Appeal No. 2016-2358

IN THE UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

MIT,

Appellee,

v.

MICRON TECHNOLOGY, INC. and MICRON MEMORY JAPAN, INC.,

Appellants.

Appeal from the United States District Court of Massachusetts
Case No. 15-10374-FDS

APPELLANTS' OPENING BRIEF

NON CONFIDENTIAL VERSION

Edward R. Reines
Principal Attorney
WEIL, GOTSHAL & MANGES LLP
201 Redwood Shores Parkway
Redwood Shores, CA 94065
(650) 802-3000

October 19, 2016

Counsel for Appellants

TABLE OF CONTENTS

PAGE

TABLE OF AUTHORITIES iii

CERTIFICATE OF INTEREST v

STATEMENT OF RELATED CASES 1

JURISDICTIONAL STATEMENT 1

STATEMENT OF ISSUES PRESENTED 1

I. STATEMENT OF THE CASE 2

A. The Now-Invalidated Patent-In-Suit 2

B. The Infringement Accusations 3

C. MIT Obtained An Ex Parte Reexamination Certificate For The '221 Patent By Misdirection 4

D. With Its Ill-Gotten Reexam Certificate, MIT Renews Its Enforcement Efforts 5

E. The Patent Office Recognized The Evidence MIT Suppressed 5

F. MIT Did Not Contest The Invalidation Of The '221 Patent 6

G. The District Court Denies The Motion For Attorneys' Fees 7

II. SUMMARY OF ARGUMENT 9

III. ARGUMENT 12

A. Governing Law 12

B. The District Court Improperly *Assumed* That MIT Acted In Good Faith 14

C. The District Court Improperly *Assumed* That MIT's Invalidity Positions Were "Colorable" Without Analyzing The Facts 15

1. It Was Exceptional For MIT To Deny That The Koyou Cut-Link Was Wider Than The Connecting Lines.....16

2. It Was Exceptional For MIT To Deny That The Koyou Cut-Link Has Substantially Less Thermal Resistance Per Unit Length Than The Connecting Lines 20

D. Rather Than Supporting The District Court's Decision, The Ex Parte Reexamination Highlights Why MIT Should Reimburse Micron Its Legal Expenses.....22

1. MIT Misled The Patent Office Into Believing That Koyou Does Not Disclose A Cut-link Wider Than The Connecting Wires.....23

2. MIT Misled The Patent Office Into Believing That Koyou Does Not Disclose A Cut-link Pad That Has Substantially Less Thermal Resistance Than The Connected Lines.....26

E. The District Court Improperly Concluded MIT's Infringement Position Was Not Objectively Unreasonable.....27

IV. CONCLUSION.....33

The material redacted from pages 4 and 5 discloses parties' settlement negotiations

TABLE OF AUTHORITIES

PAGE(S)

CASES

Commil USA, LLC v. Cisco Sys., Inc.,
135 S. Ct. 1920 (2015) 12

Cooter & Gell v. *Hartmarx Corp.*,
496 U.S. 384 (1990) 14

eSpeed, Inc. v. Brokertec USA, LLC,
480 F.3d 1129 (Fed. Cir. 2007) 23

Highmark Inc. v. Allcare Health Mgmt. Sys.,
134 S. Ct. 1744 (2014) 13, 14

MarcTec, LLC v. Johnson & Johnson,
664 F.3d 907 (Fed. Cir. 2012) 13

Octane Fitness v. ICON Health & Fitness,
134 S. Ct. 1749 (2014) 13, 14, 16

Raylon, LLC v. Complus Data Innovations, Inc.,
700 F.3d 1361 (Fed. Cir. 2012) 13

Senmed, Inc. v. Richard-Allan Medical Industries,
888 F.2d 815 (Fed. Cir. 1989) 9, 11, 31, 32

SFA Sys., LLC v. Newegg Inc.,
793 F.3d 1344 (Fed. Cir. 2015) 16

TIP Sys., LLC v. Phillips & Brooks/Gladwin, Inc.,
529 F.3d 1364 (Fed.Cir.2008) 32, 33

Yamanouchi Pharmaceutical Co., Ltd. v. Danbury Pharmacal, Inc.,
231 F.3d 1339 (Fed. Cir. 2000) 14

STATUTES

28 U.S.C. § 1295(a)(1) 1

28 U.S.C. § 1331 1

28 U.S.C. § 1338(a) 1

28 U.S.C. § 2107(a) 1

35 U.S.C. § 285..... 13, 15

Fed. R. App. P. 4.....1

OTHER AUTHORITIES

Merriam-Webster.com.
Merriam-Webster, n.d. Web. 3 Oct. 2016.....28

CERTIFICATE OF INTEREST

Counsel for Appellants Micron Memory Japan, Inc. and Micron Technology, Inc. certifies as follows:

1. The full name of every party or amicus represented by us is:

   Micron Memory Japan, Inc. and Micron Technology, Inc.

2. The name of the real party in interest represented by us is:

   Micron Memory Japan, Inc.: None

   Micron Technology, Inc.: None

3. All parent corporations and any public companies that own 10 percent or more of the stock of the parties represented by us are:

   Micron Memory Japan, Inc.: Micron Technology, Inc.

   Micron Technology, Inc.: None

4. The names of all law firms and the partners or associates that appeared for the parties now represented by us in the trial court or are expected to appear in this Court are:

   DONNELLY, CONROY &GELHAAR, LLP: T. Christopher Donnelly, Brendan T. St. Amant; SHERMA & STERING LLP: Thomas R. Makin; KENYON & KENYON LLP: David J. Cooperberg, Rose Cordero Prey; WEIL, GOTSHAL & MANGES, LLP: Edward R. Reines

STATEMENT OF RELATED CASES

No other appeal in or from this same civil action was previously before this Court or any other court of appeals. Micron Memory Japan, Inc. and Micron Technology, Inc. ("Micron") and its undersigned counsel are unaware of any other actions now pending in this or any other court that may directly affect or be directly affected by this Court's decision in the present appeal.

JURISDICTIONAL STATEMENT

This is an appeal from the district court's final order issued June 17, 2016 denying Micron's motion for attorneys' fees and costs. The district court had original jurisdiction under 28 U.S.C. §§ 1331, 1338(a). Micron filed a timely notice of appeal under 28 U.S.C. § 2107(a) and Federal Rule of Appellate Procedure 4. This Court has jurisdiction under 28 U.S.C. § 1295(a)(1).

STATEMENT OF ISSUES PRESENTED

Did the district court improperly deny Micron's motion for attorneys' fees and costs by committing the following legal errors:

1) Accepting without supporting evidence that MIT abandoned its patent because IPR statistics supposedly doomed it rather than because of the poverty of its position.

2) Failing to assess the unreasonableness of MIT's invalidity position based on the record evidence.

3) Concluding wrongly that Micron did not submit proof that MIT misled the Patent Office by intentionally misconstruing the prior art.

4) Concluding wrongly that MIT's infringement position was "not entirely unreasonable."

I. STATEMENT OF THE CASE

A. The Now-Invalidated Patent-In-Suit

Massachusetts Institute of Technology ("MIT"), the original patentee and plaintiff in this case, filed a request for adverse judgment with the Patent Trial and Appeal Board ("PTAB") following the PTAB's determination that Micron had demonstrated a reasonable likelihood of invalidity of MIT's patent in suit. That patent, U.S. Patent No. 6,057,221 ("the '221 patent"), is now invalid.

The '221 Patent relates to the use of fuses in integrated circuits ("IC") to reroute electrical signals to bypass defects detected during the testing process. The fuses are blown (set off) to disconnect the defective circuit components, thereby allowing redundant circuity to be used in lieu of the defective circuitry.

Fuses were common in the prior art. They are called a laser cut-link, or simply a cut-link. To "blow" this type of fuse, the cut-link is exposed to a laser beam to evaporate the element, thereby creating an open circuit. The '221 patent claims methods to sever connections between electrical circuits using cut-links having a particular structure.

B. The Infringement Accusations

In 2008, Massachusetts Institute of Technology ("MIT") threatened Elpida Memory, Inc. (Micron's predecessor) with an infringement claim for the '221 patent. Appx71 [Ex. 1, May 23, 2008 Fortney letter to Elpida Memory, Inc.]. MIT warned that "patent infringement (and particularly willful patent infringement) is a serious matter." *Id*.

Elpida investigated the matter, determined the patent was invalid and not infringed, and promptly informed MIT of this in detail. Appx93-154, Appx158-177, Appx179-241, Appx244-247. Indeed, Elpida prepared detailed presentations demonstrating to MIT that: (1) the '221 patent was invalid, and (2) its products could not infringe the '221 patent. *Id.*

Elpida demonstrated the invalidity of the '221 patent claims in light of prior art references, including Japan Pat. Appl. Publ. No. 8-213465 ("Koyou"). Appx237. This is the same prior art that the Patent Office eventually relied on in the IPR proceedings to conclude that the claims of the '221 patent were likely unpatentable and that ultimately caused their cancellation. Appx478-528. Elpida explained that it did not infringe the '221 patent because the patent claims require that the two electrically-conductive lines attached to the cut-link pad be "on a substrate." Appx158-177. However, MIT never identified lines in the accused products that were "on" a substrate, but rather pointed to lines that passed

CONFIDENTIAL MATERIAL HAS BEEN REDACTED

vertically into and through the substrate. *Id.* MIT's infringement charts never even considered this "on a substrate" limitation, or purported to find it present in the accused devices. Appx249-265.

MIT demanded more than a [redacted] dollars from Elpida. Appx265.

C. MIT Obtained An Ex Parte Reexamination Certificate For The '221 Patent By Misdirection

After Elpida presented invalidating prior art in response to MIT's infringement threats, MIT initiated ex parte reexamination proceedings at the Patent Office. This allowed MIT to obtain Patent Office consideration of the key invalidating prior art without an adversary to challenge its positions. Appx555-623.

In the ex parte proceedings, MIT did not present Elpida's invalidity positions to the Patent Office. Instead, MIT manipulated the record with deceptive testimony from the inventor and misleading arguments based on that testimony. This caused the Patent Office to issue a reexamination certificate notwithstanding the invalidity of the claims. This maneuver would not have succeeded if an adversary was participating to keep things honest or even if MIT had fairly presented Elpida's positions.

CONFIDENTIAL MATERIAL HAS BEEN REDACTED

D. With Its Ill-Gotten Reexam Certificate, MIT Renews Its Enforcement Efforts

Armed with its ex parte reexamination certificate, MIT again threatened Elpida in 2012. Appx547 [IPR2015-01087 Ex. 2001 and 2001ET, Proof of Reorganization Claims Form] (seeking a total of [redacted] in damages under the '221 patent in Tokyo District court).

Elpida met with MIT once again to try to avoid unnecessary litigation with all the expense that entails. Elpida demonstrated in detail how MIT had misrepresented the prior art to the Patent Office in the ex parte reexamination proceeding and again explained that the '221 patent was invalid. Appx457, Appx463-474. After extended negotiations, MIT dropped its demand from what had been more than [redacted] to [redacted] Appx476. MIT unreasonably limited its license, causing the talks to end.

MIT thereafter filed this lawsuit.

E. The Patent Office Recognized The Evidence MIT Suppressed

In response to MIT's lawsuit, Micron initiated an IPR challenge to the '221 patent to expose the evidence that had been suppressed in the ex parte reexamination proceedings. Appx555, Appx562. After considering Defendants' petition and the preliminary response submitted by MIT, the Patent Office instituted the IPR soundly rejecting MIT's positions regarding Koyou. Appx526-527. The Patent Office agreed that MIT had not described the full teaching of the

prior art during the ex parte reexamination proceedings. Appx479, Appx502, Appx513, Appx518, Appx526-527.

F. MIT Did Not Contest The Invalidation Of The '221 Patent

After the Patent Office embraced Defendants' analysis of Koyou, MIT cancelled all claims of the '221 patent, asked that judgment be entered against it. Appx1014 [D.I. 47], Appx1020-1021 [D.I. 47-1 (Ex. 1)].

In withdrawing its opposition to Defendants' IPR petition, MIT included a self-serving explanation to the effect that it was abandoning its positions merely because the odds were stacked against it once the IPR was instituted:

> Patent Owner is cognizant of the statistics weighing against it once a decision instituting proceedings has been issued. In light of this, Patent Owner requests cancellation of the challenged claims.

Appx988.

In cancelling the '221 patent, the Patent Office repudiated MIT's "unsupported" excuse for abandoning its validity position:

> Patent Owner makes its request to cancel the challenged claims "in light of" alleged "statistics weighing against it once a decision instituting proceedings has been issued." Paper 23. Each case presents its own unique facts and our decision to grant Patent Owner's Request for Adverse Judgment is in ***no way influenced by Patent Owner's unsupported assertion***. This judgment is entered solely on the basis of Patent Owner's request, without regard to any factor Patent Owner alleges as its motivation.

Appx1020-1021 [*Micron Tech., Inc. v. Massachusetts Institute of Tech.*, No. IPR2015-01087 (P.T.A.B. Jan. 5, 2016)] (emphasis supplied).

G. The District Court Denies The Motion For Attorneys' Fees

The heart of Micron's motion for attorneys' fees is that MIT engaged in a multi-year effort to extort millions of dollars from Elpida, and utilized false declarations and intentional misrepresentations to obtain the Patent Office's blessing of the claims on false premises.

Before its first meeting with Elpida in 2008, the worst that could be said of MIT's conduct related to this case is that it aggressively sought to license its patents. However, from the moment Elpida brought the invalidity of the '221 patent to MIT's attention, based on the very same art the Patent Office ultimately determined justified post-grant review, MIT has acted with persistent bad faith. MIT filed a manipulative and misleading ex parte reexamination request designed to suppress improperly the evidence of invalidity. After obtaining the reexamination certificate, MIT filed suit. After Micron (Elpida's successor) brought the invalidity to the Patent Office's attention through an IPR petition, MIT abandoned the patent, and this lawsuit. On top of all this, MIT studiously ignored the reality that its infringement theory was meritless from the outset.

The district court's rejection of Micron's motion starts off on the wrong foot by accepting – without analysis or evidence – MIT's assertion that it acquiesced to

the invalidation of the ’221 patent and abandoned this suit merely because IPR statistics doomed its chances. Appx2 (“Because the PTAB usually invalidates patents after instituting full IPR review, MIT requested that the Court enter an adverse judgment and dismiss the case.”). The PTAB itself rejected this self-serving excuse, noting that it essentially amounted to an “unsupported” attack on whether the PTAB applies the legal standards in good faith. Appx1020-1021 [*Micron Tech., Inc. v. Massachusetts Institute of Tech.*, No. IPR2015-01087 (P.T.A.B. Jan. 5, 2016)].

On the merits, the district court failed to evaluate for itself the unreasonableness of MIT’s position, relying instead on the review performed by the “three expert examiners” during ex parte reexamination. Appx7 (“Defendants’ contention that MIT’s validity argument was objectively unreasonable necessarily means that the three expert examiners who reexamined the patent with full knowledge of Koyou also reached an objectively unreasonable, borderline frivolous, conclusion.”). It did so without meaningfully evaluating the lack of integrity of the ex parte reexamination proceedings.

