, the semiconductor wafer is separated or divided into individual semiconductor chips or die, and each chip is encapsulated in a package. Since each semiconductor chip typically contains a large number of integrated devices, there is a probability of producing one or more defective integrated devices. Therefore, it is desirable to test the integrated devices prior to packaging them to ensure that time, money, and manufacturing capacity are not wasted by packaging defective semiconductor chips. Moreover, testing semiconductor chips in wafer form is easier and more cost efficient than testing a single semiconductor chip that has been separated from the semiconductor wafer. ***In other words, wafer-level testing or probing, i.e., testing semiconductor chips before the semiconductor wafer is separated into individual chips, reduces the manufacturing costs and cycle times associated with manufacturing semiconductor products.***

Ex. 1010-7, 1:13-33; *see also* Ex. 1011-1, [57]; Ex. 1011-9, 1:23-49 (“wafer level testing” of wafer comprising flip-chip type semiconductor chips) (2004); Ex. 1012-19, 1:18-27; Ex. 1012-21, 6:42-46 (wafer-level testing of flip chips) (2003); Ex. 1004-1, [57] (same) (2005). Ex. 1008, ¶¶100-101. These references show a POSITA

knew wafer-level testing of flip-chips reduces manufacturing costs and cycle times. A POSITA would have used the *Mardi* testing method to test flip-chips at the wafer-level. Thus, “wafer-level testing” as claimed in claim 1 (and claims 2-7 that depend from claim 1) would have been obvious to a POSITA. Ex. 1008, ¶102.

B. Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”

As discussed for claim 5 in Ground 1, *Mardi* expressly discloses claim 5. Ex. 1008, ¶¶ 69-72. Alternatively, it would have been obvious to modify *Mardi* to include a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another. Ex. 1008, ¶103. A POSITA knows that **top conductor layer 36** is a metal layer, and this layer can include conductive routing interconnect in addition to the conductive metal that makes up **test pad 26A** and **bond pad 22A**. A POSITA knows this because metal layers are typically fabricated as solid metal layers which are then patterned to remove portions of the metal and leave behind structures such as routing interconnect (*e.g.*, traces) and test/bond pads.

This knowledge is evidenced by patent references that predate the ’173 patent’s September 29, 2004 filing date, such as *Yong* (published September 18, 2003) (Ex. 1007-1); U.S Patent No. 6,392,301 to Waizman (issued May 21, 2002) (“*Waizman*”) (Ex. 1013); and U.S. Patent Application Publication 2005/0037601 to

Hsu (filed October 27, 2003) (“*Hsu*”) (Ex. 1014). For example, as discussed in Ground 5, *infra*, *Yong* discloses pad 10 (which has probe region 14 and wire bond region 12) as part of the upper conductive metal layer 28:

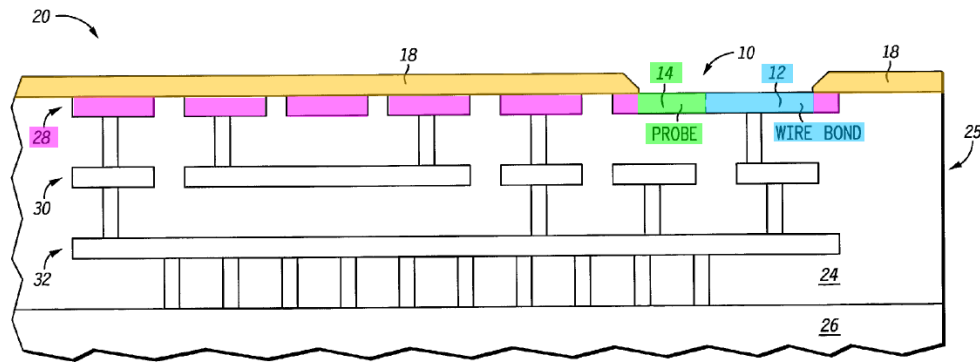


FIG. 2

Ex. 1007-2, Fig. 2. Pad 10 is coplanar with, and electrically connected to, other routing interconnect traces that are part of upper conductive layer 28. Ex. 1007-10 to -11, [0013]-[0015]; Ex. 1008, ¶104.

Similarly, *Waizman* discloses metal routing/trace layer 220, which is coplanar with pads 205, 207, 209, and 211 (Ex. 1013-8, 3:1-4:12):

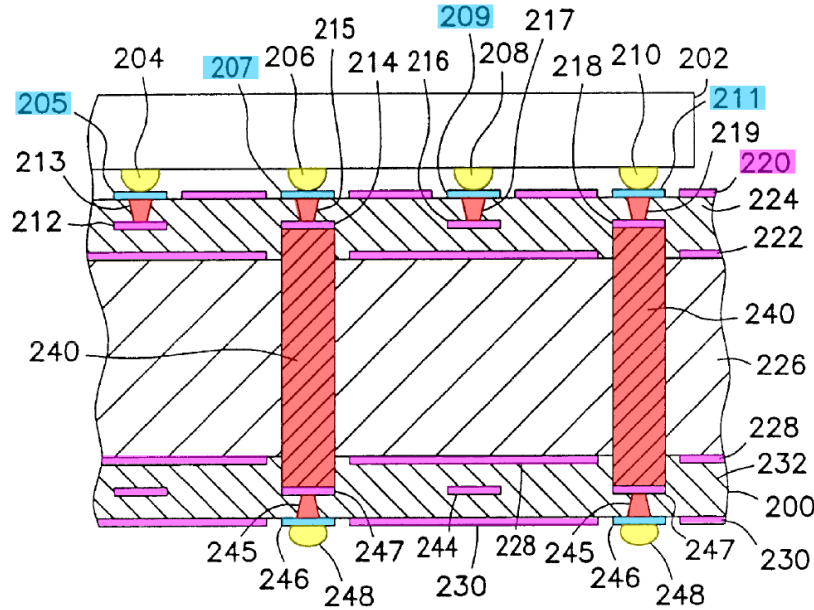


FIG. 2A

Ex. 1013-3, Fig. 2a. And *Hsu* discloses “patterned trace layer 33” which is coplanar with “a plurality of contact pads 330” (Ex. 1014-14, [0046]):

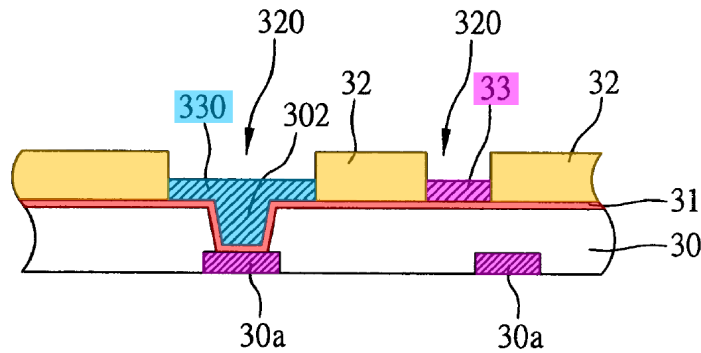


FIG. 3C

Ex. 1014-7, Fig. 3C; Ex. 1008, ¶105.

Yong, *Waizman*, and *Hsu* show that it was common—and a POSITA would have known—to include a redistribution layer for interconnect routing on the same metal layer that is used to form the bond/test pads. Ex. 1008, ¶106. A POSITA would know that such interconnect would be electrically connected to one or more

bonding/test pads in order to route the signals connected to those pads to “the semiconductor devices/circuits within the semiconductor portion 32” of *Mardi*. Ex. 1005-7, 4:45-48. Thus, it would have been obvious to modify *Mardi* to include a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another. Ex. 1008, ¶106.

C. Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”

As discussed for claim 6 in Ground 1, *Mardi* expressly discloses vias are used to connect “redistribution layers” at different planes within the semiconductor. As noted above with respect to claim 5, top conductor layer 36 and/or the uppermost conductor layer within the internal conductor portion 34 correspond to a “first metal redistribution layer” (Ex. 1005-7, 4:36-39; Ex. 1005-3, Fig. 5), and at least one of the conductor layers within the internal conductor portion 34 corresponds to the claimed “second redistribution layer”:

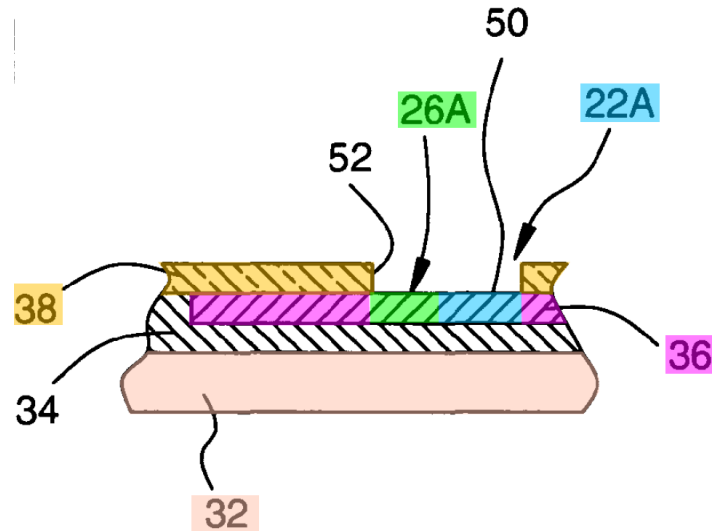


FIG. 5

Ex. 1005-3, Fig. 5; Ex. 1005-7, 4:39-42 (“[I]nternal conductor portion 34 compris[es] one or more internal conductor layers between the substrate portion 32 and the top conductor layer 36.”) *Mardi* teaches these “redistribution layers” are separated by insulating layers and connected by vias: “all of the conductor layers may be separated by respective insulating layers, and may be connected to each other using vias (not shown for simplicity).” Ex. 1005-7, 4:42-45; Ex. 1008, ¶107.

However, Figure 5 of *Mardi* does not expressly show insulating layers between the redistribution layers and it does not expressly show the vias connecting the redistribution layers. These features are described in the text. Alternatively, these features would be obvious based on a POSITA’s knowledge. A POSITA was familiar with both insulation layers and vias. *Id. Mardi* says these features are “not shown for simplicity” (Ex. 1005-7, 4:42-45), and a POSITA would agree it is not necessary for these features to be illustrated. Ex. 1008, ¶108.

Modified Figure 5 below shows the POSITA's understanding of *Mardi* based on its disclosure that the redistribution layers are separated by an insulating layer and connected by vias:

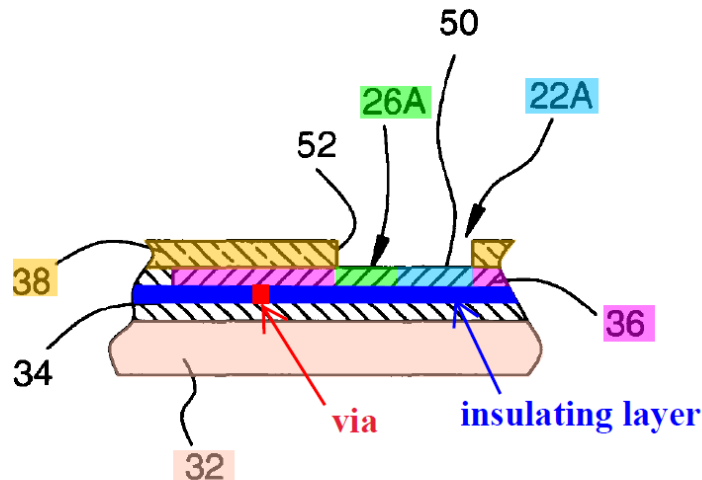


FIG. 5

Ex. 1005-3, Fig. 5 (modified) (showing case where conductor portion 34 has only one internal insulating layer); Ex. 1008, ¶109. If not expressly disclosed, the limitations of Claim 6 would have been obvious to a POSITA in view of *Mardi* and the POSITA's knowledge. Ex. 1008, ¶110.

D. Independent Claim 9 — “wafer test”

Mardi teaches “wafer test” as explained above for the “wafer-level testing” of claim 1. Ex. 1008, ¶111.

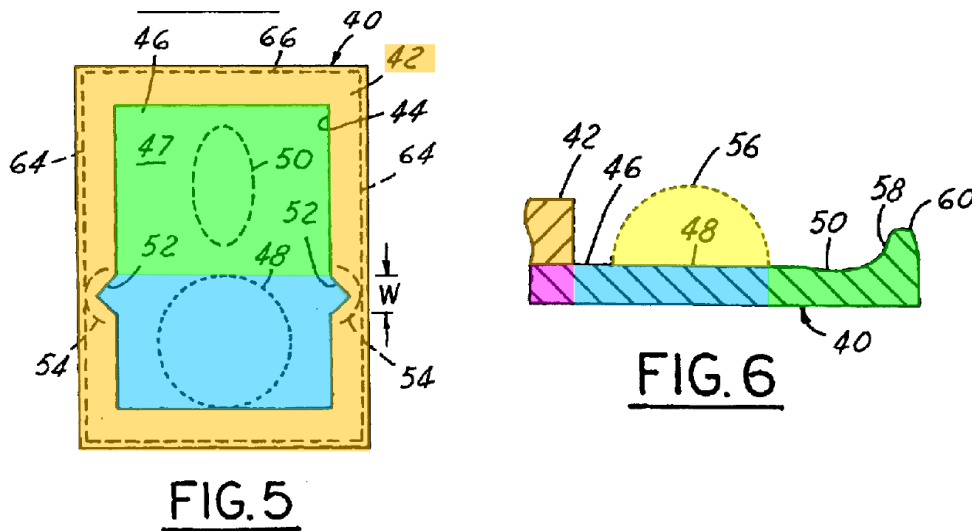
E. Independent Claim 10 — “performing wafer-level testing”

Mardi teaches “performing wafer-level testing” as explained above for claim 1. Ex. 1008, ¶112.

IX. GROUND 3: CLAIMS 1-4, 7 AND 9 ARE ANTICIPATED BY *LIN*

A. Overview of *Lin*

U.S. Patent 6,765,228 (“*Lin*”) (Ex. 1006) issued to *Lin et al.* and is titled “Bonding Pad with Separate Bonding and Probing Areas.” *Lin* was filed on October 11, 2002 and issued on July 20, 2004 (Ex. 1006-1, [45]), and thus qualifies as §102(a) and (e) prior art because it was filed and published before the ’173 patent’s September 29, 2004 filing date. *Lin* is directed to flip chip semiconductor wafers having bond pads with separate areas for probe needle contact and wire bonding. Ex. 1006-1, [54], [57].



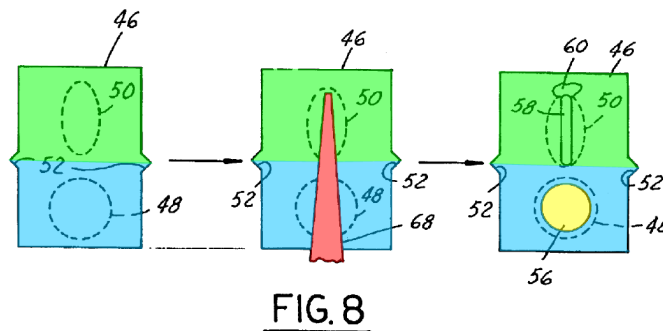
Ex. 1006-2 to -3, Figs. 5-6. The surface 47 of the bonding pad 46 has a **wire bonding area 48** and a **probe needle contact area 50**. Ex. 1006-5 to -6, 4:56-5:4; Ex. 1008, ¶51. Prior to packaging and formation of solder bumps on the respective bonding pads, the chip is subjected to parametric testing which utilizes test structures to assess the electrical characteristics and reliability of the devices on the wafer. Ex.

1006-6, 5:30-45; Ex. 1008, ¶51. Probe cards with probe needles are used to interface between the devices on the chip and the test equipment. *Id.* Each probe needle forms a scrub mark and a hump of pad material, which is why separate test regions are provided so the bond region remains unmarked for effective bonding. *Id.*

B. Independent Claim 1

1. Element 1[preamble] — “an interface assembly for a semiconductor wafer”

To the extent the preamble is limiting, it is disclosed by *Lin*. Ex. 1008, ¶¶113-115. *Lin* expressly discloses bonding pad 46 as “an interface assembly for a semiconductor wafer” because it provides an interface for testing the wafer with a probe needle:



Ex. 1006-3, Fig. 8. “As shown in FIG. 8, during the parametric testing procedure, the tip of each **probe needle 68** contacts the **probe needle contact area 50** of the corresponding bonding pad 44 [Fig. 6] and forms a scrub mark 58 and a hump 60 of pad material in the bonding pad 46 [Fig. 8]....” Ex. 1006-6, 5:30-35. *Lin* expressly discloses this testing method is for a semiconductor wafer: “a method which enhances wafer sort yield....” Ex. 1006-4, 2:61-62; Ex. 1008, ¶115.

2. Element 1[a] — “a flip chip bonding pad including a region for performing a bumping process; and”

Lin discloses this element. Ex. 1008, ¶¶116-117. The bottom half of “bonding pad 46” (shaded in blue below and including “wire bonding area 48”) corresponds to the claimed “flip chip bonding pad.” First, marks 52 in Figure 5 delineate the boundaries between **wire bonding area 48** and the **probe contact area 50** of bonding pad 46:

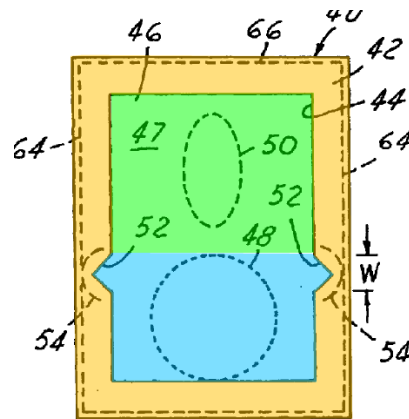


FIG. 5

Ex. 1006-2, Fig. 5; Ex. 1006-6, 5:1-4 (“[M]arks 52 delineate the boundary between wire bonding area 48 and probe contact area 50.”)

Second, the “bonding pad 46” is for flip chips: “The bonding pad of the present invention is suitable for wire bonding techniques ... *and flip-chip packaging techniques.*” Ex. 1006-5, 4:24-26. *Lin* discloses the **wire bonding area 48** is where the solder bump or bond wire contact is formed on bonding pad 46. Ex. 1006-6, 5:40-43 (“Finally, the bonding ball 56 or other electrical contact is formed on the

wire bonding area 48 of the bonding pad 46 for electrical contact with a bonding wire”)

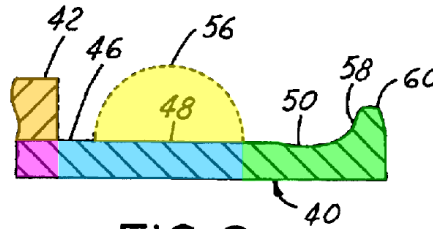


FIG. 6

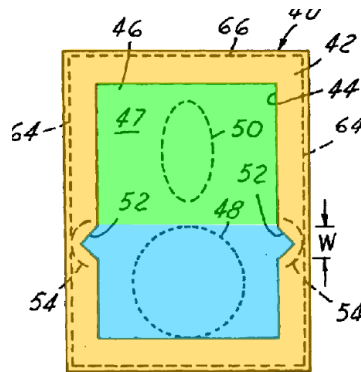
Ex. 1006-3, Fig. 6. Thus, *Lin* teaches a flip chip bonding pad with a region for performing a bumping process because the wire bonding area 48 would be bumped with a solder bump when the bonding pad is used with flip-chip packaging techniques. Ex. 1006-5, 3:52-54 (“FIG. 1A is a top view of ... a chip surface prior to bonding of a wire or solder bump to the bonding pad”); Ex. 1006-5, 3:1-28 (embodiments of the present invention include “bonding of a solder bump or bond wire to the bonding pad”); Ex. 1008, ¶117.