The district court found no evidence of MIT’s misbehavior in the reexamination proceedings because Micron’s expert did not assert in its IPR petition that MIT misled the Patent Office. Appx8 (“[T]he expert declaration submitted by defendants in their petition for IPR review does not allege that

Bernstein and MIT misled the PTO."). Setting aside the fact that a technical expert does not have the responsibility to allege misconduct by an opposing expert in support of an IPR petition, Micron's expert (Dr. Thomas), in fact, exposed MIT's (and Dr. Bernstein's) improprieties throughout his declaration. *See, e.g.*, Appx840 ("Dr. Bernstein *improperly* ignored the fuse member and contact widths shown in the plan view in Figure 1(a) of Koyou"); *see also* Appx840 n.3 ("[T]his *correction* to Dr. Bernstein's analysis would be sufficient to insure that even tungsten vias have a thermal resistence per unit length substantially higher than that of the fuse pad."), Appx841 ("Dr. Bernstein's conclusion as to the full disclosure of Koyou is *incorrect*"), Appx844 ("Dr. Bernstein, however, *failed* to credit Koyou's Figure 1(a)").

The district court's evaluation of MIT's infringement theory also went awry. It concluded that MIT's infringement theory was "not entirely unreasonable," even though it contorted the common sense meaning of the phrase "on a substrate." The district court's erroneous construction of this straightforward phrase relied on a stark misreading of *Senmed, Inc. v. Richard-Allan Medical Industries*, 888 F.2d 815 (Fed. Cir. 1989). Appx6.

II. SUMMARY OF ARGUMENT

The district court legally erred in denying Micron's motion for attorneys' fees and costs. That decision should be reversed.

First, MIT abandoned this case and the patent-in-suit after Micron incurred much expense. MIT claims that it did so because the PTAB statistics show "the PTAB regularly rules against patent holders." Appx639. The district court erroneously accepted as fact MIT's excuse for abandoning the patent without any supporting evidence or analysis. Appx2. As this brief demonstrates, a far better explanation for the abandonment of the patent is that MIT's patent is definitely invalid. As will be seen, the district court's uncritical acceptance of MIT's positions, notwithstanding the facts, is characteristic of the district court's opinion in general.

Second, the district court improperly assumed MIT's invalidity positions were colorable. It relied on the fact that the '221 patent survived ex parte reexamination as a proxy for analyzing the record evidence showing those positions were fallacious. That was legal error, too.

The '221 patent touts that the claimed invention is different from the prior art because the inventors bucked the conventional wisdom. According to the patent, when prior artists were using cut-links that were the same or narrower than their connecting lines, the inventors had the insight to use cut-links ***wider*** than the connecting lines. Elpida, Micron's predecessor, saw this and promptly alerted MIT that there were prior art fuses with cut-links wider than the connecting lines, including Koyou.

MIT's response was to file an ex parte reexamination petition in which Elpida was not permitted to participate. Indeed, MIT did not even inform Elpida of its filing, notwithstanding their on-going engagement relating to this patent. Instead of fairly presenting the issues to the Patent Office, MIT submitted an inventor declaration that misled the Patent Office on critical issues. MIT did not present Elpida's side of the story to the Patent Office. As documented below, the evidence proves that MIT's invalidity positions are intolerably meritless. It appears that the district court never evaluated the weakness of MIT's position because it relied on the ex parte reexamination certificate instead. That was legal error.

Third, on top of the rank invalidity of the '221 patent, MIT never had a colorable infringement theory. The claims all require that the connecting lines be "on a substrate." Yet, the claims are asserted against designs that have connecting lines ***within*** the substrate. The district court found this meritless position acceptable because it concluded that this Court had construed "on" consistent with MIT's infringement theory in *Senmed, Inc. v. Richard-Allan Medical Industries*, 888 F.2d 815 (Fed. Cir. 1989). The district court had it backwards. *Senmed* confirms that "on" means "on the surface: on it." That was another legal error.

Finally, the district court concluded that MIT did not behave inappropriately during the ex parte reexamination proceedings. To reach this conclusion the

district court relied on the fact that Micron's expert in IPR proceedings had supposedly not alleged culpable conduct on MIT's part during the ex parte reexamination. That makes no sense. There is no reason why an expert would be responsible for alleging wrongdoing. In any event, the record shows that MIT misled the Patent Office in the reexamination proceedings and the evidence of that should have been considered. And Micron's expert did explain that the testimony submitted by MIT was "improper" and "erroneous."

The denial of Micron's motion for attorneys' fees and costs should be reversed.

III. ARGUMENT

A. Governing Law

Section 285 is a "safeguard" against litigants that "use patents as a sword to go after defendants for money, even when their claims are frivolous." *Commil USA, LLC v. Cisco Sys., Inc.*, 135 S. Ct. 1920, 1930 (2015). District courts accordingly have a "responsibility to ensure frivolous cases are dissuaded." *Id.* It follows necessarily that this Court plays an important role to ensure that district courts are fulfilling that vital responsibility to keep the system in balance.

In addressing whether a case is exceptional the trial court is required to consider "both the governing law and facts of the case" to evaluate the weakness of the loser's position. *Octane Fitness v. ICON Health & Fitness*, 134 S. Ct. 1749,

1756 (2014) (a case is exceptional if it "stands out from others with respect to the substantive strength of a party's litigating position (considering both the governing law and the facts of the case)"). These same principles logically apply to an award under the Court's inherent authority.

The denial of a motion for attorneys' fees under 35 U.S.C. § 285 is reviewed for abuse of discretion. *Highmark Inc. v. Allcare Health Mgmt. Sys.*, 134 S. Ct. 1744, 1747 (2014). A district court's decision not to award attorneys' fees and expert fees under its inherent authority is likewise reviewed for an abuse of discretion. *MarcTec, LLC v. Johnson & Johnson*, 664 F.3d 907, 921 (Fed. Cir. 2012).

As this Court explained in *Raylon, LLC v. Complus Data Innovations, Inc.*, 700 F.3d 1361 (Fed. Cir. 2012), notwithstanding the deferential standard of review, this Court is responsible for ensuring that "there is a threshold below" which arguments must not sink. In *Raylon*, this Court reversed a finding that the infringement claims were not sufficiently meritless and ordered the reimbursement of the accused infringer's legal expenses.

As reinforced by *Octane*, the failure of a district court to consider sufficiently "both the governing law and facts of the case" to determine whether that threshold was crossed constitutes legal error. This is because in "assessing whether a case qualifies as exceptional, the district court ***must*** look at the totality

of the circumstances." *Octane Fitness*, 134 S. Ct. at 1754 (*quoting Yamanouchi Pharmaceutical Co., Ltd. v. Danbury Pharmacal, Inc.*, 231 F.3d 1339, 1347 (Fed. Cir. 2000)) (emphasis supplied).[1]

B. The District Court Improperly *Assumed* That MIT Acted In Good Faith

The district court opinion accepts as fact MIT's assertion that the reason it abandoned its patent was because the IPR statistics doomed its defense of the patent. This unsupported finding is a red flag that the district court's opinion heads in the wrong direction.

MIT's position is dubious and it was error to accept it uncritically. Patent owners routinely defend their patents on the merits before the PTAB after an institution decision. Indeed, many prevail. MIT's assertion that it abandoned its patents for reasons unrelated to the emptiness of its position essentially assumes the PTAB is a lawless judicial body.

The PTAB properly took exception to MIT's position, rejecting it flatly as "unsupported" in the process of cancelling the '221 patent. Appx1020-1021 [*Micron Tech., Inc. v. Massachusetts Institute of Tech.*, No. IPR2015-01087 (P.T.A.B. Jan. 5, 2016)]. The district court did not. That error betrayed the district

[1] "The abuse-of-discretion standard does not preclude an appellate court's correction of a district court's legal or factual error: 'A district court would necessarily abuse its discretion if it based its ruling on an erroneous view of the law or on a clearly erroneous assessment of the evidence.'" *Highmark*, 134 S. Ct. at 1748 n. 2 (quoting *Cooter & Gell* v. *Hartmarx Corp.*, 496 U.S. 384, 405 (1990)).

court's unsupported ***presumption*** that MIT's position on the merits was above the minimum acceptable threshold.

C. The District Court Improperly *Assumed* That MIT's Invalidity Positions Were "Colorable" Without Analyzing The Facts

The district court concluded that MIT's position on the merits had to be above the minimum acceptable threshold because three examiners in an ex parte reexamination issued a reexamination certificate. Micron's motion identified two key invalidity issues where MIT took indefensible positions and explained that MIT's misdirection to obtain the certificate was an aggravating factor, not exculpatory.

Nevertheless, in its opinion denying the attorneys' fees motion, the district court does not even ***mention*** these two key issues, much less the facts or evidence relating to them. Instead, the district court relied only on the decision in the reexamination proceeding as a proxy and did not perform its own analysis of the facts and the evidence:

> Defendants' contention that MIT's validity argument was objectively unreasonable necessarily means that the three expert examiners who reexamined the patent with full knowledge of Koyou also reached an objectively unreasonable, borderline frivolous, conclusion. That is, to say the least, doubtful. MIT's validity position may have ultimately been without merit, but there is a sizeable gap between taking a losing position and taking unreasonable positions; otherwise the statute's use of the term "exceptional" is meaningless. The relevant inquiry in deciding fee motions under § 285 focuses on the

> substantive strength of a party's litigating position, "not the correctness or eventual success of that position." *SFA Sys., LLC v. Newegg Inc.*, 793 F.3d 1344, 1348 (Fed. Cir. 2015); *see also Octane Fitness*, 134 S. Ct. at 1753 (noting that fee awards are not to be used "as a penalty for failure to win a patent infringement suit"). In short, it appears that MIT's validity position was not objectively unreasonable.

Appx7.

The district court's statement that it "appears" that MIT's validity position was not objectively unreasonable is legally insufficient. The district court was required to consider the evidence to determine if that was in fact true. Mere reliance on the Patent Office reexamination certificate as a proxy is legal error.

As demonstrated in the following two sections, if the district court had performed the required analysis, it would have concluded that MIT's positions were exceptional because they were so meritless.

1. It Was Exceptional For MIT To Deny That The Koyou Cut-Link Was Wider Than The Connecting Lines

The '221 patent is particularly clear that its main contribution to the field is the concept of using a fuse with a cut-link that is ***wider*** than the lines to which it is connected. According to the patent, this is a key differentiator from the prior art that goes against "intuition." Appx28 at 2:8. In trying to monetize this patent, MIT called this a "groundbreaking innovation" and a "breakthrough." Appx925, Appx912.

The patent states that the prior art cut-links either had a cut-link the same width as the connecting lines or in a "dog bone" arrangement where the cut-link is narrower than the connecting lines. Indeed, it displays the criticized prior art in the patent:

Same Width

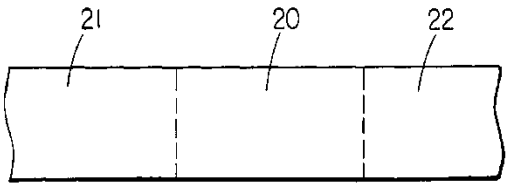


FIG. 1
PRIOR ART

Narrower Cut-Link

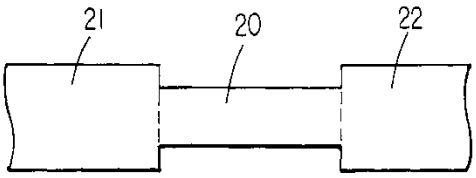


FIG. 2
PRIOR ART

Appx22, Figs. 1, 2.

The '221 patent explains that it bucked the prior art and instead used a cut-link that is ***wider*** than the connecting lines:

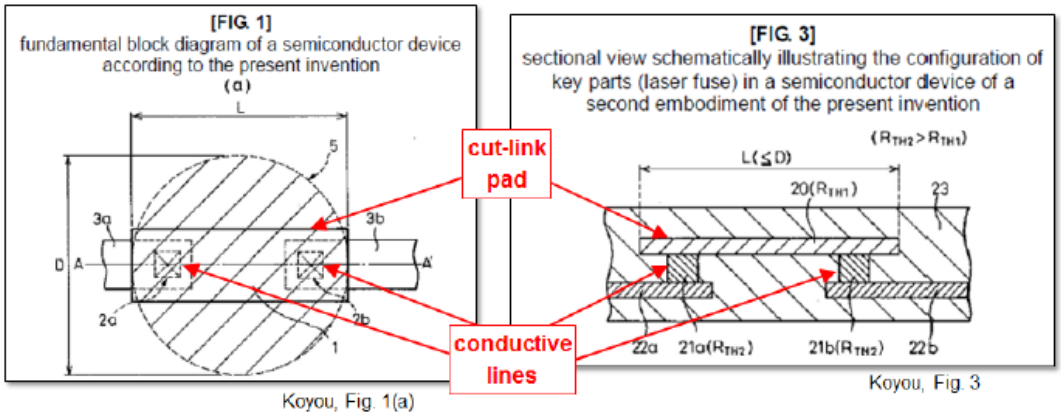
> Whereas the design of earlier cut-links mirrors the narrowed "dog-bone" of conventional fuse design, a preferred embodiment of this invention rejects this model and, instead, widens the segment where the circuit is to be severed. Where circuitry is cut by a laser, the high resistance of a fuse is not required to produce the needed influx of thermal energy. In this context, the thermal energy needed to melt the conductive material is supplied by an external source, i.e., the laser. As the present inventors have recognized, the use of the laser frees the designer from the necessity of using a high resistance segment to generate the heat necessary to cut the circuit.
>
> Although intuition might further suggest that a fuse-shaped cut-link of thin width could be severed with

> greater precision and efficiency than an otherwise comparable cut-link of greater width, the present inventors have recognized that this notion is generally false. To the contrary, an electrical interconnect which may be cut with greater success and with improved efficiency includes a cut-link pad in which the thermal resistance per unit length is lower, rather than higher, than the connected lines. In a preferred embodiment, the thermal resistance is lowered by adopting a form that is the inverse of the traditional "dog bone" design. The form of this new design is such that the width of the cut-link pad is substantially greater than the width of the lines.

Appx28 ['221 patent] at 1:64-2:21.

From the outset Micron and its predecessor Elpida explained to MIT that this fundamental premise of the patent is false. The prior art shows cut-links that are wider than the connecting lines. As one example, Elpida identified Koyou. Appx237-240.

Figure 1 of Koyou shows a top view of the primary embodiment of the invention itself and Figures 2-5 show different versions of that embodiment from different sectional views. The Figure 1 embodiment shows a cut-link much wider than the connecting lines. This is simple to see. Compare the width of the cut-link (1) with the connecting lines (2a and 2b):



Koyou, Fig. 1(a)

Koyou, Fig. 3

Appx514. Indeed, Koyou's cut-link pad (element 1) is substantially wider than the underlying wiring layers (elements 3a, 3b), which in turn are substantially wider than the connecting lines (elements 2a, 2b).

MIT made two arguments on this fundamental point. Both are meritless.

First, MIT argued that Figure 3 does not correspond to Figure 1. At the outset, Figure 1 itself shows that the cut-link fuse (1) is substantially wider than the connecting lines (2a and 2b). And, beyond that, MIT is wrong in denying that Figure 3 is described as a version of the structure shown in Figure 1. The claims of Koyou tie the figures together unmistakably. Claim 1 refers to the cut-link specifically by identifying the cut-link from Figure 1 and Claim 4 is dependent on that and specifically adds to the cut-link(1) from Figure 1 the components 21a and 21b, which are the connecting lines from Figure 3. Case closed.