3. **Element 1[b] — “a test pad integrally constructed with said bonding pad that form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”**

Lin discloses this element. Ex. 1008, ¶¶118-120. The upper half of “bonding pad 46” (shaded in green below and including “probe needle contact area 50”) corresponds to the claimed “test pad” because that is the area where a test probe contacts the pad during testing: “As shown in FIG. 8, during the parametric testing

procedure, the tip of each probe needle 68 contacts the **probe needle contact area 50** of the corresponding bonding pad 44 [sic] and forms a scrub mark 58 and a hump 60 of pad material in the bonding pad 46....” Ex. 1006-6, 5:30-35.

The “test pad” (**green area**) and the “bonding pad” (**blue area**) are integrally constructed without interconnect testing lines.



Ex. 1006-2, Fig. 5. There are no interconnect lines because the two areas are simply different regions of the same bonding pad: “Accordingly, the **wire bonding area 48** and the **probe needle contact area 50** are located in separate, non overlapping areas on the surface 47 of the bonding pad 46.” Ex. 1006-5, 4:61-63; Ex. 1008, ¶119.

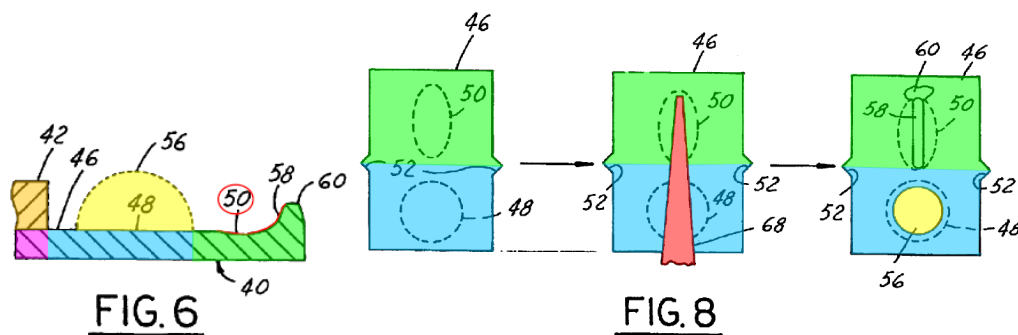
Finally, the bonding pad 46, which includes the “test pad” (**green area**) and the “bonding pad” (**blue area**), is a conductive structure: “Each bonding pad 46 may be constructed of aluminum or other suitable electrically-conductive material.” Ex. 1006-5, 4:51-53; Ex. 1008, ¶120.

4. Element 1[c] — “said test pad being coplanar relative to said flip chip bonding pad”

Lin discloses this element. Ex. 1008, ¶121. The “test pad” (green area) and the “bonding pad” (blue area) are coplanar because they are simply separate areas of the metal bonding pad 46: “[T]he wire bonding area 48 and the probe needle contact area 50 are located in separate, non overlapping areas on the surface 47 of the bonding pad 46.” Ex. 1006-5, 4:56-63; Ex. 1006-2, Fig. 5.

5. Element 1[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”

Lin discloses this element. Ex. 1008, ¶¶122-125. The probe needle contact area 50 corresponds to the “probe region for performing wafer-level testing” because, “during the parametric testing procedure, the tip of each probe needle 68 contacts the probe needle contact area 50 of the corresponding bonding pad [46] [Fig. 6] and forms a scrub mark 58 and a hump 60 of pad material in the bonding pad 46 [Fig. 8], as further shown in FIGS. 6 and 8.” Ex. 1006-6, 5:31-35.



Ex. 1006-3, Figs. 6 and 8.

Lin discloses the parametric testing occurs prior to performing a bumping process: “Prior to packaging and formation of the bonding balls 10 on the respective

bonding pads 14, the chip 26 is subject to parametric testing....” Ex. 1006-4, 2:25-27. Ex. 1008, ¶123. Further, this testing is for a semiconductor wafer: “a method which enhances *wafer* sort yield....” Ex. 1006-4, 2:61-62. The wire bonding area 48 is bumped with a solder ball (*i.e.*, a “bumping process”) when the bonding pad is used with flip-chip packaging techniques. Ex. 1006-5, 4:24-26 (“[t]he bonding pad of the present invention is suitable for wire bonding techniques, as well as ball grid array (BGA) and flip-chip packaging techniques.”) Ex. 1006-5, 3:52-54 (“FIG. 1A is a top view of ... a chip surface prior to bonding of a wire **or solder bump** to the bonding pad.”) Ex. 1006-5, 3:1-28 (embodiments of the present invention include “bonding of a **solder bump** or bond wire to the bonding pad.”) Ex. 1008, ¶124.

C. Claim 2 — “The interface assembly of claim 1 wherein said test pad may be disposed anywhere along a periphery of said bonding pad.”

Lin discloses this claim. Ex. 1008, ¶¶126-127. *Lin* teaches the test pad (**green area**) may be anywhere at the periphery of the bonding pad (**blue area**) because they are merely regions of the same bonding pad 46 separated by marks 52 on two opposite sides: “[M]arks 52 delineate the boundary between wire bonding area 48 and probe contact area 50.” Ex. 1006-6, 5:1-4.

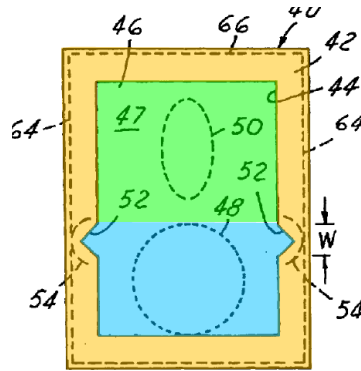


FIG. 5

Ex. 1006-2, Fig. 5. “The bonding pads 46 may be arranged in any desired alternative configuration on the chip 40 consistent with the particular use requirements of the chip 40.” Ex. 1006-5, 4:40-43. Thus, *Lin* teaches the test pad (green area) may be anywhere along periphery of the bonding pad (blue area). Ex. 1008, ¶127.

D. Claim 3 — “The interface assembly of claim 1 wherein said bonding pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”

Lin discloses this claim. Ex. 1008, ¶128. *Lin* teaches a rectangular-shaped (“polygonal”) bonding pad.

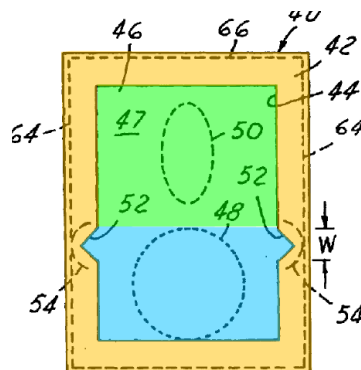


FIG. 5

Ex. 1006-2, Fig. 5. “As shown in FIG. 5, each bonding pad 46 typically has a generally elongated, *rectangular shape*, having longitudinal edges 64 and transverse edges 66 that may be overlapped by the passivation layer 42.” Ex. 1006-5, 4:43-51. Additionally, marks 52 delineate the boundary between wire bonding area 48 and probe contact area 50: “The notch mark or marks 52 serve to clearly indicate the locations of the **wire bonding area 48** and the **probe needle contact area 50** on the bonding pad 46.” Ex. 1006-6, 5:1-4. Both the bonding pad (**blue area** including **wire bonding area 48**) and the test pad (**green area** including **probe needle contact area 50**) are rectangular-shaped polygons. Even if the notch marks 52 are considered part of the shape, the pad is polygonal.

E. Claim 4 — “The interface assembly of claim 1 wherein said test pad comprises a shape selected from the group consisting of a polygonal shape, and a circular shape.”

Lin discloses this claim. Ex. 1008, ¶129. *Lin* teaches the test pad is a rectangular-shaped polygon for the same reasons as explained relative to claim 3 above.

F. Claim 7 — “The interface assembly of claim 1 wherein the region to be bumped is defined by a first opening in a passivation layer.”

Lin discloses this claim. Ex. 1008, ¶130. The “first opening” is “**pad opening 44**” in *Lin*, which is an opening in **passivation layer 42**: “A rectangular **pad opening 44** extends through the **passivation layer 42** to expose the upper surface of the bonding pad 46.” Ex. 1006-5, 4:53-55. As discussed with respect to element 1[a],

the **wire bonding area 48** corresponds to the “region to be bumped.” As shown in Figure 5, **wire bonding area 48** is defined by the first opening even if it is just a portion of the surface within that opening.

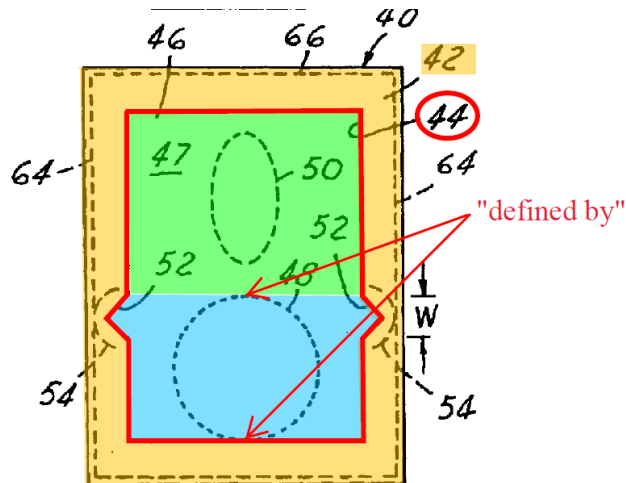


FIG. 5

Ex. 1006-2, Fig. 5. Indeed, notches 52 in the passivation layer further define opening 44 and delineate the boundary between **wire bonding area 48** (the region to be bumped) and **probe needle contact area 50**: “The notch mark or marks 52 serve to clearly indicate the locations of the **wire bonding area 48** and the **probe needle contact area 50** on the bonding pad 46.” Ex. 1006-6, 5:1-4. Thus, the **wire bonding area 48** (e.g., the “region to be bumped”) is defined by the **pad opening 44**, as claimed.

G. Independent Claim 9

1. Element 9[preamble] — “method for testing a semiconductor wafer prior to performing a flip chip bumping process”

To the extent the preamble is limiting, it is disclosed by *Lin*. Ex. 1008, ¶¶131-132. *Lin* expressly teaches wafer testing prior to a flip chip bump bonding process. Ex. 1006-4, 2:61-62 (patent is directed to wafer-level testing: “a method which enhances wafer sort yield...”); Ex. 1006-4, 1:38-65 (describing “flip-chip” technology); Ex. 1006-5, 4:24-26 (bonding pad suitable for “ball grid array (BGA) and flip-chip packaging techniques”); Ex. 1006-4, 1:6-10 (“the present invention relates to a new and improved bonding pad having separate areas for probe needle contact and wire bonding in semiconductor packaging technology.”); Ex. 1006-6, 5:30-35, Fig. 8 (“As shown in FIG. 8, during the parametric testing procedure, the tip of each **probe needle 68** contacts the **probe needle contact area 50** of the corresponding bonding pad 44 and forms a scrub mark 58 and a hump 60 of pad material in the bonding pad 46, as further shown in FIGS. 6 and 8.”); Ex. 1006-4, 2:25-2 (“Prior to packaging and formation of the bonding balls 10 on the respective bonding pads 14, the chip 26 is subject to parametric testing....”)

2. Element 9[a] — “providing a flip chip bonding pad having a region for performing said bumping process”

Lin discloses this element. Ex. 1008, ¶133. The “bonding pad 46” of *Lin* corresponds to the claimed “flip chip bonding pad.” *Lin* discloses “a flip chip

bonding pad having a region for performing said bumping process” as shown for element 1[a] above. To the extent the method claim step of “providing” this structural feature requires additional disclosure, *Lin* discloses “providing” such a structure by fabricating it: “[I]n typical application of the present invention, the chip 40, with the bonding pads 46 of the present invention fabricated thereon, as shown in FIG. 7, is initially subjected to conventional parametric testing....” Ex. 1006-6, 5:18-21.

3. Element 9[b] — “integrally constructing a test pad with said bonding pad to form an integral conductive structure such that separate interconnect testing lines from said test pad to said bonding pad are not present in said integral structure”

Lin discloses this element. Ex. 1008, ¶134. *Lin* discloses this element as shown for element 1[b] above. To the extent the method claim step of “integrally constructing” this structural feature requires additional disclosure, *Lin* discloses “integrally constructing” such a structure by fabricating it: “[I]n typical application of the present invention, the chip 40, with the bonding pads 46 of the present invention fabricated thereon, as shown in FIG. 7, is initially subjected to conventional parametric testing....” Ex. 1006-6, 5:18-21.

4. Element 9[c] — “disposing said test pad coplanar with said flip chip bonding pad”

Lin discloses this element. Ex. 1008, ¶135. *Lin* discloses this element as shown for element 1[c] above. To the extent the method claim step of “disposing”

this structural feature requires additional disclosure, *Lin* discloses “disposing” such a structure by fabricating it: “[I]n typical application of the present invention, the chip 40, with the bonding pads 46 of the present invention fabricated thereon, as shown in FIG. 7, is initially subjected to conventional parametric testing....” Ex. 1006-6, 5:18-21.

5. Element 9[d] — “said test pad including a probe region for performing a wafer test prior to performing said bumping process”

Lin discloses this element. Ex. 1008, ¶136. *Lin* discloses this element as shown for element 1[d] above. To the extent the method claim step of “disposing” this structural feature requires additional disclosure, *Lin* discloses “disposing” such a structure by fabricating it: “[I]n typical application of the present invention, the chip 40, with the bonding pads 46 of the present invention fabricated thereon, as shown in FIG. 7, is initially subjected to conventional parametric testing....” Ex. 1006-6, 5:18-21.

X. GROUND 4: CLAIMS 1-7 AND 9-10 ARE OBVIOUS OVER *LIN* IN VIEW OF POSITA’S KNOWLEDGE

As addressed in Ground 3, *Lin* fully discloses all elements of claims 1-4, 7, and 9. To the extent it is argued that *Lin* fails to disclose any element, it would have been obvious to a POSITA to modify *Lin* in view of the POSITA’s knowledge to achieve the features of claims 1-4, 7, and 9. Ex. 1008, ¶137. In addition, it would be

obvious to modify *Lin* in view of the POSITA's knowledge to achieve the features of claims 5-6 and 10. Ex. 1008, ¶137.

A. Independent Claim 1 (and all dependent claims) — “performing wafer-level testing”

As discussed for claim 1, *supra*, with reference to Figures 6 and 8, *Lin* discloses testing prior to the bumping process. First, testing occurs via “multiple **probe needles 68** (one of which is shown in FIG. 8).”

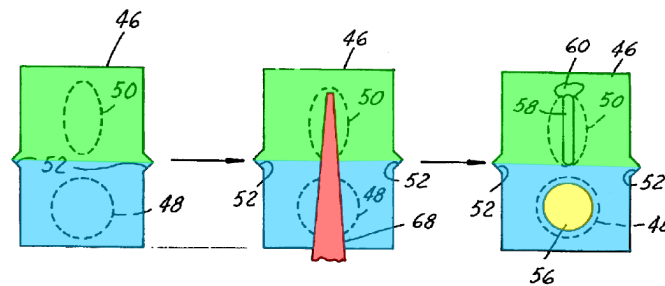


FIG. 8

Ex. 1006-6, 5:28; Ex. 1006-3, Fig. 8. Second, testing occurs prior to performing a bumping process. Ex. 1006-4, 2:25-27; Ex. 1008, ¶138. Further, this testing is for a semiconductor wafer: “The chip 40 [FIG. 7] is typically **one of multiple chips** having had integrated circuits (not shown) previously fabricated thereon **on a semiconductor wafer substrate (not shown).**”



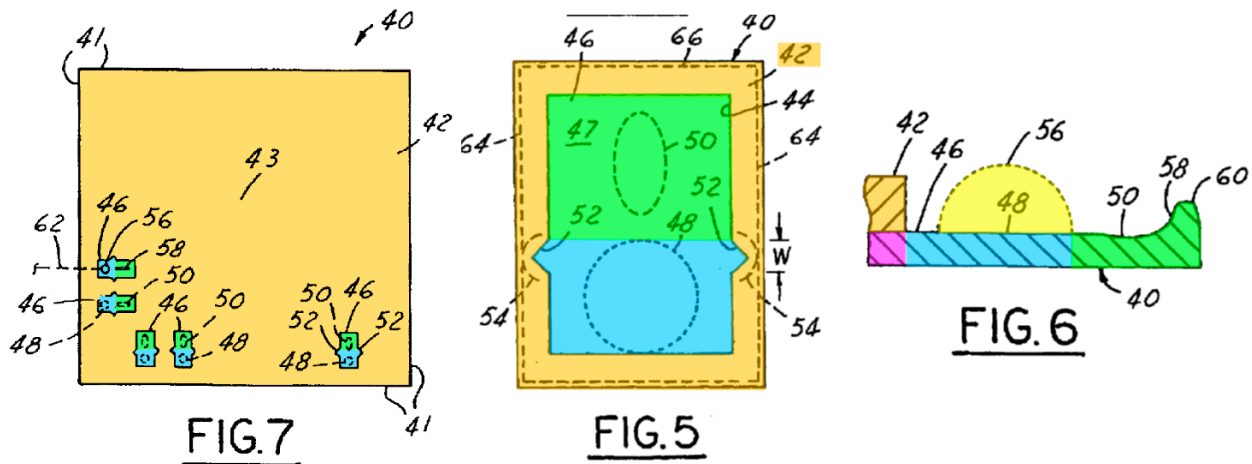
performing “wafer-level testing” because the testing “enhances **wafer sort yield...**”

Ex. 1006-4, 2:61-62; Ex. 1008, ¶¶139-140.

Alternatively, a POSITA would have found it obvious to use *Lin*'s process for "wafer-level testing" because POSITAs knew that wafer-level testing (as opposed to testing one chip at a time) reduces manufacturing costs and manufacturing time as discussed above for Ground 2 (*see* discussion citing *Nelson, Farnworth, Eldridge*, and *Yu*). Thus, "wafer-level testing" as claimed in claim 1 (and claims 2-7 that depend from claim 1) would have been obvious based on *Lin* combined with the POSITA's knowledge. Ex. 1008, ¶¶141-142.