The PTAB recognized that Claim 4 proved that Figure 1 and Figure 3 are part of the same structure and laid it out chapter and verse. Appx514-515.

Second, MIT argued that the drawing may look to the naked eye like the cut-

link is much wider than the connecting lines, but the figures are supposedly not to scale. While this argument might be relevant for fine gradations, it is empty as it relates to basic figures showing that the cut-link is much wider than the connections. This is especially true given the theory of the '221 patent is that it supposedly was the first disclosure of that feature. In any event, as the PTAB recognized, the inventor himself relied on the Koyou figures to show specific dimensions when it advanced his cause. Appx508-509; *see* Appx345, ¶ 22; Appx374. Given that MIT itself relied upon the Koyou figures as correctly scaled, its attempts to reverse course should be rejected.

In sum, it is apparent from the figures in Koyou that the fuse is wider than the connecting lines. Given the theory of the '221 patent, MIT's continued pursuit of its claims against Micron after it was given notice of this prior art was improper. If the district court had looked at the facts and evidence for itself, rather than relying on the results of the ex parte reexamination as a surrogate, it would have understood why Micron's attorneys' fees should have been reimbursed.

2. It Was Exceptional For MIT To Deny That The Koyou Cut-Link Has Substantially Less Thermal Resistance Per Unit Length Than The Connecting Lines

The '221 patent touts that the patented wide cut-link has a lower thermal resistance per unit of length. It explains that this lower thermal resistance is valuable because the relatively high resistance of the connected lines helps keep

the heat from the laser concentrated on the cut-link to perform the task of blowing the fuse rather than heating the lines. Appx30 ['221 patent] at 5:13-15 ("Transfer of heat away from the cut-link is minimized by creating a comparatively-lower thermal resistance per unit length within the pad than without."). As explained in the '221 patent, the width of the cut-link reduces the resistance as does the choice of materials. Appx30 at 5:56-67 ("the pad may be both wider than the lines and comprised of a material having greater thermal conductivity than the lines.").

Koyou proposes using titanium or titanium nitride for the contacts that function as the connecting lines precisely so that the cut-link will have ***less*** thermal resistance than the lines. Appx539, ¶ 21 ("In the present embodiment, the thermal resistance [of the contacts] is selected so as to be ***higher*** than the thermal resistance R[th1] of the fuse member 20.") (emphasis supplied). This is exactly the feature that MIT has insisted is missing from Koyou.

In view of this devastating disclosure, MIT focused on the use of tungsten for the contacts, rather than titanium or titanium nitride – even though Koyou suggests using ***any*** of those materials to make the conductive lines. MIT argued that the use of titanium or titanium nitride is somehow mixing and matching. That argument insults the intelligence. Koyou proposes three materials to fill the contact holes. Appx510, ¶ 21 ("For example, tungsten(W), titanium (Ti), titanium nitride or the like, may be used for the filling material."). There is no principled

reason to assume the use of tungsten, but not titanium or titanium nitride.

Because the prior art proposes three different materials, that is a direct and focused teaching to use ***any*** of the three. The PTAB correctly rejected this "mix and match" argument:

> Koyou is not disclosing three possible materials in disparate embodiments but, rather, is disclosing titanium and titanium nitride alongside tungsten as possible contact materials. Therefore, the present situation is not a case in which petitioners are "picking, choosing, and combining various disclosures not directly related to each other by the teachings of the cited reference (*Sanofi-Synthelabo*, 550 F.3d at 1083), as suggested by Patent Owner [MIT]."

Appx510.

In sum, two of three materials disclosed in Koyou for the connecting lines result in a cut-link that has substantially less thermal resistance per unit length than the connecting lines. The inventors had touted this feature as a novel concept that justified the '221 patent. This is another situation where, if the district court had looked at the evidence for itself, rather than relying on the results of the ex parte reexamination as a surrogate, it would have understood why Micron's attorneys' fees should have been reimbursed.

D. Rather Than Supporting The District Court's Decision, The Ex Parte Reexamination Highlights Why MIT Should Reimburse Micron Its Legal Expenses

As explained above, rather than evaluating the evidence, the district court erred by accepting the results of the ex parte reexamination as a proxy for whether

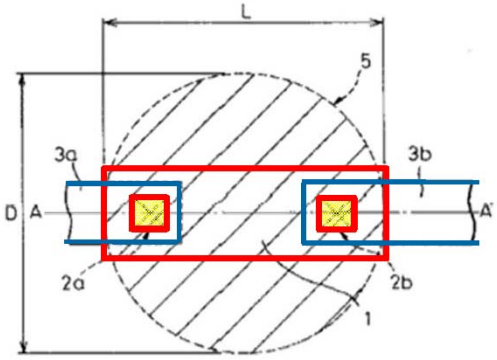
MIT acted unfairly in defending the validity of its patent. This was error first off because the district court should have reviewed the evidence itself, regardless. Moreover, because the ex parte reexamination proceeding was infected by misleading arguments the outcome was particularly unreliable and MIT's behavior in that proceeding was inculpatory.

The submission of misleading declarations and arguments to the Patent Office can prevent the Patent Office from properly analyzing information in its possession. *eSpeed, Inc. v. Brokertec USA, LLC*, 480 F.3d 1129 (Fed. Cir. 2007). This is especially true for ex parte proceedings where there is no adversary to ensure that the record is corrected. That is why the duty of candor is so important for such proceedings. As demonstrated below, MIT misled the Patent Office into accepting its positions and failed to present the facts that Elpida had presented to it.

1. MIT Misled The Patent Office Into Believing That Koyou Does Not Disclose A Cut-link Wider Than The Connecting Wires

As explained above, Koyou plainly discloses a cut-link wider than the connecting wires. This is readily apparent from this annotated figure:

[FIG. 1]
fundamental block diagram of a semiconductor device according to the present invention
(a)



Appx540.

To distract the Patent Office from this teaching, MIT submitted Dr. Bernstein's testimony to argue that Figure 3 does ***not*** disclose the width of the cut-link:

> 17. However, Koyou is silent with regard to the relative widths of the fuse member 20 and the material filling each of the contact holes 21a and 21b. Thus, Koyou does not affirmatively disclose that the width of the cut-link pad is at least ten percent greater than the width of each of the first and second electrically-conductive lines.

Appx343. This "silence" argument could only be made by ignoring that Figure 3 and Figure 1 are different perspectives of the ***same*** embodiment – with Figure 1 serving as the universal top view and Figure 3 showing one version of this embodiment from a side view. Figure 1 clearly shows that the cut-link is much wider than the contacts that are the connecting lines. As explained above, the claims of Koyou themselves definitively disclose an embodiment with the cut-link

(1) of Figure 1 as part of the same structure as the connecting lines of Figure 3 (21a and 21b). Figure 1 is shown as the fundamental embodiment and Figures 2-5 are sectional views of variants of that main embodiment.

In an odd twist, the district court rejected Micron's exposure of MIT's misconduct in the Patent Office because Micron's technical expert did "not allege that Bernstein and MIT misled the PTO." Appx8. However, there is no reason why a technical expert's declaration in support of an IPR petition would allege culpable conduct.

Moreover, the entire theory of the successful IPR petition was that MIT had misled the Patent Office away from important evidence of invalidity during the ex parte proceedings. Micron was very direct about this:

> Patent Owner then submitted a declaration by named inventor Dr. Joseph Bernstein. Ex. 1016. As explained in detail below, this declaration contains misstatements and omissions, including: (i) failure to address the full-scope of Koyou's disclosure of fuse dimensions and materials…

Appx573.

Micron's position was fully supported by Dr. Thomas's (Micron's expert) very direct statement that it was "improper" for Dr. Bernstein to have ignored the disclosures of Koyou Figure 1 when he denied that the Koyou cut-link was shown as wider than the connecting lines:

> Dr. Bernstein improperly ignored the fuse member and contact widths shown in the plan view in Figure 1(a) of

> Koyou, and therefore underestimated the ratio of fuse member area to contact area. However, even using Dr. Bernstein's assumptions, as will be shown below, this limitation is met.

Appx840, ¶ 116.

It was legally improper for the district court to rely on the absence of an allegation of culpable conduct because that is legally irrelevant. And it was factually faulty because Dr. Thomas ***did*** identify the improprieties in the Bernstein's declaration, as documented in this brief.

2. MIT Misled The Patent Office Into Believing That Koyou Does Not Disclose A Cut-link Pad That Has Substantially Less Thermal Resistance Than The Connected Lines

As explained above, Koyou plainly discloses a cut-link that has substantially less thermal resistance than the connected lines. Indeed, Koyou expressly teaches that the thermal resistance of the connecting lines should be higher than the cut-link: "the thermal resistance R[th2] of the material for filling the contact holes 21a and 21b is selected so as to be ***higher*** than the thermal resistance R[Th1] of the fuse member 20." Appx539, ¶ 21 (emphasis supplied).

In the face of this statement, Dr. Bernstein purported to perform a complex analysis of the thermal resistance given the dimensions shown in the Koyou figures using tungsten as the material for the connecting lines. This flurry of complexity obscured that Dr. Bernstein assumed tungsten would be the metal and ignored that Koyou also proposed the use of titanium and titanium nitride.

MIT has never provided a good explanation for selecting tungsten and ignoring the other two materials that Koyou also proposed.

And, once again, the district court's reliance on the absence of allegations of culpable conduct by Dr. Thomas during the IPR proceedings misses the mark. Dr. Thomas politely and methodically revealed Dr. Bernstein's misdirection in denying that the Koyou cut-link had substantially less thermal resistance per unit length than the connecting lines:

> 111. In support of this argument, Patent Owner's declarant, Dr. Bernstein, performed a calculation purporting to show that Koyou fails to disclose a "cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines" (Bernstein Decl. at ¶¶ 18, 22-27), upon which the examiner relied in his decision to withdraw initial rejections (Ex. 1017 at 4). Appx838-839.
>
> 112. Dr. Bernstein's calculation, however, only accounts for one combination of fuse member and contact materials. If he had chosen other combinations identified by Koyou, he would have correctly concluded, as I have, that Koyou, in fact, does disclose this limitation. Appx839.

Again, the district court's reliance on the alleged absence of support from Dr. Thomas is both legally and factually erroneous.

E. The District Court Improperly Concluded MIT's Infringement Position Was Not Objectively Unreasonable

MIT's infringement case was also unreasonable. MIT defends its position by arguing that it is plausible that a connecting line that is within a substrate is "on

a substrate," as required by all the asserted claims of the '221 patent. This defies common English. The standard definition of "on" is "touching and being supported by the top surface of (something)." *Merriam-Webster.com*. Merriam-Webster, n.d. Web. 3 Oct. 2016.

The '221 patent has many embodiments. For most of them, the lines connected to the cut-link are on the substrate and thus lie in the same plane as the substrate on top of it. For the more complex, the lines are instead ***within*** the substrate.

The following top-down illustration shows the cut-link embodiment with the connecting lines "on the substrate":

Cut-Link On A Substrate

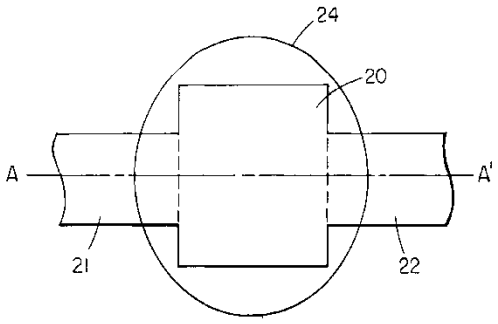


FIG. 3

Appx23, Fig. 3; Appx29 at 4:36-39 ("A cut-link shaped in the form of a square pad is illustrated in FIG. 3. The cut-link pad 20, is bonded to a pair of lines 21 and 22,

each positioned ***on the substrate*** of a chip or circuit board within a single plane.").

Figure 5 shows how the lines are "on" the substrate in the primary embodiment with the horizontal connecting lines:

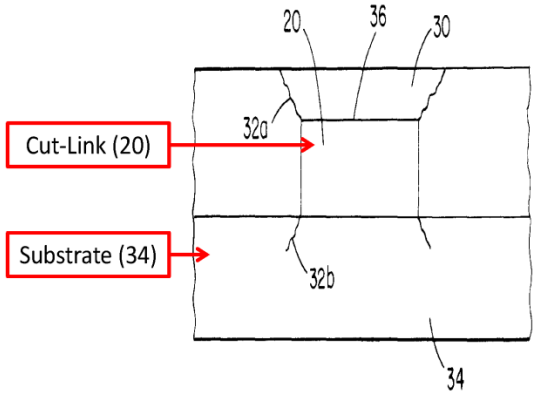


FIG. 5

Appx24, Fig. 5.

The following illustrations show the cut-link embodiment with the connecting lines ***within*** the substrate:

Connecting Lines Within The Substrate

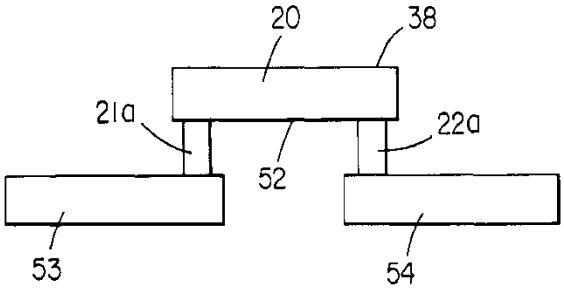
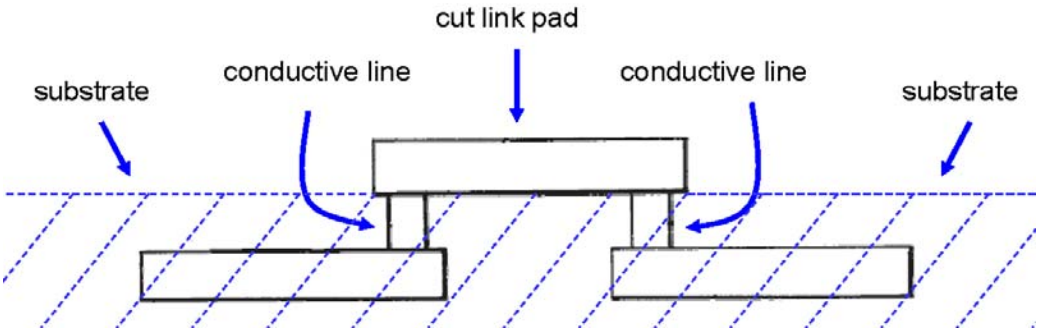


FIG. 10

Appx26, Fig. 10; Appx31 at 8:25-28. ("[I]n place of the laterally-extending lines, the lines take the form of vias 21a and 22a extending downward from the surface

52 of the pad 20 away from the laser and into the substrate.”).

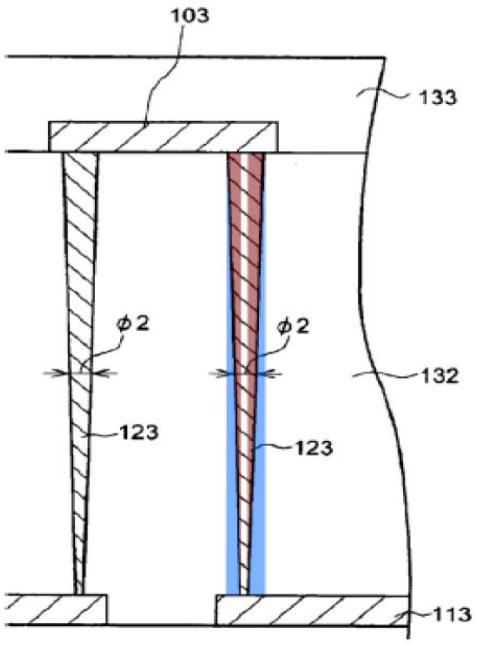
The following figure illustrates how, in the design where the connecting lines are vertical vias, the lines are not “on a substrate”:



Appx164.

The claims of the ’221 patent all require the connecting lines to be “on a substrate” and did not include the design where the lines are orthogonal to the substrate and are instead embedded within it. MIT alleged that lines within vertical vias are “on a substrate.”

This figure illustrates that conductive lines that are in vertical vias within the substrate are not ***on*** the substrate:



Appx165.

The district court found MIT's position "not entirely unreasonable." Appx6. The only basis identified by the district court for this conclusion is that this Court has found "'on' to mean in a 'position of contact' in other circumstances," citing *Senmed, Inc. v. Richard-Allan Medical Industries*, 888 F.2d 815 (Fed. Cir. 1989). Appx6.

The district court's reliance on this Court's *Senmed* decision is misplaced. *Senmed* ***confirms*** that MIT's position is unreasonable. In *Senmed*, this Court found "on" to be synonymous with "upon," meaning "on the surface: on it." *Senmed*, 888 F.2d at 820 n.9. That is exactly what "on" means here and exactly why MIT's infringement claim was so unreasonable. This Court, in *Senmed*, rejected a construction of "on" to cover an object ***above*** and not touching a surface,

stating that "on" means that the item "on" an object must be upon it and thus touching it.

MIT could never meet the definition applied in *Senmed.* The vias in the accused products are within the substrate – not on it. In reaching its conclusion, this Court in *Senmed* condemned creative interpretations of the common word "on" such as MIT proposes here:

> "On" is clearly neither a technical term nor a word of art having special meaning to those skilled in the art such that expert testimony is required for its interpretation. Lawyers may create a "dispute" about any word, but there is nothing ambiguous or linguistically obscure about "on" as used in the present claim. Whereashere "on" was clearly given its ordinary meaning in the specification and prosecution history, Becht's self-serving, *post-hoc* opinion testimony on the legal question of whether it should have a different meaning was of little if any significance.

Senmed, 888 F.2d at 819 n.8.

MIT's primary response to the normal meaning of "on" has been that the '221 patent includes an alternative embodiment where the connecting lines are within the substrate, not on it. True enough. But the plain language of the claims should not be contorted to force them to cover all embodiments. *See TIP Sys., LLC v. Phillips & Brooks/Gladwin, Inc.*, 529 F.3d 1364, 1373 (Fed.Cir.2008) ("to construe the claim term to encompass the alternative embodiment in this case

would contradict the language of the claims"). Indeed, it is well-established that the "claims of the patent need not encompass all disclosed embodiments." *Id*.

IV. CONCLUSION

For the foregoing reasons, the Court should find that the district court's denial of Micron's motion for attorneys' fees and costs was legally erroneous and should be reversed.

Respecfully submitted,

Dated: October 19, 2016

/s/ *Edward R. Reines*

Edward R. Reines
Principal Attorney
WEIL GOTSHAL & MANGES LLP
201 Redwood Shores Parkway
Redwood Shores, CA 94065
Telephone: (650) 802-3000

Counsel for Appellants

CERTIFICATE OF COMPLIANCE

The undersigned certifies that this brief complies with the type-volume limitations of Fed. R. App. P. 32(a)(7)(B). This brief contains 6,534 words as calculated by the "Word Count" feature of Microsoft Word 2010, the word processing program used to create it.

The undersigned further certifies that this brief complies with the typeface requirements of Fed. R. App. P. 32(a)(5) and the type style requirements of Fed. R. App. P. 32(a)(6). This brief has been prepared in a proportionally spaced typeface using Microsoft Word 2010 in Times New Roman 14 point font.

Dated: October 19, 2016

/s/ *Edward R. Reines*

Edward R. Reines
Principal Attorney
WEIL GOTSHAL & MANGES LLP
201 Redwood Shores Parkway
Redwood Shores, CA 94065
Telephone: (650) 802-3000

Counsel for Appellants

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

CERTIFICATE OF COMPLIANCE MOTIONS OR BRIEFS CONTAINING MATERIAL SUBJECT TO A PROTECTIVE ORDER

Motion / Response / Reply Containing Material Subject to a Protective Order

☐ This motion, response, reply complies with the limitations set forth in Fed. Cir. R. 27(m) and contains [*state the number of*] _____ words (including numbers) marked as confidential, or

☐ This motion, response, reply does not comply with the word count limitations set forth in Fed. Cir. R. 27(m) and a motion requesting permission to exceed the maximum word count limitation is being filed contemporaneously with the filing of this motion, response, or reply.

Briefs Containing Material Subject to a Protective Order

☑ This brief complies with the limitations set forth in Fed. Cir. R. 28(d) and contains [*state the number of*] ____**7**____ words (including numbers) marked as confidential, or

☐ This brief does not comply with the word count limitations set forth in Fed. Cir. R. 27(m) and a motion is requesting permission to exceed the maximum word count limitation is being filed contemporaneously with the filing of this brief.

/s/ Edward R. Reines
(Signature of Attorney)

Edward R. Reines
(Name of Attorney)

Appellants
(State whether representing appellant, appellee, etc.)

10/19/2016
(Date)

CERTIFICATE OF SERVICE

I hereby certify that on October 19, 2016, I filed or caused to be filed copies of the foregoing with the Clerk of the United States Court of Appeals for the Federal Circuit via the CM/ECF system and served or caused to be served a copy on all counsel of record by the CM/ECF system and email.

Dated: October 19, 2016

/s/ *Edward R. Reines*

Edward R. Reines
Principal Attorney
WEIL GOTSHAL & MANGES LLP
201 Redwood Shores Parkway
Redwood Shores, CA 94065
Telephone: (650) 802-3000

Counsel for Appellants

ADDENDUM

Appx	Description	Date
Appx1-8	Order Denying Fees Motion	6/17/2016
Appx21-36	Patent No. 6,057,221	5/2/2000

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,	)	
Plaintiff,	)	
v.	)	**Civil Action No. 15-10374-FDS**
MICRON TECHNOLOGY, INC.; APPLE, INC.; ELPIDA MEMORY, INC.; MICRON MEMORY JAPAN, INC.; and ELPIDA MEMORY USA, INC.,	)	
Defendants.	)	

MEMORANDUM AND ORDER ON DEFENDANTS' MOTION FOR ATTORNEYS' FEES UNDER 35 U.S.C. § 285

SAYLOR, J.

This is a motion for attorneys' fees, arising out of a patent infringement action concerning fuses in integrated circuits. In February 2015, after spending seven years negotiating a licensing agreement, plaintiff Massachusetts Institute of Technology filed suit against defendants Micron Technology, Inc.; Elpida Memory, Inc.; Micron Memory Japan, Inc.; and Elpida Memory USA, Inc.[1] The complaint alleged that defendants' laser-fuse technology infringed on MIT's U.S. Patent No. 6,057,221 ("the '221 patent").

Shortly after MIT filed suit, defendants petitioned the Patent Trial and Appeal Board ("PTAB") for *inter partes* review ("IPR"), seeking a declaration that the '221 patent was invalid. Defendants contended that the '221 patent was invalid because prior art in a Japanese patent application anticipated the patent and rendered it obvious. In November 2015, the PTAB granted

[1] MIT also filed suit against Apple, Inc. Apple, however, has not moved for attorneys' fees.

defendants' petition to review the validity of the '221 patent. Because the PTAB usually invalidates patents after instituting full IPR review, MIT requested that the Court enter an adverse judgment and dismiss the case.

Defendants did not assent to dismissal. Instead, they have moved for attorneys' fees and costs pursuant to 35 U.S.C. § 285. Defendants contend that this case is exceptional because MIT asserted unreasonable infringement and validity arguments and engaged in vexatious litigation conduct. Among other things, defendants allege that MIT and the lead inventor, Dr. Joseph Bernstein, intentionally misled the United States Patent and Trademark Office ("PTO").

Under § 285, district courts have the authority to award attorney's fees and costs in "exceptional" cases. For the reasons set forth below, this case does not rise to the level of an "exceptional" case warranting the imposition of attorneys' fees. It appears that MIT pressed not-unreasonable infringement positions, rebutted defendants' invalidity challenges with legitimate—but ultimately unmeritorious—arguments, and conducted the litigation in a good faith manner. Accordingly, defendants' motion for attorneys' fees and costs will be denied.

I. Background

The technology at issue involves fuses in integrated circuits. In integrated circuits, each fuse has a cut-link pad on a substrate that is electrically connected to two conductive lines. A laser in the circuit can instantly disconnect the cut-link pad, creating an open circuit and blowing the fuse.

In May 2000, the '221 patent was issued to lead inventor Dr. Joseph Bernstein, who conceived of the invention while pursuing his Ph.D. at MIT. Bernstein and his co-inventor assigned the patent to MIT and another university. Fuse technology was well-established in integrated circuitry when Bernstein applied for the patent. However, the '221 patent included

two important limitations. First, it claimed a cut-link pad that was at least ten percent wider than the connecting electrical lines. Second, it claimed a cut-link pad that was substantially less thermally resistant than the connecting lines.

In May 2008, MIT contacted Elpida, a Japanese manufacturer of dynamic random-access memory products that rely on integrated circuits, and notified the company that it needed a license for the '221 patent. In support of its assertions, MIT sent Elpida a copy of the '221 patent and drawings demonstrating alleged infringement by one of Elpida's products.

Over the next two years, MIT and Elpida exchanged correspondence and met multiple times to discuss the validity of the patent and MIT's infringement assertion. Elpida contended that the patent was not valid because a Japanese patent application by Koyou anticipated it or rendered it obvious. Specifically, Elpida contended that Koyou disclosed a cut-link pad that was substantially wider and less thermally resistant than the connecting electrical lines. As to MIT's infringement assertion, Elpida contended that its accused product lacked electrically-conductive lines "on a substrate," as required by the '221 patent claims, because the lines in its product passed vertically into and through the substrate.

In March 2011, negotiations between the parties broke down. MIT, without notifying Elpida, requested that the PTO reexamine the validity of the '221 patent. With its reexamination petition, MIT provided the PTO with all of the prior art that Elpida had identified during their negotiations, including Koyou. MIT also submitted written reasons why it believed the patent was novel and non-obvious despite Koyou—the same arguments that it provided to Elpida during the parties' negotiations.

Three examiners from the PTO's Central Reexamination Unit initially rejected all of the claims of the '221 patent as unpatentable over Koyou. In response, MIT submitted an inventor

declaration, in which Bernstein explained his reasoning in support of the conclusion that a person having ordinary skill in the art would not read Koyou as (1) affirmatively disclosing a cut-link pad having a width at least ten percent greater than the width of each connecting electrical line, and (2) suggesting a cut-link pad having substantially less thermal resistance than the lines. Agreeing with Bernstein's conclusions, the PTO issued a notice of intent to issue an *ex parte* reexamination certificate for the patent.

After the reexamination, MIT reengaged Elpida in negotiations. Although Elpida contended that MIT had misrepresented Koyou to the PTO, the parties nearly reached a settlement. MIT lowered its settlement demand to $500,000, at least in part, because Elpida was in bankruptcy and planned to eliminate laser fuses from its product line. Although the parties reached a settlement agreement in principle, they failed to finalize an agreement because of a disagreement over the scope of the license.

In February 2015, after seven years of negotiations, MIT filed suit against defendants for patent infringement. In May 2015, defendants filed a petition with the PTAB seeking IPR of the '221 patent, and this Court stayed the case pending resolution of that petition. In support of their petition, defendants submitted an expert declaration from a litigation consultant who disagreed with Bernstein's conclusions as to how a person having ordinary skill in the art would read Koyou.

In November 2015, the PTAB granted IPR review of the '221 patent. In light of the probability that the PTAB would invalidate its patent, MIT requested that the Court grant an adverse judgment and dismiss the case.[2] Defendants objected to dismissal, and moved for attorneys' fees pursuant to 35 U.S.C. § 285.

[2] According to MIT, the PTAB invalidates roughly 75 percent of all patents that proceed to a final IPR decision.

II. Analysis

Pursuant to 35 U.S.C. § 285, defendants have moved for attorneys' fees and costs incurred in defending against MIT's patent infringement claims. Under § 285, district courts have the discretion to award attorneys' fees and costs to a prevailing party in "exceptional cases." 35 U.S.C. § 285.

In *Octane Fitness, LLC v. ICON Health & Fitness, Inc.*, the Supreme Court provided guidance on this fee-shifting provision:

> An "exceptional" case is simply one that stands out from others with respect to the substantive strength of a party's litigating position (considering both the governing law and the facts of the case) or the unreasonable manner in which the case was litigated. District courts may determine whether a case is "exceptional" in the case-by-case exercise of their discretion, considering the totality of the circumstances.

—— U.S. ——, 134 S. Ct. 1749, 1754 (2014). The Supreme Court noted a non-exclusive list of factors that a district court may consider in evaluating whether a case is exceptional, including "frivolousness, motivation, objective unreasonableness (both in the factual and legal components of the case) and the need in particular circumstances to advance considerations of compensation and deterrence." *Id.* at 1756 n.6. The Federal Circuit has also considered whether a plaintiff engaged in any preparation and investigation of the patent claims and a defendant's product before filing suit. *See, e.g.*, *Superior Fireplace Co. v. Majestic Prods. Co.*, 270 F.3d 1358, 1378 (Fed. Cir. 2001).

Defendants contend that this case is "exceptional" for two principal reasons. First, they contend that MIT's infringement and invalidity positions were objectively unreasonable. Second, they contend that MIT litigated its infringement position against defendants in a vexatious manner by, among other things, misleading the PTO about Koyou. Based on the

totality of the circumstances, defendants fall short of satisfying their burden of demonstrating that this is an exceptional case.

To begin, MIT's infringement position was not entirely unreasonable, and certainly not frivolous. Defendants contend that MIT's infringement claims were baseless "because the '221 patent claims require that the two electrically-conductive lines attached to the cut-link pad be 'on the substrate,' [but] MIT never identified lines in the accused products that were 'on' a substrate, but rather pointed to lines that passed vertically into and through the substrate." (Def. Mem. 5). Essentially, the parties' infringement dispute hinged on the meaning of the claim "on the substrate." That definition would have depended on a *Markman* determination by the Court, and MIT's contention that "on the substrate" encompassed passing "into and through" the substrate is not entirely unreasonable. Indeed, as MIT notified defendants throughout their negotiations, the Federal Circuit has found "on" to mean in a "position of contact" in other circumstances. *See Senmed, Inc. v. Richard-Allen Med. Indus., Inc.*, 888 F.2d 815, 819 (Fed. Cir. 1989). Accordingly, MIT's infringement position falls appreciably short of making this an "exceptional" case. *See, e.g.*, *Barron v. SCVNGR, Inc.*, 100 F. Supp. 3d 47, 49 (D. Mass. 2015) (denying patent infringement defendant's motion for attorneys' fees even though Court granted summary judgment before "any scheduling conference or discovery," and noting that while the outcome "bears some reflection of the substantive strength of [p]laintiff's claim, [it] does not require the conclusion that the action was *exceptionally* meritless" (emphasis in original)); *EON Corp. IP Holdings LLC v. Cisco Sys., Inc.*, 2014 WL 3726170, at *5 (N.D. Cal. July 25, 2014) (declining to award fees where plaintiff's argument, although so "stretched . . . that few patentees would pursue it," was not so meritless that no reasonable patentee would pursue it).