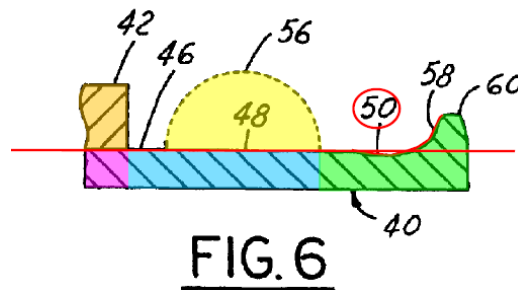
B. Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”

Lin renders this claim obvious. Ex. 1008, ¶¶143-148. The **top conductive layer** in *Lin* corresponds to the “first metal redistribution layer” of claim 5. The **top conductive layer** is immediately under the **passivation layer 42** and comprises: all of the the bonding pads (**blue area** including **wire bonding area 48**), all of the test pads (**green area** including **probe needle contact area 50**), and the remaining portion of the conductive layer extending under **passivation layer 42** (pink in Figure 6):



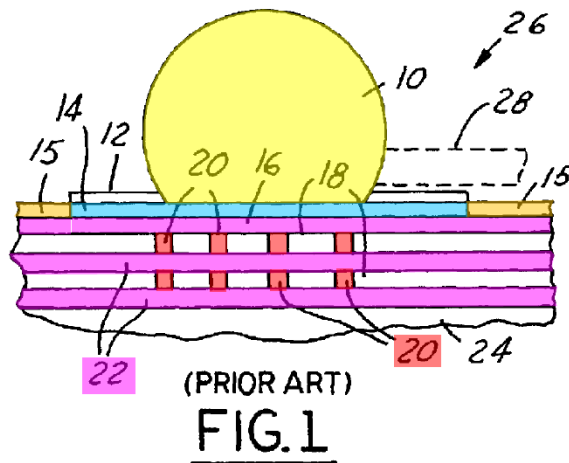
Ex. 1006-2 to -3, Figs. 5-7. The **top conductive layer** is formed across the entire surface of the wafer and includes all bond pads 46 as shown in Figure 7. A POSITA understands the **top conductive layer** could include other routing traces under **passivation layer 42** electrically connected to the test/bond pads, as discussed for claim 5 in Ground 2 (discussing knowledge of a POSITA as evidenced by *Yong*,

Waizman, and *Hsu*). *Lin* explains the bond pad 46 is “embedded in the **passivation layer 42**, in electrical contact with integrated circuits (not shown) formed in the chip 40, typically in conventional fashion.” Ex. 1006-5, 4:32-37. This description confirms the **top conductive layer** is “electrically connected to said bonding and test pads,” as claimed in claim 5. Further, *Lin* teaches, “[e]ach bonding pad 46 may be constructed of aluminum or other suitable electrically conductive material” (Ex. 1006-5, 4:51-53), which confirms it is “metal,” as claimed.



Because the **top conductive layer** comprises: the bonding pad (**blue area** including **wire bonding area 48**) and the test pad (**green area** including **probe needle contact area 50**), and the remaining portion of the conductive layer under **passivation layer 42** (pink), as illustrated in Figure 6, they are “co-planar with one another” along the plane indicated by the straight red line. Ex. 1006-3, Fig. 6 (modified). To the extent hump 60 is argued to not be co-planar with the rest of the top conductive layer, *Lin* teaches the **probe needle contact area 50** was co-planar prior to scrub mark 58 and hump 60 being formed during a parametric testing procedure. Ex. 1008, ¶143.

While *Lin* discloses a “prior art” embodiment where the **bonding pad 14** is a separate aluminum plating on top of the first metal redistribution layer, this is not required. It would have been obvious to a POSITA that the aluminum plating could be omitted, and the bumping process performed directly on the first metal redistribution layer. Ex. 1008, ¶144.



Ex. 1006-2, Fig. 1; Ex. 1006-4, 2:12-14 (“[a]s further shown in FIG. 1, the the **bonding pad 14** is provided in electrical contact with an upper conductive **upper conductive layer 16**.”) *Lin* teaches bonding pads 46 of Figures 5-7 “may be constructed of aluminum or other suitable electrically conductive material.” Ex. 1006-5, 4:51-53; Ex. 1008, ¶145. A POSITA would understand the bonding pad 46 shown in Figures 5-7 may have an aluminum plating over the copper upper conductive layer, or the bonding pad 46 may simply comprise the copper upper conductive layer by itself. Ex. 1008, ¶146.

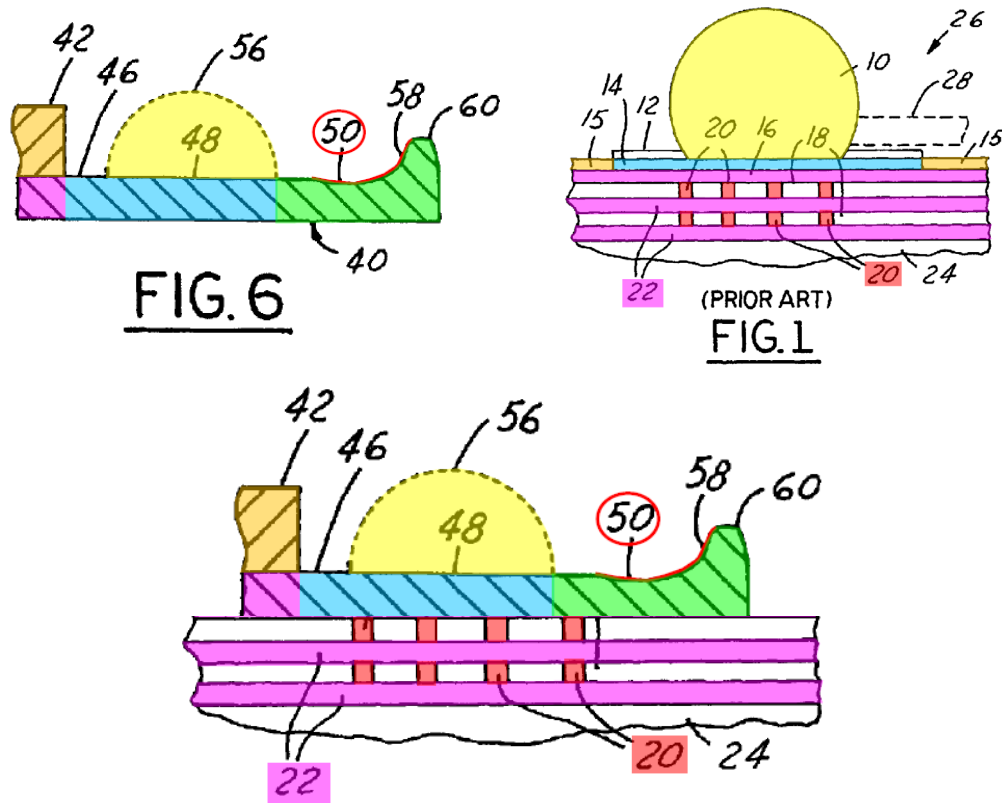
Alternatively, it would be obvious to try either of these two identified, well-known solutions (*i.e.*, aluminum or “other suitable” metal), with a reasonable expectation of success. A POSITA understood an aluminum bond pad would typically be used for wire bonding techniques, because either gold or aluminum wire had been found to create reliable thermosonic bonds with aluminum pads. In particular, using aluminum for both the wire and pad would not be prone to intermetallic formation or corrosion. Ex. 1008, ¶147.

A POSITA also understood a copper bond pad would be used for solder bump bonding techniques in BGA applications because, copper was used to form a metallic system that minimized interdiffusion, eliminated corrosion, and provided the needed solder wettability, adhesion and electrical conductivity when used with Pb-free solder balls. As the upper conductive layer is typically already copper, a POSITA understood there was no need to form a separate copper pad on top of the copper upper conductive layer. Instead, a POSITA would have used the upper conductive layer itself as the bond pad. *Yong* provides evidence a POSITA knows this, as described for claim 5 in Ground 5 below. Ex. 1008, ¶148.

A. Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”

Lin renders this claim obvious. Ex. 1008, ¶149. As noted relative to claim 5 (this Ground 4), the **top conductive layer** in *Lin* corresponds to the “first metal

redistribution layer.” The **top conductive layer** is immediately under the **passivation layer 42** and comprises: all of the the bonding pads (**blue area** including **wire bonding area 48**), all of the test pads (**green area** including **probe needle contact area 50**), the remaining portion of the conductive layer extending under **passivation layer 42**. The **top conductive layer** also includes other routing traces under **passivation layer 42**, as discussed for claim 5 in Ground 2 (discussing knowledge of a POSITA as evidenced by *Yong*, *Waizman*, and *Hsu*). With reference to the embodiment illustrated in Figures 5-7, *Lin* explains, “multiple bonding pads 46 of the present invention are typically embedded in the **passivation layer 42**, in electrical contact with integrated circuits (not shown) formed in the chip 40, typically in conventional fashion.” Ex. 1006-5, 4:34-37, Figs. 5-7. *Lin* further illustrates this “conventional fashion” for electrical contacts and integrated circuits via Figure 1 (prior art). As shown in Figure 1 (prior art), “[t]he **conductive layers 16, 22** are disposed in electrical contact with each other through conductive **vias 20** that extend through the insulative layers 18” (Ex. 1006-4, 2:14-17):



Ex. 1006-2 to -3, Figs. 1 and 6 (modified). With the **conductive layers 22** of Figure 1 shown in Figure 6 (these layers are necessarily present under the pad of Figure 6), the **conductive layers 22** correspond to the “second redistribution layer” and the **vias 20** correspond to the “via,” as claimed in claim 6. As shown in Figure 1, *Lin* discloses **top layer 16** is in a different plane than the **conductive layers 22**, such that the **top conductive layer** of Figure 6 is similarly in a different plane, which correspond with the “second redistribution layer being disposed in a different plane than the first redistribution layer,” as recited in claim 6.