MIT's assertion that the '221 patent was valid—that is, not anticipated or rendered

obvious by Koyou—was also unexceptional. There was certainly a colorable argument that the patent's increased fuse width and substantially lower thermal resistance were novel and non-obvious limitations over Koyou. Three expert patent examiners in the PTO's Central Reexamination Unit initially rejected MIT's arguments; however, upon closer examination of Bernstein's explanations, they concluded that the patent was valid.

The PTAB's decision to review the patent's validity by granting defendants' IPR petition essentially amounts to a preliminary determination that defendants advanced a reasonable invalidity position. However, the PTAB's preliminary conclusion that *defendants* advanced a reasonable *invalidity* argument does not make MIT's *validity* argument unreasonable. Defendants' contention that MIT's validity argument was objectively unreasonable necessarily means that the three expert examiners who reexamined the patent with full knowledge of Koyou also reached an objectively unreasonable, borderline frivolous, conclusion. That is, to say the least, doubtful. MIT's validity position may have ultimately been without merit, but there is a sizeable gap between taking a losing position and taking unreasonable positions; otherwise the statute's use of the term "exceptional" is meaningless. The relevant inquiry in deciding fee motions under § 285 focuses on the substantive strength of a party's litigating position, "not the correctness or eventual success of that position." *SFA Sys., LLC v. Newegg Inc.*, 793 F.3d 1344, 1348 (Fed. Cir. 2015); *see also Octane Fitness*, 134 S. Ct. at 1753 (noting that fee awards are not to be used "as a penalty for failure to win a patent infringement suit"). In short, it appears that MIT's validity position was not objectively unreasonable.

Finally, MIT did not litigate this case in a manner that warrants a fee award. If MIT's behavior was exceptional at all, it was notable for its willingness to try to negotiate a license in good faith for seven years before filing suit. *See Barron*, 100 F. Supp. 3d at 49 (finding no "fault

in plaintiff's litigation strategy" because it "investigated [defendant's] product for several months before inviting [defendant] to negotiate a license agreement to avoid litigation").

Defendants' contention that Bernstein and MIT misled the PTO about Koyou by manipulating its teachings is not supported by the record. At its core, defendants' argument ignores the fact that MIT disclosed Koyou to the PTO and attempted to explain why it believed that a person having ordinary skill in the art would not find the '221 patent obvious in light of Koyou. Also, the expert declaration submitted by defendants in their petition for IPR review does not allege that Bernstein and MIT misled the PTO. Instead, it simply highlights areas where their expert *disagreed* with Bernstein about his *projection* of how a person having ordinary skill in the art would *interpret* Koyou. In short, MIT's conduct before the PTO and throughout the litigation as a whole was not "exceptional" within the meaning of § 285.

III. Conclusion

For the foregoing reasons, defendants' motion for attorneys' fees and costs is DENIED.

So Ordered.

/s/ F. Dennis Saylor
F. Dennis Saylor IV
United States District Judge

Dated: June 17, 2016

US006057221A

United States Patent [19]

Bernstein et al.

[11] **Patent Number: 6,057,221**

[45] **Date of Patent: May 2, 2000**

[54] **LASER-INDUCED CUTTING OF METAL INTERCONNECT**

[75] Inventors: **Joseph B. Bernstein**, Potomac, Md.; **Zhihui Duan**, Erie, Pa.

[73] Assignees: **Massachusetts Institute of Technology**, Cambridge, Mass.; **University of Maryland**, College Park, Md.

[21] Appl. No.: **08/825,808**

[22] Filed: **Apr. 3, 1997**

[51] **Int. Cl.**[7] **H01L 21/44**

[52] **U.S. Cl.** **438/601**; 438/132

[58] **Field of Search** 438/601, 132

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,959,047	5/1976	Alberts et al.	156/8
4,198,744	4/1980	Nicolay .	
4,259,367	3/1981	Dougherty, Jr.	427/96
4,682,204	7/1987	Shiozaki et al. .	
4,720,470	1/1988	Johnson	437/173
4,748,491	5/1988	Takagi	357/51
4,849,363	7/1989	Coffey et al.	437/19
4,853,758	8/1989	Fischer	357/51
5,070,392	12/1991	Coffey et al.	357/71
5,134,585	7/1992	Murakami et al.	365/200
5,265,114	11/1993	Sun et al.	372/69
5,374,590	12/1994	Batdorf et al.	437/173
5,471,427	11/1995	Murakami et al.	365/200
5,473,624	12/1995	Sun	372/69
5,578,517	11/1996	Yoo et al.	437/60
5,589,706	12/1996	Mitwalsky et al.	257/529
5,608,257	3/1997	Lee et al. .	
5,882,998	12/1996	Sur, Jr. et al. .	

FOREIGN PATENT DOCUMENTS

62-162344 7/1987 Japan .

OTHER PUBLICATIONS

Cohen, S., et al., "Laser–Induced Line Melting and Cutting," *IEEE Transactions on Electron Devices,* Nov. 1992, at 2480–2485.

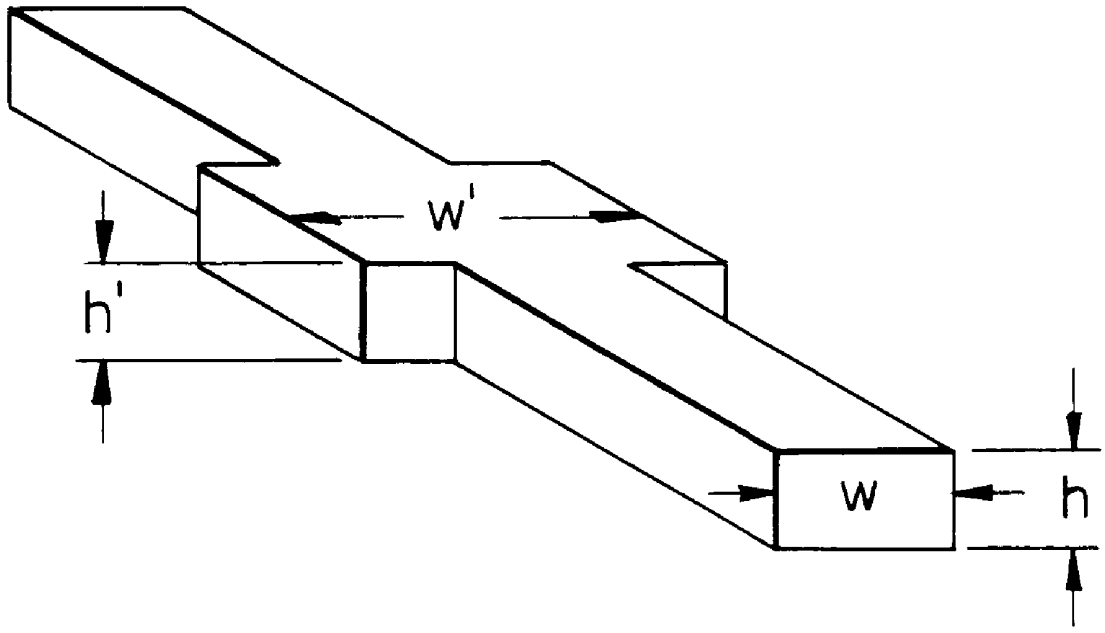
Wu, W., "Laser Connection and Disconnection Scheme," IBM Technical Disclosure Bulletin, Jun. 1978, at 268.

Primary Examiner—Richard Booth
Assistant Examiner—Jonathan Hack
Attorney, Agent, or Firm—Hamilton, Brook, Smith & Reynolds

[57] **ABSTRACT**

An electrical interconnect includes a substrate having an insulating surface upon which is placed an electrically-conductive cut-link pad and a pair of electrically-conductive lines. The lines are bonded to the cut-link pad and are substantially more resistant to heat flow per unit length than is the cut-link pad. In a preferred embodiment, the thermal resistance per unit length of the cut-link pad is lowered by designing the pad such that its width is greater than the width of either of the lines. A method for cutting a circuit includes directing a laser upon the cut-link pad of an interconnect, as described above. The laser is maintained upon the pad until the cut-link pad is ablated, severing the circuit.

21 Claims, 6 Drawing Sheets



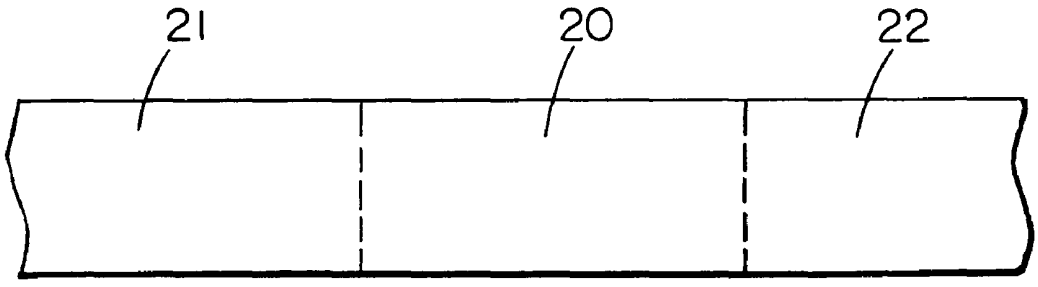


FIG. 1
PRIOR ART

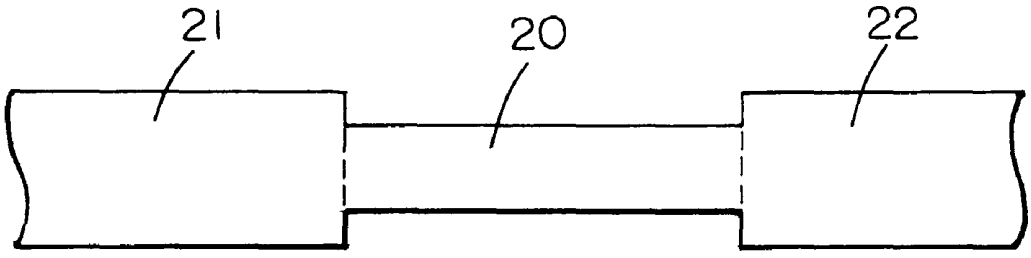


FIG. 2
PRIOR ART

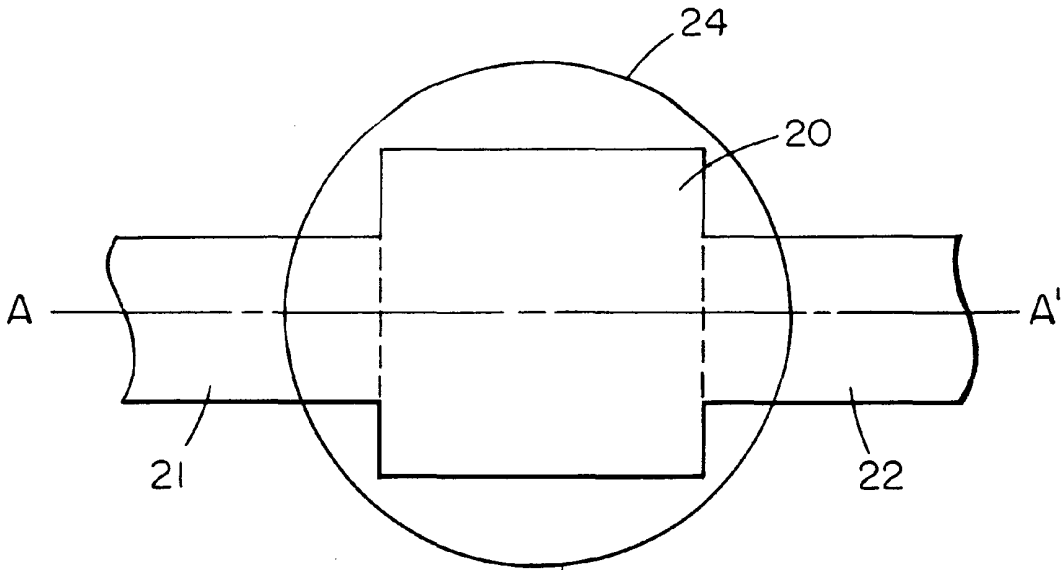


FIG. 3

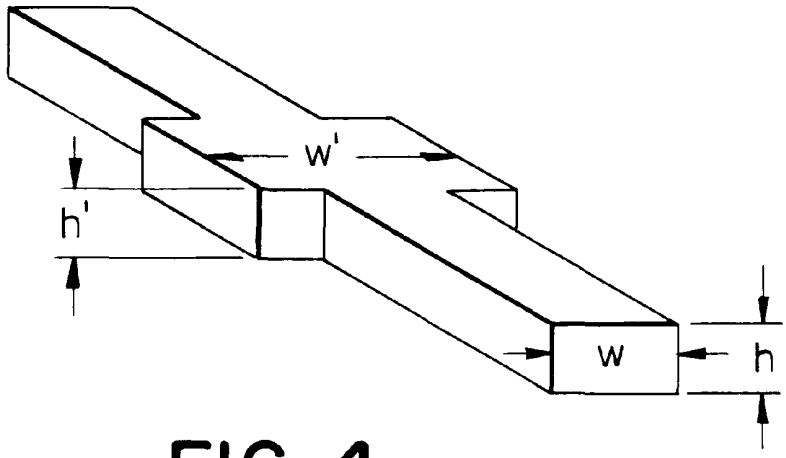


FIG. 4

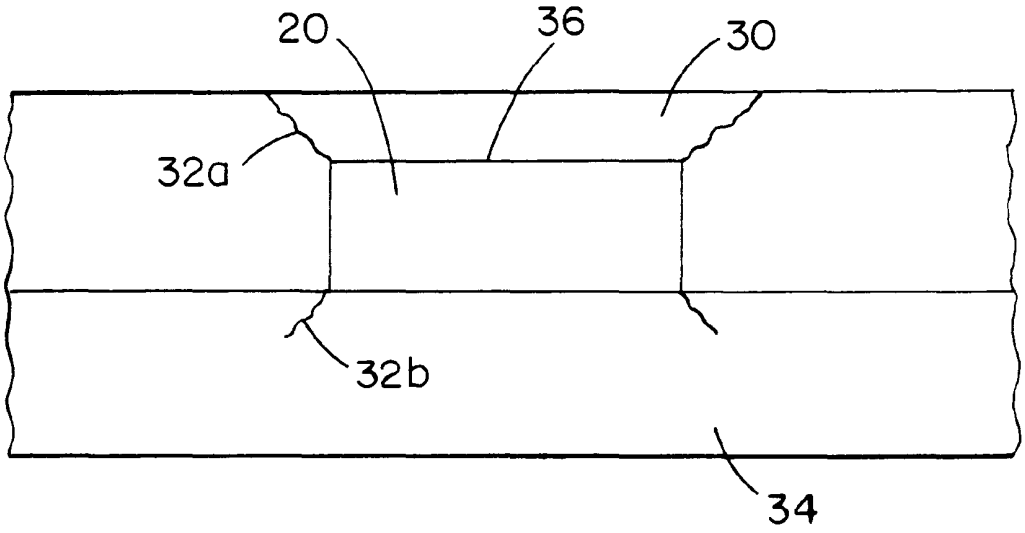


FIG. 5

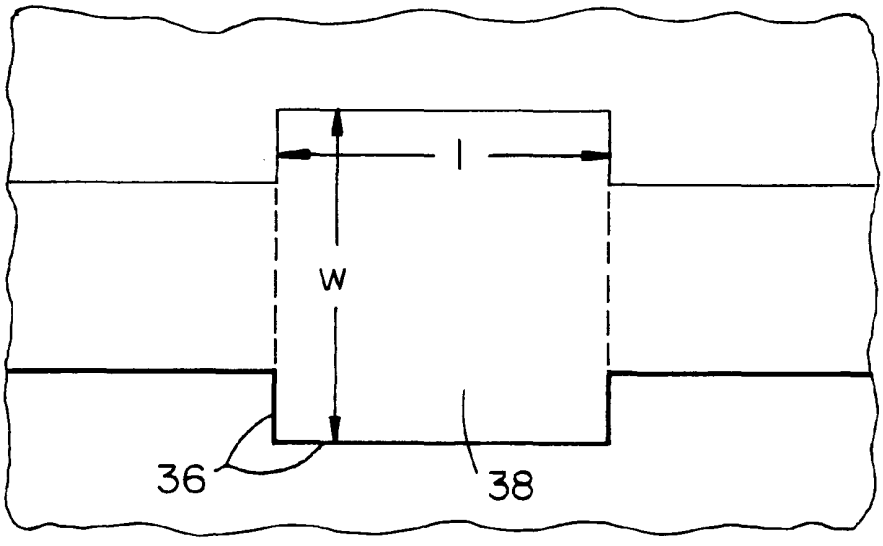


FIG. 6

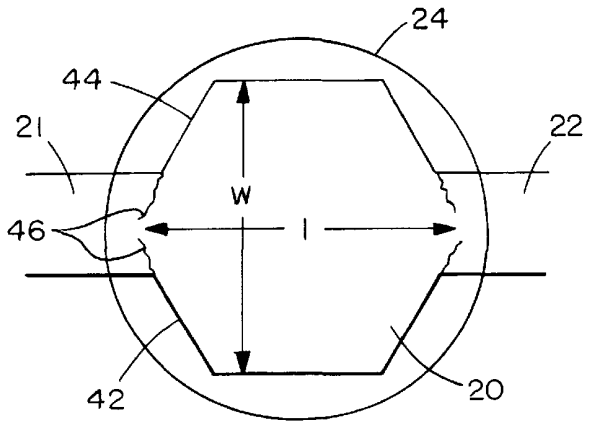


FIG. 7

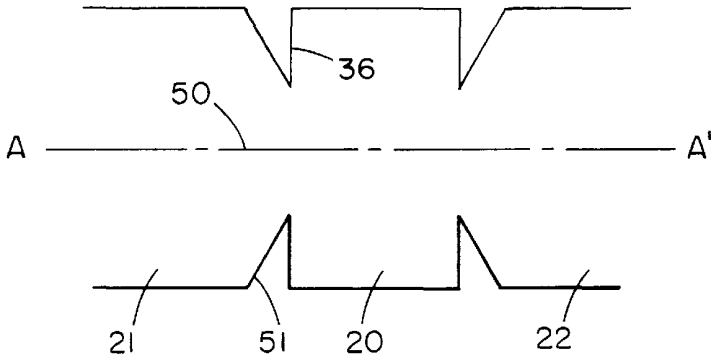


FIG. 8

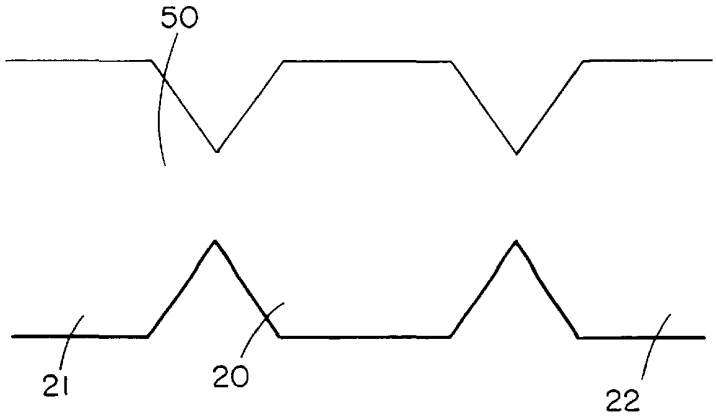


FIG. 9

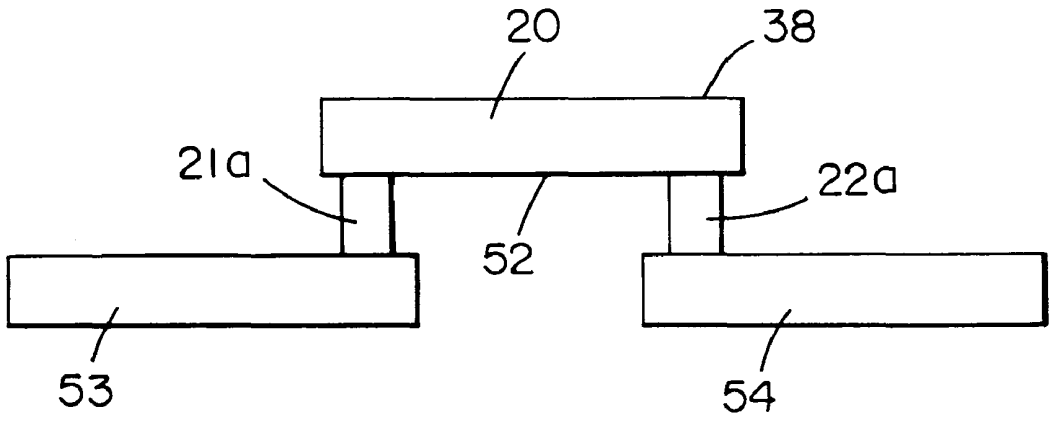


FIG. 10

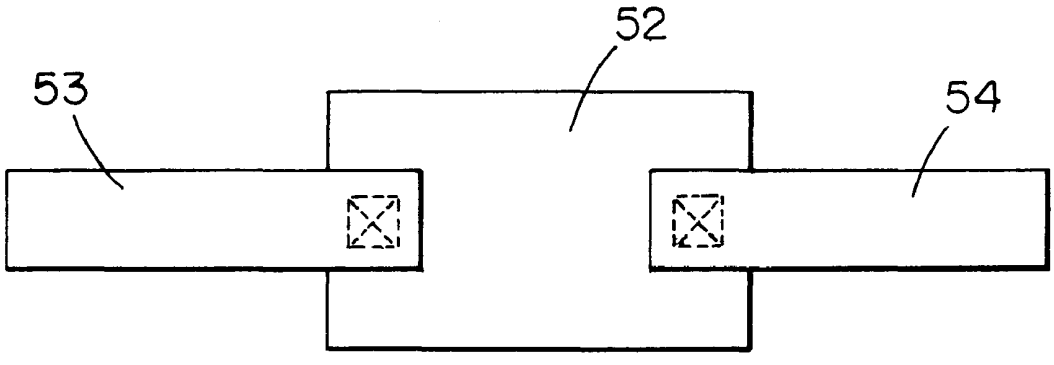


FIG. 11

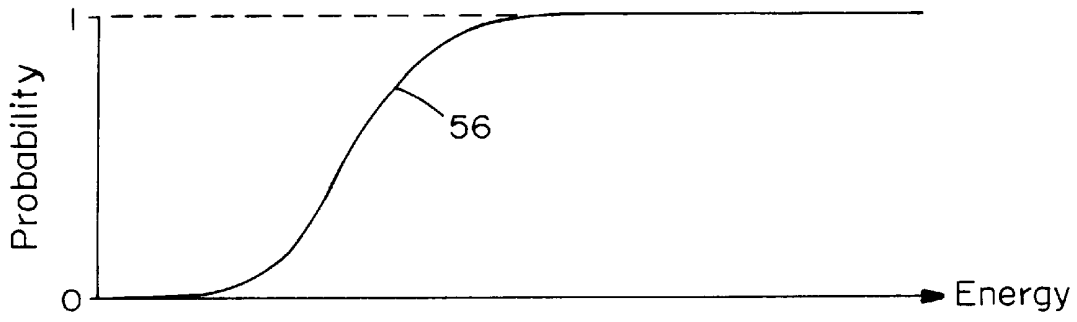


FIG. 12

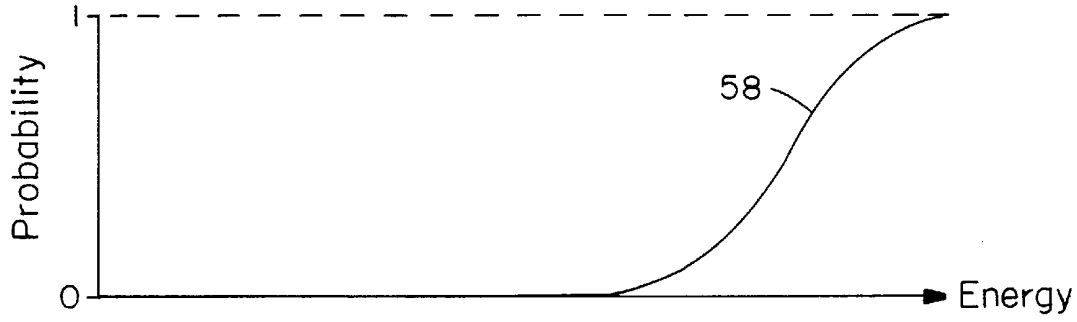


FIG. 13

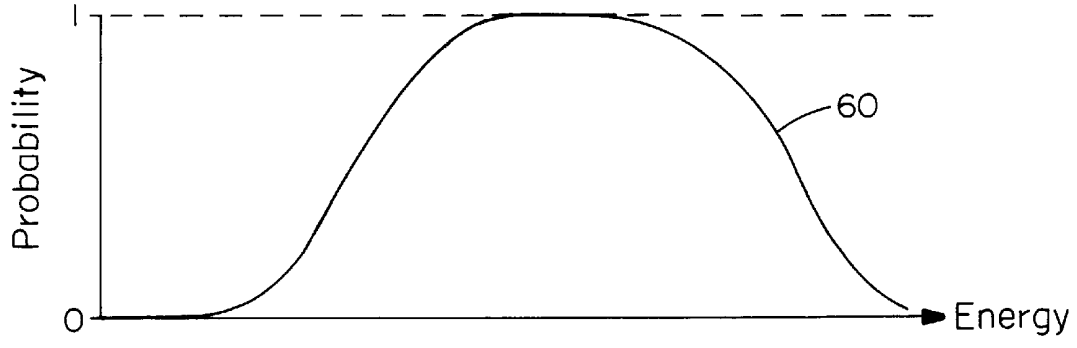


FIG. 14

LASER-INDUCED CUTTING OF METAL INTERCONNECT

GOVERNMENT SUPPORT

This invention was made with government support under Contract number F19628-95-C-0002, awarded by the United States Air Force. The government has certain rights in the invention.

BACKGROUND OF THE INVENTION

The use of lasers to cut integrated circuits is well-known in the art. In existing methods, a laser is directed onto a cut-link segment of the circuit. The laser supplies sufficient heat to vaporize the cut-link, thereby severing the cut-link. In many cases such as in a typical microchip, the circuit is coated with a passivation layer to protect the circuit from oxidation. To allow the cut-link to vaporize, the passivation layer is usually etched away from the site above the cut-link to expose the cut-link to the atmosphere in advance of cutting.

Lasers are used to cut circuits for a variety of purposes including the avoidance of defects, the replacement of defective circuits with redundant circuits, and the programming of circuits. The practices used to achieve each of these objectives are described, below.

Lasers have been used to avoid defects by circumventing a short through laser-induced cuts. This practice is described in U.S. Pat. No. 4,259,367, issued to Doherty, Jr. The circuit is repaired by using a laser to cut the lines connected to the short to thereby isolate the short. Patch lines may then be used to reestablish severed connections.

The use of redundant circuitry has become an industry standard for memory chip fabrication. Redundant circuitry in a chip is typically supplied in the form of identical segments of circuitry occupying remote areas on the chip. If a segment is flawed, that segment is disconnected and replaced by activating its redundant counterpart elsewhere on the chip.

Finally, circuits may be programmed by cutting lines from a generic, repeating pattern to disconnect unwanted or unnecessary segments and thereby produce the desired pattern through a process of reduction. Circuitry produced by this method may extend across a plurality of levels as well. One example of multi-level circuit design by laser-induced cutting is disclosed in U.S. Pat. No. 4,720,470, issued to Johnson.

Typically, the cut-link has taken one of two forms. First, the cut-link is often an undistinguished segment of a line in the circuit, where the width of the cut-link is equal to the width of the lines to which it is conductively coupled. A cut-link exhibiting these characteristics is illustrated in FIG. **1** and disclosed, for example, in the following U.S. Pat. Nos.: No. 4,853,758, issued to Fischer, and No. 5,589,706, issued to Mitwalsky et al. The second common form is that of a "dog bone," which is illustrated in FIG. **2**. This design is disclosed, for example, in the following U.S. Pat. Nos.: No. 4,748,491, issued to Takagi, and No. 5,374,590, issued to Batdorf et al. In this design, the cut-link **20** is narrower than the lines **21**, **22** to which it is connected.

DISCLOSURE OF THE INVENTION

Whereas the design of earlier cut-links mirrors the narrowed "dog-bone" of conventional fuse design, a preferred embodiment of this invention rejects this model and, instead, widens the segment where the circuit is to be severed. Where circuitry is cut by a laser, the high resistance of a fuse is not required to produce the needed influx of thermal energy. In this context, the thermal energy needed to melt the conductive material is supplied by an external source, i.e., the laser. As the present inventors have recognized, the use of the laser frees the designer from the necessity of using a high resistance segment to generate the heat necessary to cut the circuit. Although intuition might further suggest that a fuse-shaped cut-link of thin width could be severed with greater precision and efficiency than an otherwise comparable cut-link of greater width, the present inventors have recognized that this notion is generally false.

To the contrary, an electrical interconnect which may be cut with greater success and with improved efficiency includes a cut-link pad in which the thermal resistance per unit length is lower, rather than higher, than the connected lines. In a preferred embodiment, the thermal resistance is lowered by adopting a form that is the inverse of the traditional "dog bone" design. The form of this new design is such that the width of the cut-link pad is substantially greater than the width of the lines.

The electrical interconnect of this invention includes an insulating substrate upon which a pair of electrically-conductive lines are bonded to a cut-link pad, wherein the cut-link pad has substantially less thermal resistance per unit length, i.e., along the axis of the lines, than each of the lines to which it is bonded. The cut-link pad may lie in the same plane as the lines, or the pad may lie on a plane which is merely intersected by the lines, as in a via structure where the lines, or vias, extend from the underside of the pad into the substrate to a lower level of circuitry. Alternatively, the cut-link pad may be bonded both to a line on the same plane as the pad and also to a via extending from the pad deeper into the substrate.