B. Independent Claim 9 — “wafer test”

Lin teaches “wafer test” as explained above for the “wafer-level testing” of claim 1. Ex. 1008, ¶150.

C. Independent Claim 10

1. Element 10[preamble] — “an interface assembly for a semiconductor wafer”

Lin discloses this element as shown for element 1[preamble] in Ground 3 above. Ex. 1008, ¶151.

2. Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”

Lin discloses this element as shown for element 1[a] in Ground 3 above. Ex. 1008, ¶152.

3. Element 10[b] — “a test pad integrally constructed with said bonding pad”

Lin discloses this element as shown for element 1[b] in Ground 3 above. Ex. 1008, ¶153.

4. Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”

Lin discloses this element as shown for element 1[c] in Ground 3 above. Ex. 1008, ¶154.

5. Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”

Lin discloses this element as shown for element 1[d] in Ground 3 above. Further, *Lin* teaches “performing wafer-level testing” as explained for claim 1 in this Ground 4. Ex. 1008, ¶155.

6. Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”

Lin renders this element obvious as shown for claim 5 in this Ground 4 above. Ex. 1008, ¶156.

7. Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”

Lin renders this element obvious as shown for claim 6 in this Ground 4 above. Ex. 1008, ¶157.

D. Independent Claim 10 — “performing wafer-level testing”

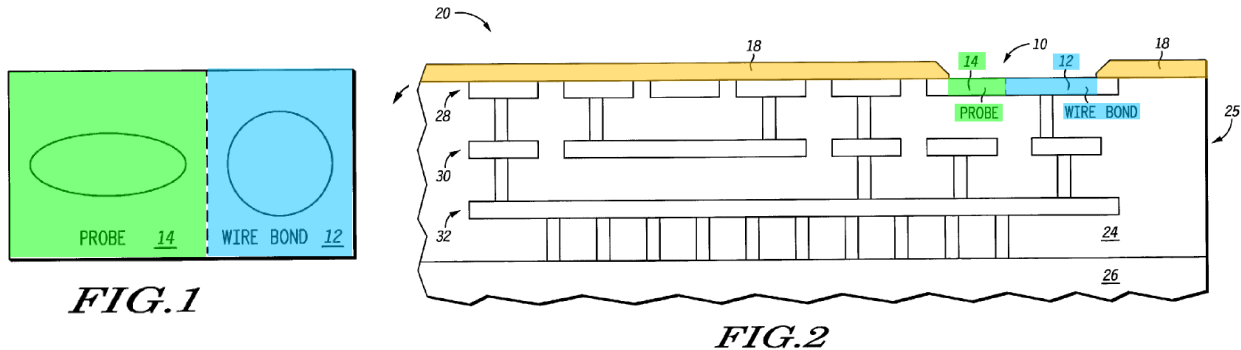
Lin teaches “performing wafer-level testing” as explained for claim 1. Ex. 1008, ¶158.

XI. GROUND 5: CLAIMS 5-6 AND 10 ARE OBVIOUS IN VIEW OF *LIN* AND *YONG*

A. Overview of *Yong*

U.S. Publication 2003/0173667 (“*Yong*”) lists inventors *Yong et al.* and is titled “Semiconductor Device Having a Bond Pad and Method Therefor.” Ex. 1007-

1, [54], [76]. *Yong* published on September 18, 2003 (Ex. 1007-1, [43]), and thus qualifies as §102(a)-(b), and (e) prior art because it published more than one year prior to the '173 patent's September 29, 2004 filing date. *Yong* relates to probe and wire bond regions of a bond pad. Ex. 1007-1, [54], [57].



Ex. 1007-2, Figs. 1-2 (excerpted). While the **probe region 14** and **wire bond region 12** are merely separate regions of an integrated bond pad, the separate regions prevent the final metal layer pad from being damaged by probe testing. Ex. 1007-10 to -12, [0013], [0023]; Ex. 1008, ¶52.

B. Independent Claim 1

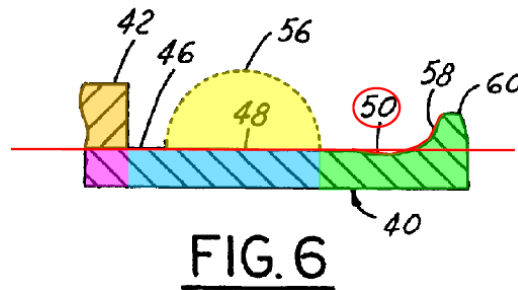
Claims 5-6 depend from claim 1. As noted above in Ground 3, *Lin* discloses every element of claim 1. Further, *Yong* discloses every element of claim 1. Ex. 1008, ¶¶159-173.

C. Claim 5 — “The interface assembly of claim 1 further comprising a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another.”

Lin combined with *Yong* renders this claim obvious. Ex. 1008, ¶¶174-181.

The **top conductive layer** of *Lin* corresponds to the “first metal redistribution layer”

and is co-planar along the plane indicated by the straight red line with the bonding pad (blue area including wire bonding area 48) and the test pad (green area including probe needle contact area 50) in Figure 6 because they are all parts of the same conductive layer, as discussed relative to claim 5 in Ground 4. Ex. 1008, ¶174.



Ex. 1006-3, Fig. 6 (modified). *Lin* teaches aluminum may be used as the bond pad 46: “Each bonding pad 46 may be constructed of aluminum or other suitable electrically conductive material.” Ex. 1006-5, 4:51-53; Ex. 1008, ¶174.

Yong similarly teaches aluminum may be used as a bond pad on top of a copper conductive layer but goes even further to teach the aluminum bond pad may be omitted. *Yong* teaches a redistribution layer coplanar with the test/bonding pads, because it teaches to omit an upper aluminum layer so wire can be bonded directly to a copper top conductive layer. In particular, *Yong* teaches that aluminum bond pad 36 may be formed on top of the copper upper conductive layer 28 to allow for wire bonding to the pad, as shown in Figure 3:

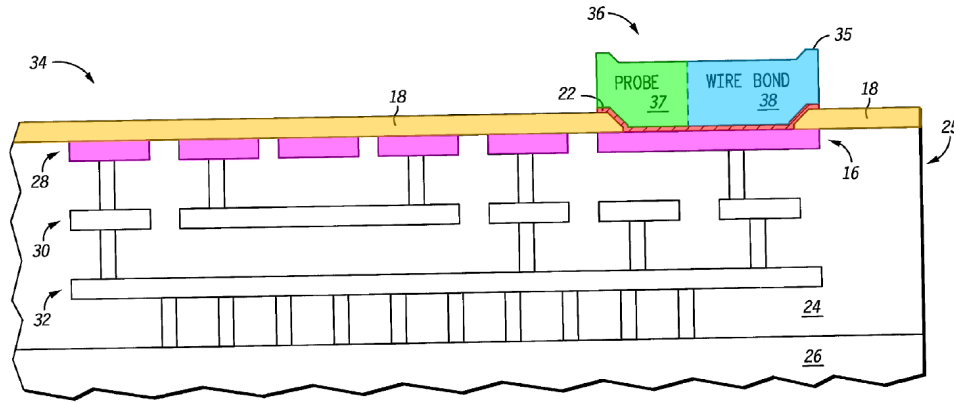


FIG. 3

Ex. 1007-3, Fig. 3. “Bond pad 36 includes final metal layer pad 16 and aluminum pad layer 35.” Ex. 1007-11, [0016]; Ex. 1008, ¶175.

However, *Yong* teaches aluminum bond pads are not necessary to withstand wire bonding. Instead, aluminum bond pads may be omitted and wire may be bonded directly to the top surface of the copper upper conductive layer 28, which is exposed through an opening in the passivation layer 18, as shown in Fig. 2:

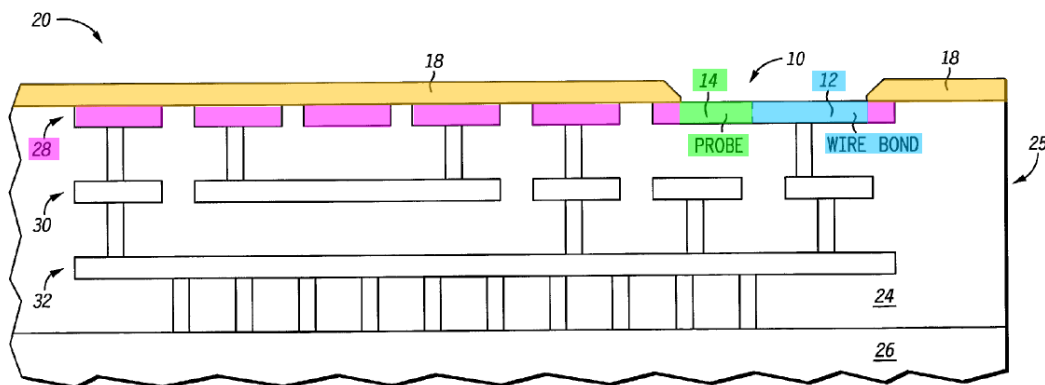
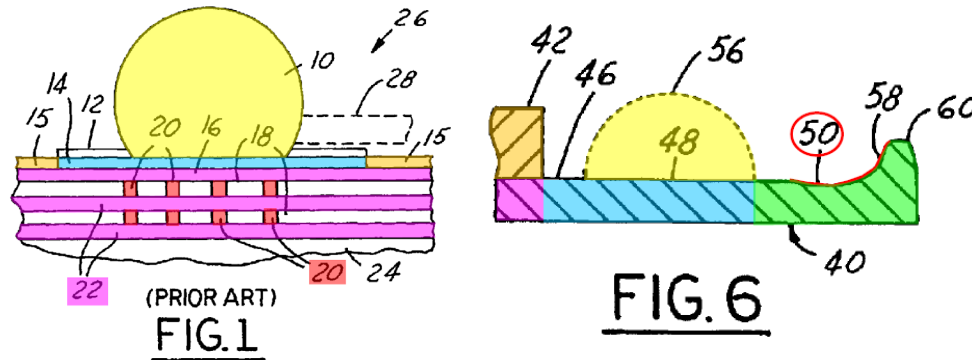


FIG. 2

Ex. 1007-2, Fig. 2. *Yong* teaches that no aluminum bond pad layer is needed because “[t]ests have shown that bond pad 10 is strong enough to withstand the impact of a wire bonding tool and can be formed over interconnect layer 24 without damage to

interconnect layer 24 and any underlying circuits of active region 26 as illustrated in FIG. 2.” Ex. 1007-11, [0015]; Ex. 1008, ¶176. A POSITA understands that if the bond pad 10 is strong enough to withstand the impact of a wire bonding tool, the bond pad 10 would be strong enough to withstand the impact of soldering a solder ball, as discussed above relative to Ground 4, Claim 5. Thus, *Yong* teaches an aluminum bond pad is expressly not needed. Ex. 1008, ¶176.

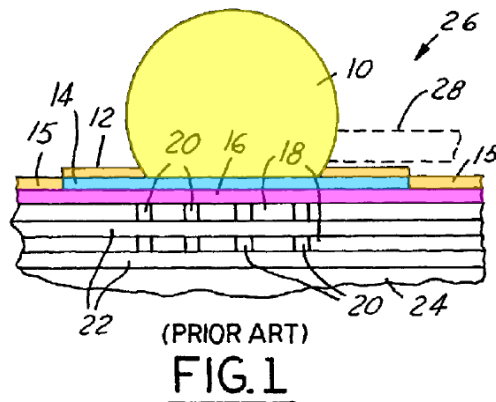
A POSITA would have been motivated to remove or omit the **aluminum layer 14** from the Figure 1 prior art embodiment of *Lin* so the bonding ball 10 can be soldered directly to the **copper upper conductive layer 16** similar to the embodiment of Figure 6.



Compare Ex. 1006-4, 2:4 and 2:21 (Fig. 1 shows “wire bonding ball 10” connects “a bonding wire 28”) and Ex. 1006-6, 5:40-41 (Fig. 6 shows “the bonding ball 56 or other electrical contact”). A POSITA would view this modification of the *Lin* prior art embodiment of Figure 1 as the simple substitution of one known element for another (*e.g.*, it was known based on *Yong* to omit an aluminum plating to allow wire

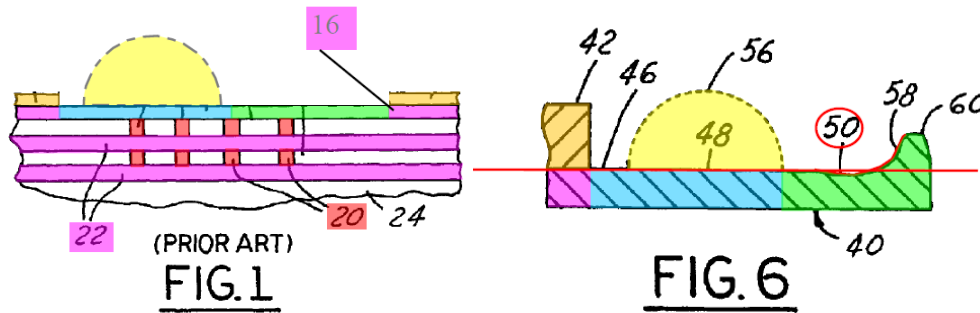
bonding and soldering directly to the copper upper conductive layer) to obtain predictable results. Ex. 1008, ¶177.

With reference to the prior art embodiment of Figure 1, *Lin* teaches an aluminum **bonding pad 14** may be formed on top of the **copper upper conductive layer 16** to allow for a **wire bonding ball 10** to be bound to the pad. Ex. 1006-5, 4:51-53 (“[e]ach bonding pad 46 may be constructed of aluminum or other suitable electrically-conductive material.”)



Ex. 1006-2, Fig. 1; Ex. 1008, ¶178.

Because *Yong* teaches the **copper upper conductive layer** “is strong enough to withstand the impact of a wire bonding tool,” a POSITA would have been motivated to omit the aluminum bonding pad 14 from the *Lin* “prior art” embodiment and solder the **bonding ball 56** directly to the **top surface** of the **copper upper conductive layer 16**, as shown in modified Fig. 1:



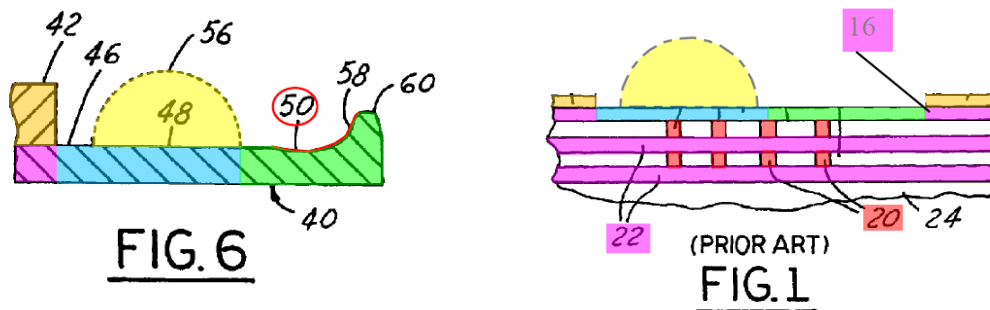
Ex. 1006-2, Fig. 1 (modified) and Ex. 1006-3, Fig. 6 (modified). In this configuration, the **probe needle contact area 50** and **wire bonding area 48** are simply regions of, and coplanar with, **upper conductive layer 16**, identical to the embodiment shown in Figure 6. Ex. 1008, ¶179.

In other words, *Yong*'s teaching that the wire can be bound directly on the upper conductive layer would have led one of ordinary skill to modify the *Lin* "prior art" embodiment to solder a solder bump in a similar manner to achieve a predictable result, *i.e.*, "a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another." In particular, a POSITA would have known the advantage of coplanarity by omitting the aluminum plating from the redistribution layer would be the elimination of a processing step (aluminum plating), elimination of the contact resistance between two metal layers (aluminum and copper), particularly when the interconnection area is reduced to save area, or when a diffusion barrier is required between layers (like aluminum and copper). The contact resistance can cause unwanted voltage drop in high speed serial connections, and in power supply and ground return lines carrying current during testing. Thus, a

POSITA would have been motivated to omit the aluminum plating from the upper conductive layer of the *Lin* “prior art” embodiment as taught by *Yong*. Ex. 1008, ¶180.

D. Claim 6 — “The interface assembly of claim 5 wherein said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer.”

Lin combined with *Yong* renders this claim obvious. Ex. 1008, ¶¶182-184. Beginning with the combinations achieved relative to claim 5, the **top conductive layer** (Fig. 6 modified) and the **upper conductive layer 16** (Fig. 1 modified) of *Lin* correspond to the claimed “first metal redistribution layer.” Further, the **underlying conductive layers 22** correspond to the claimed “second redistribution layer,” and are layers in different planes electrically connected by way of vias 20.



Ex. 1006-3, Fig. 6 (modified); Ex. 1006-2, Fig. 1 (modified). “[U]pper conductive layer 16 ... is separated from an underlying conductive layer 22 by an insulative layer 18. The conductive layers 16, 22 are disposed in electrical contact with each

other through conductive vias 20 that extend through the insulative layers 18.” Ex. 1006-4, 2:12-18; Ex. 1008, ¶182.

Similarly in *Yong*, the **metal layer 28** corresponds to the claimed “first metal redistribution layer,” either of **metal layers 30 and 32** correspond to the claimed “second redistribution layer,” and the layers in different planes are electrically connected by way of vias. In particular, as shown by the red line, the wire bond pad 12 is connected to the metal layer 28 through vias and lower metal layers 30 and 32.

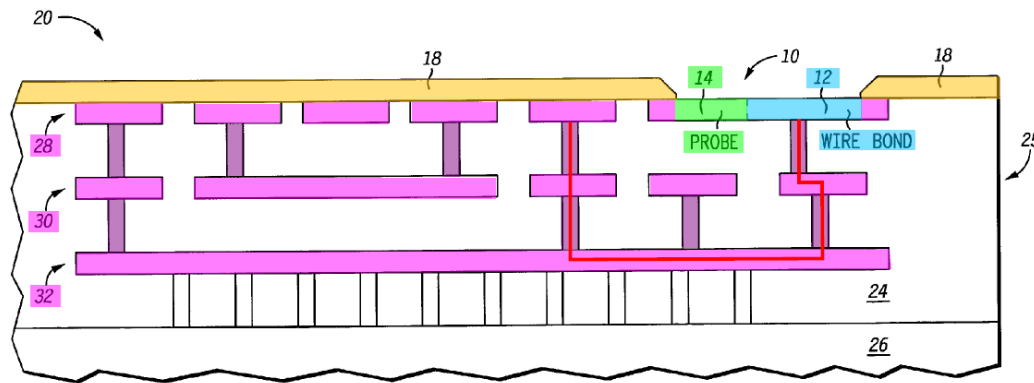


FIG. 2

Ex. 1007-2, Fig. 2 (modified). “Interconnect region 24 includes metal layers 28, 30, and 32 for routing power, ground, signal, and other lines between various components of semiconductor device 20. ... The metal layers of interconnect region 24 may be interconnected between each other using vias.” Ex. 1007-10, [0013]; Ex. 1008, ¶183.