In a preferred embodiment of the electrical interconnect, the thermal resistance of the pad is decreased, relative to the lines, by increasing the width of the pad such that the pad's width is greater than that of the lines to which it is connected. Benefit is provided in an interconnect where the cut-link pad is just 10 percent greater than the width of each of the lines. Benefits rise in significance when the pad has a width that is at least 25 percent greater than the width of each of the lines. The full advantage of this embodiment, however, is usually not realized until the width of the pad is at least 50 percent greater than the width of each of the lines. In a further preferred embodiment, the width of the pad is approximately equal to its length, i.e., the distance between the lines.

In an alternative embodiment, the thermal resistance of the pad is decreased, relative to the lines, by comprising the cut-link pad of a material having lower thermal conductivity than the material comprising the lines. In another alternative embodiment, the per-unit-length thermal resistance of the pad is decreased both by comprising the cut-link pad of a material having greater thermal conductivity than the material of the lines and by providing the pad with a width greater than that of the lines.

In another preferred embodiment, the surface of the substrate upon which the circuit lies is comprised of a silicon oxide, and the circuit is covered by a passivation layer which prevents oxidation of the circuit yet which can be removed from the site of the cut-link pad upon heating the pad with the laser. To promote the desired fracture of the passivation layer, the passivation layer is preferably comprised of a material, such as silicon nitride, that is harder than the substrate.

In the method of this invention a laser is directed upon a cut-link pad, as described above, and the laser is maintained there until the conductive link between the lines is broken. Preferably, the laser beam covers the entirety of the cut-link pad when the laser is directed upon the pad.

The metallic cut-link pads of the present invention can be more efficiently and more effectively ablated for the following reasons. First, the structures of the present invention retain thermal energy at the site of the cut-link more effectively than the cut-links of the prior art by restricting dissipative heat transfer from the cut-link into the connected lines. Second, the shapes of preferred structures produce increased stress at the perimeter of the cut-link pad, thereby generating a more forceful fracture of the surrounding material. Third, the shapes of preferred structures create stress concentration points that will produce fractures radiating outwardly from the site of the cut-link pad, thereby improving the likelihood that the fracture will be clean, i.e., will not create inter-linked fracture passages through which escaping metal may form a "short" defeating the attempt to cleanly sever the circuit. Fourth, where the cut-link pad more closely approximates the size and shape of the laser beam, the cut-link absorbs a greater portion of the laser's energy, thereby producing a more efficient transfer of energy and a reduced danger of damaging the surrounding material. Fifth, where a passivative coating comprised of a brittle material is used, the fracture is biased toward the passivative coating, and, hence, toward the surface of a chip for efficient removal of the passivative coating and non-damaging expulsion of the metal comprising the cut-link pad. Sixth, by trapping the heat within the confines of the cut-link pad and limiting its escape through the connected lines, the site at which the cut develops is confined within this narrow region and damage to other parts of the circuit is minimized. Each of these phenomena will be discussed in greater detail and with greater clarity in the context of describing the structure and methods of several preferred embodiments of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following, more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily drawn to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. **1** is a cross-sectional illustration of a cut-link pad of the prior art, from a perspective normal to the plane of the substrate, where the width of the pad is equal to the width of the lines.

FIG. **2** is a cross-sectional illustration of a cut-link pad of the prior art, from a perspective normal to the plane of the substrate, where the interconnect has the shape of a dog bone.

FIG. **3** is a cross-sectional illustration of a cut-link pad in the form of a square, from a perspective normal to the plane of the substrate, where the width of the pad is greater than the width of each of the lines.

FIG. **4** is a perspective view of the cut-link pad and the lines shown in FIG. **3**.

FIG. **5** is a cross-sectional illustration of a cut-link pad, from a perspective within the axis of the lines, illustrating the fractures which typically form during cutting.

FIG. **6** is a cross-sectional illustration of a cut-link pad in the form of a square, from a perspective normal to the plane of the substrate, where the width of the pad is greater than the width of each of the lines.

FIG. **7** is a cross-sectional illustration of a hexagonally-shaped cut-link pad from a perspective normal to the plane of the substrate.

FIG. **8** is a cross-sectional illustration of an electrical interconnect, from a perspective normal to the plane of the substrate, where the width of each of the lines is equal to the width of the cut-link pad, except in the vicinity of the juncture between the line and the pad, where the width of the line narrows.

FIG. **9** is a cross-sectional illustration similar to FIG. **8**, except that the cut-link pad is in the form of a hexagon, rather than a square.

FIG. **10** is a side-view, through the substrate, of a multi-level via structure from a perspective within the plane of the substrate.

FIG. **11** is a view of the multi-level circuit of FIG. **10** from underneath the via structure.

FIG. **12** is a chart illustrating the approximate shape of a cumulative probability function measuring the likelihood that a circuit will be cut over a range of energy levels.

FIG. **13** is a chart illustrating the approximate shape of a cumulative probability function measuring the likelihood that the integrated circuit will be damaged over the same range of energy levels depicted in FIG. **12**.

FIG. **14** is a chart illustrating the approximate shape of the combined cumulative probability that a circuit will be cut without otherwise damaging the circuit over the same range of energy levels charted in FIGS. **12** and **13**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A cut-link shaped in the form of a square pad is illustrated in FIG. **3**. The cut-link pad **20**, is bonded to a pair of lines **21** and **22**, each positioned on the substrate of a chip or circuit board within a single plane. The pad and the lines are all electrically conductive, whereas that part of the substrate that contracts the metal is dielectric. Although this embodiment could just as fairly be described as a single line including a cut-link site, the embodiment is herein broken down into narrower constituents to provide greater clarity when different embodiments are discussed and differentiated, below. As can be seen by juxtaposing the cut-link of this figure with those illustrated in FIGS. **1** and **2**, the cut-link pad of FIG. **3** has a much greater width in relation to the width of each of the attached lines. The reasons for widening the cut-link are explained below.

First, ablation, or rupture, of the cut-link requires an accumulation of thermal energy within the cut-link. During cutting, the accumulation of thermal energy within the link can be roughly measured as the difference between the energy supplied by the laser and the heat conductively transferred out of and away from the cut-link. Therefore, the cut-link can be ablated from its site most efficiently by maximizing the absorption of laser energy and minimizing the transfer of that energy, in the form of heat, away from the cut-link.

The amount of laser energy absorbed by the cut-link is maximized by providing a cut-link shaped in a form approximating that of the laser beam spot **24**. Although the shape of the beam spot is Gaussian, i.e., no clear delineation exists for identifying the outer edge of the spot; the position of the edge may be approximated using, for example, the full-width half-max method. Using the full-width half-max

method, the edge of the spot is designated as the boundary at which the intensity of the laser drops to half of the maximum intensity. When cutting, the cut-link should ideally be entirely within the beam spot as determined above. Absorption across the entire surface promotes uniform heating of the pad. An infrared laser typically produces beams having a minimum diameter of about two microns. Further, the tolerance for beam positioning error is typically about 0.2 to 0.5 microns. Accordingly, a pad designed to have a preferable length and width of two to three microns can absorb the bulk of the energy transmitted by the laser while remaining entirely within the beam spot.

Transfer of heat away from the cut-link is minimized by creating a comparatively-lower thermal resistance per unit length within the pad than without. Because the top layer of the substrate and any passivative coating are insulators, the primary mode through which heat is transferred from the pad is through the connected lines. Accordingly, the direction of heat transfer out of the pad can be approximated as being along axis A-A', shown in FIG. **3**. Along axis A-A', thermal resistance is a function of the heat transfer coefficient of the conducting material and the cross-sectional area of the conducting material measured in the plane normal to the axis. The pad and the lines are preferably comprised of a material with high thermal conductivity and high thermal expansion, such as aluminum and copper. In such a case, where the composition of the pad is identical to the composition of each of the lines, a differential in thermal resistance is due primarily to a difference in cross-sectional area. The dimensions of the cross-section normal to the A-A' axis are illustrated in FIG. **4**. As shown, the cross-section of the line (the product of w and h) is much smaller than the cross-section of the pad (the product of w' and h'). Accordingly, the thermal resistance along the A-A' axis will be much greater in each of the lines than in the pad. This differential reduces the loss of heat into and through the line and thereby allows the temperature of the pad to quickly rise.

Moreover, the difference in thermal resistance produces a sharp temperature differential between the pad and the lines to create stress at the interface which promotes a clean severance at the interface between the pad and the line. The difference in thermal resistance also creates a boundary limiting the area within which fracture will occur. I.e., fracture will not initiate from a comparatively cool region beyond the area where heat is concentrated. The differential on each side of the pad thereby ensures that fracture will commence from the pad, rather than from a line, providing greater cutting accuracy and minimizing damage to the surrounding circuitry.

Means other than increasing the width of the pad exist for creating a differential in thermal resistance at the interface of the pad and the line. For example, in one embodiment, the pad may be fabricated from a material having greater thermal conductivity than the material from which the lines are comprised. In another alternative embodiment the pad may be both wider than the lines and comprised of a material having greater thermal conductivity than the lines.

In addition to improving the absorption and retention of thermal energy from the laser, creating a roughly square-shaped pad reduces the likelihood of producing a short circumventing the cut. As noted, the metal from the cut site escapes through fractures in the passivation layer. After or during a cut, the circuit will be shorted if metal migrates through the fractures to provide a continuous link from one line to the other. Because a comparatively large void is left after the ablation of a wide, square cut-link, the passage created by a fracture and the accompanying flow of metal linking the two lines must cover a greater distance to circumscribe the two lines must cover a greater distance to circumscribe the void and create a short. Further, cracks generated in the horizontal plane on which the circuit lies will typically emanate from the corners where stress is concentrated. As is shown in FIG. **5**, cracks **32***a* and **32***b* emanating from the edges **36** of a square-shaped pad **20** will typically be directed outward at an angle of 135° from the sides of the pad **20** mitigating the likelihood that cracks from opposite sides of the pad will cross to create a passage for forming a short.

Designing the cut-link pad to approximate the size and shape of the laser beam spot also provides an additional benefit. Less energy misses the cut-link pad resulting in less energy being absorbed into the surrounding dielectric material which reduces the likelihood that this surrounding material will be damaged by thermal stresses.

Both the lines and the cut-links **20** in a circuit are coated with a passivation layer **30** to protect the circuit from oxidation as a result of exposure to air. For the cut-link **20** to be ablated, fractures **32** must be created within the passivation layer **30**, which allow the section of passivation layer **30** covering the cut-link **20** to be blasted away from the chip, thereby exposing the cut-link **20** to air and allowing it to vaporize. Preferably, a hard, brittle material, such as silicon nitride is used as the passivation layer **30** because increasing hardness and brittleness is correlated with increasing susceptibility to fracture. When a laser pulse is incident on the cut-link pad **20**, the cut-link pad **20** is heated and expands. The passivation layer **30** can not be heated as quickly as the metal lines because the passivation layer **30** can not absorb energy from the laser beam directly and can not conduct heat from the metal quickly. As a result, stress develops within the passivation layer **30** due to the difference in temperature between the metal **20** and the passivative coating **30** as well as the mismatch of the thermal expansion coefficients of the two materials. As the metal **20** expands with increasing temperature, greater tensile stress is placed on the passivative coating **30**, which is why choosing a metal having a high thermal expansion coefficient is important. When the stress is sufficiently great, the passivative coating **30** is blasted from the area above the cut-link **20**, and the cut-link **20** vaporizes into the open space above it.

Typically, the substrate **34** of a chip includes a silicon wafer base upon which a dielectric material, such as a silicon oxide, is layered. The circuit is then imprinted onto the dielectric material. Because silicon nitride is more brittle than silicon oxide, fracture initiation is biased toward the silicon nitride. By promoting fracture through the passivation layer **30**, rather than through the substrate **34**, the metal is more likely to be completely ablated from the chip, and the likelihood of forming a short through the substrate is reduced. Though not as brittle as silicon nitride, silicon oxide is also sufficiently brittle to be sued as the passivation layer **30**.

Increasing the width of the cut-link also improves the fracture mechanics during ablation. The fracture initiates and grows as a result of thermal stress at the interface of the cut-link and the surrounding material. The thermal stress, in turn, is a function of the energy density at the surface of the pad. The lines of maximum stress, from which fractures typically propagate, are along the edge **36** of the pad **20** forming the perimeter of the surface **38** facing the passivation layer **30**. The energy density along the maximum stress lines **36** is governed by the ratio of the energy absorbed to the length of the perimeter.

Making the approximating assumption that the energy density of the laser beam is uniform, the energy absorbed by a square surface **38** will be the produce of k and S, where k is a constant and S represents the area of surface **38**. The energy density, E_ρ, along the perimeter, P, of the surface **38** can be expressed by the function:

$$E_\rho = k*S/P$$

As the energy density increases, the stresses increase and the cracks grow. Energy density increases as a result of increasing the surface dimensions of the pad. As the dimensions increase, the area of the square, S (S=1 *w), increases as a square function while the length of the perimeter, P [P=2 * (1+w)], increases linearly. Accordingly, S will increase at a quadratic rate while P increases at a linear rate. Because the numerator of the energy-density function increases with size at a rate faster than the denominator, a fracture driven by a large, square-shaped cut-link will propagate through the passivation layer with greater energy than a fracture driven by a small or narrow cut-link.

Of course, fracture will initiate from an edge of the outer surface because stress is concentrated at the edges. Use of a wider cut-link promotes fracture **32***a* from an edge **36** of the upper surface of the cut-link rather than fracture **32***b* from the lower surface facing toward the silicon wafer. After the fracture **32***a* has propagated through the passivation layer **30**, this segment of the passivation layer **30** can be "blown off" by the escaping metal, as desired. In contrast, fracture **32***b* commencing from the lower side can damage interconnects existing on lower levels of a chip, and the metal flowing through a fracture directed toward the silicon has no outlet and is therefore more likely to produce a short. Therefore, the likelihood of producing a clean severance of an interconnect is promoted by the wider cut-links because fracture is biased toward the passivation layer and away from the silicon wafer.

Although a preferred shape of the cut-link pad is square, other relatively compact shapes approximating the size and shape of the laser beam spot may also be used. FIG. **7** illustrates a hexagonally-shaped pad of this invention. As before, the width, w, of the pad is approximately equal to the length, l, of the pad. Although this hexagonal design is more compact and provides a better approximation of the laser beam shape **24**, as compared to a square pad, the crack **46** must propagate across a longer distance to cross the interface between the line **21** and the pad **20**. As the energy density builds along the edges **42** and **44**, the pad **20** is severed from the line **21** when cracks **46**, which parallel the edges **42**, **44**, branch across the interface.

Although each of the single-plane embodiments thus far described includes lines having widths uniformly narrower than the width of the cut-link pad, the width of the lines need not be uniform to provide benefit. FIGS. **8** and **9** illustrate embodiments wherein the cut-link and the lines **21** and **22** possess equal widths over much of their lengths. The width of each line **21**, **22** narrows only as it approaches and where it meets the pad **20**. Because the juncture of the line **21**, **22** and the pad **20** is narrow, thermal resistance along the A-A' axis increases at the juncture relative to the resistance within the pad, as in the previous embodiments. However, the overall ability to restrict heat flow out of the pad **20** may be somewhat compromised if the width beyond the bottleneck **50** is enlarged, as shown, because the resistance in the line **21** or **22** drops to the level within the pad **20** at points beyond the bottleneck **50**. Accordingly, heat can be rapidly withdrawn once it passes through the bottleneck **50** creating a more precipitous temperature drop across this interface thereby fueling the conduction of heat out of the pad **20**.