Thus, both *Lin* and *Yong* expressly teach connecting the first redistribution layer to the second redistribution layer by way of vias, where each redistribution layer is in a different plane. Ex. 1008, ¶184.

E. Independent Claim 10

- 1. Element 10[preamble] — “an interface assembly for a semiconductor wafer”**

Lin discloses this element as shown for element 1[preamble] in Ground 3 above. Ex. 1008, ¶185.

- 2. Element 10[a] — “a flip chip bonding pad including a region for performing a bumping process”**

Lin discloses this element as shown for element 1[a] in Ground 3 above. Ex. 1008, ¶186.

- 3. Element 10[b] — “a test pad integrally constructed with said bonding pad”**

Lin discloses this element as shown for element 1[b] in Ground 3 above. Ex. 1008, ¶187.

- 4. Element 10[c] — “said test pad being coplanar relative to said flip chip bonding pad”**

Lin discloses this element as shown for element 1[c] in Ground 3 above. Ex. 1008, ¶188.

- 5. Element 10[d] — “said test pad . . . including a probe region for performing wafer-level testing prior to performing said bumping process”**

Lin discloses this element as shown for element 1[d] in Ground 3 above. Ex. 1008, ¶189.

6. Element 10[e] — “a first metal redistribution layer electrically connected to said bonding and test pads, and being co-planar with one another”

Lin combined with *Yong* render this element obvious as shown for claim 5 in this same Ground 5 above. Ex. 1008, ¶190.

7. Element 10[f] — “said first metal redistribution layer is electrically connected by way of a via to a second redistribution layer being disposed in a different plane than the first redistribution layer”

Lin combined with *Yong* render this element obvious as shown for claim 6 in this same Ground 5 above. Ex. 1008, ¶191.

XII. DISCRETIONARY DENIAL IS UNWARRANTED

The Board should not exercise its discretion to deny intuition of this Petition. With respect to the district court proceedings, several of the *Apple v. Fintiv* (IPR2020-00019) factors weigh against discretionary denial:

Factor 2: As of filing this Petition, the related district court case was in its infancy—with a case management conference held October 16, 2020, and trial expected around April 2022 (trial 52 weeks after April 9, 2021 *Markman* hearing) “or as soon as practicable.” An FWD in this IPR is likely to issue prior to the conclusion of the district court trial (including post-trial briefing that typically takes 1-2 months). Further, the district court trial date setting of “or as soon as practicable” indicates some uncertainty in that schedule. *See Sand Revolution II v. Continental Intermodal*, IPR2019-01393, Paper 24 at 8-9 (June 16, 2020). Moreover, the ongoing

COVID pandemic creates increased uncertainty as to whether the trial date will be delayed.

Factor 3: As of the time of this petition, the parties and the court have made minimal investment in the parallel district court proceedings. Petitioners have answered the complaint and the court held a case management conference. Petitioners filed this Petition expeditiously, within five weeks of receiving Patent Owner's preliminary infringement contentions served October 9, 2020 in the district court. Patent Owner has asserted eight patents against Petitioners, and Petitioners have worked expeditiously to review the asserted claims and prior art to file this Petition.

Factor 4: There should be no overlap between this IPR and the district court proceeding because Petitioners stipulate not to pursue in the district court any ground raised or that could have reasonably raised in an IPR (*i.e.*, under §§ 102, 103 on the basis of prior art patents or printed publications alone) if this IPR is instituted. This stipulation is based on current PTAB precedent regarding discretionary denial under § 314(a), and Petitioners reserve the right to revoke or amend the stipulation if the precedent or governing law changes. *See* USPTO, Request for Comments on Discretion to Institute Trials Before the Patent Trial and Appeal Board, 85 Fed. Reg. 66502, 66504-05 (October 20, 2020) (questions 5 and 6 relating to whether *Fintiv* should be modified and/or codified).

Factor 6: The unpatentability grounds presented here are strong, and this IPR will efficiently resolve issues raised in the related district court lawsuit. Because the '173 patent involves semiconductor technology, resolution of invalidity is better suited for an IPR than a jury of laypersons.

Accordingly, this Petition should be allowed under 35 U.S.C. §314(a), 325(d), and/or 37 C.F.R. §42.108(a).

XIII. CONCLUSION

This petition shows there is a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. Petitioner respectfully requests a Trial be instituted by the Board and all claims 1-10 of the '173 patent be cancelled.

XIV. FEES

Petitioner has paid the filing fees via debit card. Please charge any additional fees to Deposit Account No. 50-6736.

XV. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

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

Petitioners Microchip Technology Incorporated and Microsemi Corporation are the real parties-in-interest. No other party had access to, control over, or contributed to funding of the preparation or filing of this Petition.

Microchip Technology Incorporated is a Delaware corporation. It has its principal place of business located in Chandler, Arizona. Microchip Technology Incorporated is a leading provider of smart, connected and secure embedded control solutions. (*See* www.microchip.com/en-us/about/corporate-overview).

Microsemi Corporation is a Delaware corporation. It has its principal place of business located in Chandler, Arizona. Microsemi Corporation, a wholly owned subsidiary of Microchip Technology Incorporated, offers a comprehensive portfolio of semiconductor and system solutions for communications, defense & security, aerospace and industrial markets. (*See* www.microsemi.com).

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

Bell Semiconductor sued Microchip and Microsemi for patent infringement. *Bell Semiconductor, LLC v. Microchip Technology Inc. and Microsemi Corporation*, Civil Action No. 6:20-cv-00296 (WDTX April 16, 2020). Petitioners are unaware of any other judicial or administrative matter that would affect, or be affected by, a decision in this proceeding.

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

Slayden Grubert Beard PLLC provides the following designation of counsel, all of whom are included in Customer No. 86,528 identified in Slayden Grubert Beard PLLC's Power of Attorney, filed concurrently herewith under 37 C.F.R. § 42.10(b).

Lead Counsel	Back-up Counsel
Bruce W. Slayden II (Reg. 33,790) bslayden@sgbfirm.com Tel. 512.402.3552	Brian C. Banner (<i>Pro Hac Vice</i> motion forthcoming) bbanner@sgbfirm.com Tel. 512.402.3569

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

Service information for lead and back-up counsel is Slayden Grubert Beard PLLC, 401 Congress Ave., Suite 1650, Austin, Texas 78701; Tel. 512-402-3550; Fax 512-402-6865. Petitioner consents to service by electronic mail at litigation@sgbfirm.com and bslayden@sgbfirm.com.

November 16, 2020

Date

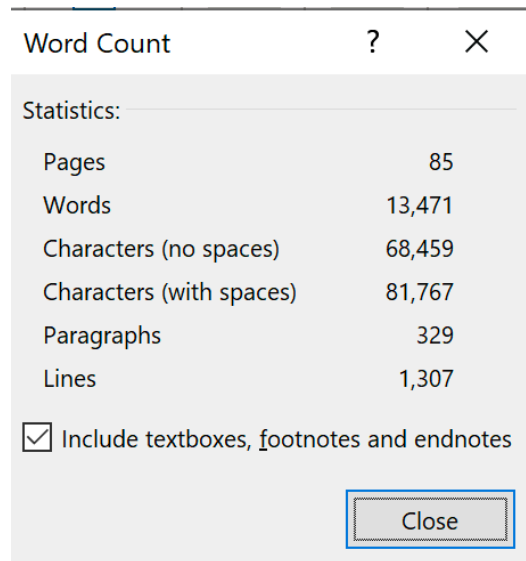
/s/ *Bruce W. Slayden II*

Bruce W. Slayden II (Reg. No. 33,790)
Brian C. Banner (*Pro Hac Vice*)

Slayden Grubert Beard PLLC
401 Congress Avenue, Suite 1650
Austin, Texas 78701
*Attorneys for Petitioners, Microchip
Technology Incorporated and
Microsemi Corporation*

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petition, exclusive of the exempted portions as provided in 37 C.F.R. § 42.24(a), contains 13,471 words, which is less than the 14,000 allowed under 37 CFR §42.24.



November 16, 2020
Date

/s/ Bruce W. Slayden II

Bruce W. Slayden II (Reg. No. 33,790)
Brian C. Banner (*Pro Hac Vice*)

Slayden Grubert Beard PLLC
401 Congress Avenue, Suite 1650
Austin, Texas 78701
*Attorneys for Petitioners, Microchip
Technology Incorporated and
Microsemi Corporation*

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies that the foregoing Petition and Exhibits 1001-1014 have been served simultaneously with filing. Service is via FedEx Priority Overnight, which is at least as fast and reliable as Priority Mail Express.

Pursuant to 37 C.F.R. § 42.105, service of the petition and supporting evidence has been made on the patent owner at the correspondence address of record for the '173 patent, which is:

Hitt Gaines, PC
LSI Corporation
PO Box 832570
Richardson, TX 75083

BELL SEMICONDUCTOR, LLC
c/o Steven Hartsell
Skiermont Derby LLP
1601 Elm Street, Suite 4400
Dallas, TX 75201

November 16, 2020
Date

/s/ Bruce W. Slayden II

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