Another advantage of the patterns illustrated in FIGS. **8** and **9** is that the fracture along the interface of the pad **20** and the line **21** or **22** is enhanced. As noted above, fractures across the interface will typically emanate along a line substantially parallel to the edge **36** of the pad **20**. In the pattern shown in FIG. **3**, the edge of the line meets the edge of the pad perpendicularly. Accordingly, the stress along the edge of the line is perpendicular to the direction in which the interfacial fracture will propagate and will provide little or no impetus toward initiating or driving this fracture. On the other hand, the edge **51** of the line **21** in FIG. **8** slopes toward the edge **36** of the pad **20**. In proportion to the component of this slope which parallels the edge **36** of the pad **20**, the stress along the edge **51** of the line **21** will supplement the stress along the edge **36** of the pad **20** to initiate and drive the fracture across the interface between the pad **20** and the line **21**.

In contrast to the embodiments thus described, wherein the pad and the lines all lie within the same plane of a chip or circuit board, the invention may also be embodied in multi-layered chips. Such an embodiment is illustrated in FIGS. **10** and **11**. As before, the orientation of the pad **20** is parallel to the plane of the chip. However, in place of the laterally-extending lines, the lines take the form of vias **21***a* and **22***a* extending downward from the surface **52** of the pad **20** away from the laser and into the substrate. These vias **21***a* and **22***a* provide a conductive link between levels of the integrated circuit. Typically, the vias **21***a* and **22***a* have a smaller cross-section than the lines of the single-level embodiments. Where half-micron technology is used in standard silicon processing, the via **21***a* or **22***a* preferably has a width of about a half micrometer across its cross-section. The vias **21***a* and **22***a* are conductively coupled to the pad **20**, which forms a conductive cap stretching across and conductively bonded to the upper end of each via **21***a*, **22***a*. At their ends opposite the pad **20**, the vias **21***a* and **22***a* are conductively bonded to lines **53**, **54** extending laterally in a layer beneath the pad **20**. By removing the pad **20** through laser ablation, the conductive link is broken.

When the laser strikes the pad **20**, heat migrates downward away from surface. During the first few nanoseconds after the laser strikes, the temperature at the bottom **52** of the pad is much lower than the temperature at the top surface **38**. As a result, less heat is dissipated through the vias **21***a*, **22***a* than if they were laterally connected, and the efficiency with which the cut is performed is thereby improved.

In either a single-layer or multi-layer embodiment of the electrical interconnect, the method for ablating the cut-link pad is substantially identical. First, a laser beam having an intensity on the order of 10 Joules per square centimeter is directed onto the site of the pad. When embodied in a chip, the pad is typically coated with a passivation layer. The beam must be able to pass through the passivation layer, which is preferably silicon nitride, and be absorbed by the metal of the cut-link pad. The wavelength of the laser beam is determined by what is transmittable through the passivation layer. Each material has an upper limit as to the size of the wavelength that it is capable of absorbing. For silicon nitride, that limit is about a half micrometer. Therefore, an infrared laser producing a beam with a wavelength of about one micrometer may be used to transmit energy through the silicon nitride layer to the underlying metallic cut-link pad where it is absorbed.

The laser generates a beam in the form of a pulse or a series of pulses. The duration of the pulse is determined by

the thickness of the pad and the rate of thermal diffusion through the pad. With these variables in mind, the pulse should be of sufficient duration for the heat to diffuse through the entirety of the pad. For the embodiments thus far described, a pulse of 5 to 10 nanoseconds is generally sufficient to produce a clean severance without damage to the circuit.

Damage can occur when too much energy is directed at the cut-link site. Specifically, excessive energy is created by a pulse having excessive intensity or excessive duration. On one hand, the pulse and duration must be sufficiently great to supply ample energy to initiate and drive the fracture severing the pad from the lines and expelling the overlying passivation layer. The remaining energy must by sufficient to vaporize the cut-link pad and produce a substantially vacant cavity at the former site of the pad. If too much energy is provided, however, a crack **32***b* can propagate, as shown in FIG. **5**, from the lower corner of the pad **20** through the dielectric material and damage the underlying circuitry.

The relation between the amount of laser-supplied energy and the probability of producing a clean severance of the circuit without damage is illustrated in the generalized cumulative probability functions charted in FIGS. **12–14**. FIG. **12** illustrates the approximate shape of a cumulative probability curve **56** measuring the likelihood that a circuit will be severed at increasing energy levels. FIG. **13** illustrates the approximate shape of a cumulative probability curve **58** measuring the likelihood that a circuit will be damaged across a range of increasing energy levels. By subtracting the probability of damaging a circuit from the probability of severing a circuit (i.e., by subtracting the values of the chart in FIG. **13** from the values of the chart in FIG. **12**), the probability of clean severance, i.e., severing a circuit without damaging it, is obtained as a function of energy. A curver **60** approximating the plot of this probability function is charted in FIG. **14**. For optimal results, the intensity and duration of the pulse should be set at levels top produce the energy at which the probability of a clean severance most nearly approaches 1.0. The limit of P=1.0 represents a certainty that the circuit will be severed without damage, a limit which can be approached with the methods of this invention.

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for cutting a link between interconnected circuits comprising the following steps:

directing a laser upon an electrically-conductive cut-link pad conductively bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the width of the cut-link pad is at least ten percent greater than the width of each of the first and second electrically-conductive lines; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines.

2. The method of claim **1**, wherein the electrically-conductive cut-link pad lies in the same plane as the first and second electrically-conductive lines.

3. The method of claim **1**, wherein the electrically-conductive cut-link pad has an inner surface facing the substrate and an opposing outer surface facing away from the substrate, the first and second electrically-conductive lines extending from the inner surface into the substrate.

4. The method of claim **3**, wherein the laser beam extends across the entirety of the cut-link pad when the laser is directed upon the cut-link pad.

5. The method of claim **1**, wherein the electrically-conductive cut-link pad has an inner surface facing the substrate, the first electrically-conductive line extending from the inner surface into the substrate, the second electrically-conductive line lying in the same plane as the cut-link pad.

6. The method of claim **1**, wherein the width of the cut-link pad is at least twenty-five percent greater than the width of each of the first and second electrically-conductive lines.

7. The method of claim **1**, wherein the width of the cut-link pad is at least fifty percent greater than the width of each of the first and second electrically-conductive lines.

8. The method of claim **7**, wherein the cut-link pad is comprised of a composition substantially identical to the composition of the first and second electrically-conductive lines.

9. The method of claim **8**, wherein the substrate is planar and the width of the cut-link pad is within 20% of the length of the cut-link pad.

10. The method of claim **9**, wherein the laser beam extends across the entirety of the cut-link pad when the laser is directed upon the cut-link pad.

11. A method for cutting a link between interconnected circuits comprising the following steps:

directing a laser upon an electrically-conductive cut-link pad conductively bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the cut-link pad is formed of a material that has greater thermal conductivity than the material that forms each of the first and second electrically-conductive lines; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines.

12. The method of claim **1**, wherein the substrate includes a silicon oxide.

13. The method of claim **1**, wherein a passivative layer covers the cut-link pad.

14. A method for cutting a link between interconnected circuits comprising the following steps:

directing a laser upon an electrically-conductive cut-link pad conductively bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the cut-link pad is covered with a passivative layer that is harder than the substrate; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines.

15. The method of claim **14**, wherein the passivation layer is comprises of silicon nitride.

16. The method of claim **13**, wherein the electrically-conductive cut-link pad lies in the same plane as the first and second electrically-conductive lines.

17. The method of claim **13**, wherein the electrically-conductive cut-link pad has an inner surface facing the substrate and an opposing outer surface facing away from the substrate, the first and second electrically-conductive lines extending from the inner surface into the substrate.

18. The method of claim **17**, wherein the laser beam extends across the entirety of the cut-link pad when the laser is directed upon the cut-link pad.

19. The method of claim **13**, wherein the width of the cut-link pad is at least fifty percent greater than the width of each of the first and second electrically-conductive lines.

20. The method of claim **19**, wherein the substrate is planar and the width of the cut-link pad is within 20% of the length of the cut-link pad, the length being measured as the distance across the cut-link pad between the first and second lines.

21. The method of claim **13**, wherein the cut-link pad is comprised of a material with greater thermal conductivity than the material comprising each of the first and second electrically-conductive lines.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

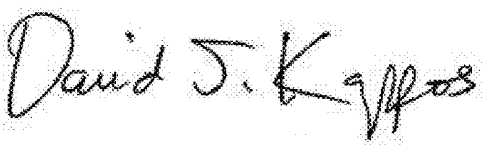
PATENT NO. : 6,057,221 C1
APPLICATION NO. : 90/011607
DATED : September 11, 2012
INVENTOR(S) : Joseph B. Bernstein et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

ON THE TITLE PAGE:

After Item "(73) Assignee", change "United States Air Force, Washington, DC (US)" to --Massachusetts Institute of Technology, Cambridge, Mass.; University of Maryland, College Park, Md.--.

Signed and Sealed this
Sixteenth Day of October, 2012



David J. Kappos
Director of the United States Patent and Trademark Office

US006057221C1

(12) EX PARTE REEXAMINATION CERTIFICATE (9289th)

United States Patent
Bernstein et al.

(10) **Number: US 6,057,221 C1**
(45) **Certificate Issued: Sep. 11, 2012**

(54) **LASER-INDUCED CUTTING OF METAL INTERCONNECT**

(75) Inventors: **Joseph B. Bernstein**, Potomac, MD (US); **Zhihui Duan**, Erie, PA (US)

(73) Assignee: **United States Air Force**, Washington, DC (US)

Reexamination Request:
No. 90/011,607, Mar. 30, 2011

Reexamination Certificate for:
Patent No.: **6,057,221**
Issued: **May 2, 2000**
Appl. No.: **08/825,808**
Filed: **Apr. 3, 1997**

(51) **Int. Cl.**
H01L 21/44 (2006.01)

(52) **U.S. Cl.** **438/601**; 438/132
(58) **Field of Classification Search** ..... None
See application file for complete search history.

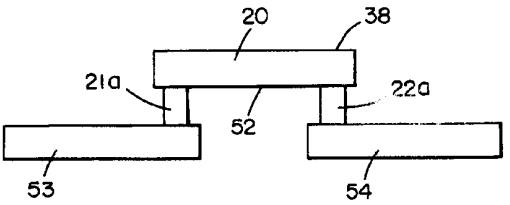
(56) **References Cited**

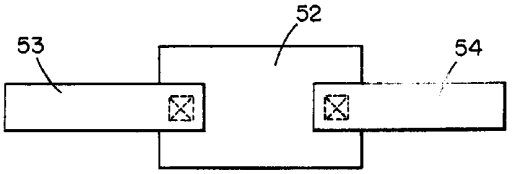
To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/011,607, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner—John Heyman

(57) **ABSTRACT**

An electrical interconnect includes a substrate having an insulating surface upon which is placed an electrically-conductive cut-link pad and a pair of electrically-conductive lines. The lines are bonded to the cut-link pad and are substantially more resistant to heat flow per unit length than is the cut-link pad. In a preferred embodiment, the thermal resistance per unit length of the cut-link pad is lowered by designing the pad such that its width is greater than the width of either of the lines. A method for cutting a circuit includes directing a laser upon the cut-link pad of an interconnect, as described above. The laser is maintained upon the pad until the cut-link pad is ablated, severing the circuit.





EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claim **14** is confirmed.

Claims **1**, **2**, **5**, **9-12**, **16**, **19** and **20** are cancelled.

Claims **3**, **6-8**, **13**, **15**, **17** and **21** are determined to be patentable as amended.

Claims **4** and **18**, dependent on an amended claim, are determined to be patentable.

New claims **22-29** and **30** are added and determined to be patentable.

3. **[**The**]** *A* method **[**of claim **1]** *for cutting a link between interconnected circuits, comprising the following steps:*

directing a laser upon an electrically-conductive cutlink pad conductively bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the width of the cut-link pad is at least ten percent greater than the width of each of the first and second electrically-conductive lines; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines, wherein the electrically-conductive cut-link pad has an inner surface facing the substrate and an opposing outer surface facing away from the substrate, the first and second electrically-conductive lines extending from the inner surface into the substrate.

6. The method of claim **[1]** *3*, wherein the width of the cut-link pad is at least twenty-five percent greater than the width of each of the first and second electrically-conductive lines.

7. The method of claim **[1]** *3*, wherein the width of the cut-link pad is at least fifty percent greater than the width of each of the first and second electrically-conductive lines.

8. The method of claim **7**, wherein the cut-link pad **[**is comprised of**]** *comprises* a composition substantially identical to the composition of the first and second electrically-conductive lines.

13. The method of claim **[1]** *3*, wherein a passivative layer covers the cut-link pad.

15. The method of claim **14**, wherein the passivation layer **[**is**]** comprises **[**of**]** silicon nitride.

17. **[**The**]** *A* method **[**of claim **1]** *for cutting a link between interconnected circuits, comprising the following steps:*

directing a laser upon an electrically-conductive cutlink pad conductively bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the width of the cut-link pad is at least ten percent greater than the width of each of the first and second electrically-conductive lines; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines, wherein *a passivative layer covers the cut-link pad, and* the electrically-conductive cut-link pad has an inner surface facing the substrate and an opposing outer surface facing away from the substrate, the first and second electrically-conductive lines extending from the inner surface into the substrate.

21. The method of claim **13**, wherein the cut-link pad **[**is comprised of**]** *comprises* a material with greater thermal conductivity than the material comprising each of the first and second electrically-conductive lines.

22. The method of claim 21, wherein the cut-link pad comprises aluminum.

23. The method of claim 3, wherein the cut-link pad has a greater cross-sectional area than the first and second electrically-conductive lines, wherein the cross-sectional area of the cut-link pad is the product of a width and a height of the cut-link pad, the first and second electrically-conductive lines comprise vias, and the cross-sectional area of each of the first and second electrically-conductive lines is defined by a width of the corresponding via.

24. The method of claim 13, wherein the passivative layer comprises silicon nitride.

25. The method of claim 4, wherein the cut-link pad has a length of 2-3 microns, and the first and second electrically-conductive lines each have a width of about 0.5 microns.

26. A method for cutting a link between interconnected circuits comprising:

directing a laser upon an electrically-conductive cut-link pad conductivity bonded between a first electrically-conductive line and a second electrically-conductive line on a substrate, the cut-link pad having substantially less thermal resistance per unit length than each of the first and second lines, wherein the cut-link pad is formed of a material that has greater thermal conductively than the material that forms each of the first and second electrically-conductive lines; and

maintaining the laser upon the cut-link pad until the laser infuses sufficient energy into the cut-link pad to break the conductive link across the cut-link pad between the pair of electrically-conductive lines, wherein the electrically-conductive cut-link pad has an inner surface facing the substrate and an opposing outer surface facing away from the substrate, the first and second electrically-conductive lines extending from the inner surface into the substrate.

27. The method of claim 26, further comprising a passivative silicon nitride layer that covers the cut-link pad.

28. The method of claim 26, wherein the cut-link pad comprises aluminum.

29. The method of claim 14, wherein the width of the cut-link pad is at least fifty percent greater than the width of each of the first and second electrically-conductive lines.

30. The method of claim 13, wherein the passivative layer is harder than the substrate.

* * * * *