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Paper No. 54
March 10, 2014

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICRON TECHNOLOGY, INC.
Petitioner

v.

THE BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS
Patent Owner

Case IPR2013-00005
Patent 6,444,533 B1

Before SALLY GARDNER LANE, BRYAN F. MOORE, and
MICHAEL J. FITZPATRICK, *Administrative Patent Judges.*

FITZPATRICK, *Administrative Patent Judge.*

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

BACKGROUND

Micron Technology, Inc. ("Micron") filed a Petition (Paper 3, "Pet.") requesting an *inter partes* review of all claims (i.e., claims 1-8) of U.S. Patent No. 6,444,533 B1 (the "'533 patent"). The Board of Trustees of the University of Illinois ("University") filed a Patent Owner Preliminary Response (Paper 14, "Prelim. Resp."). In a March 13, 2013, Decision to Institute (Paper 19, "Dec. on Pet."), the Board granted the Petition and instituted trial of all claims on the following grounds:

claims 1-8 as obvious over Lisenker (Ex. 1006)[1];

claims 1-8 as obvious over Lisenker in view of Ito (Ex. 1005)[2];

claims 1-8 as obvious over Deal (Ex. 1009)[3] in view of Lisenker; and

claims 1-8 as obvious over Deal in view of Lisenker and Ito.

Dec. on Pet. 20.

After institution, the University filed a Patent Owner Response (Paper 26, "PO Resp."). In it, the University opposes the grounds of unpatentability on two general bases: (1) the Board's findings, in instituting trial, regarding Lisenker are incorrect; and (2) objective indicia prove the claims would not have been obvious. Micron filed a Reply (Paper 28). Oral hearing was held on December 9, 2013.[4]

The Board has jurisdiction under 35 U.S.C. § 6(c). This final written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses issues and arguments raised during the trial. Issues and arguments

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[1] WO 94/19829 to Lisenker et al. (Sep. 1, 1994).
[2] US 4,980,307 to Ito et al. (Dec. 25, 1990).
[3] US 4,027,380 to Deal et al. (June 7, 1977).
[4] A transcript of the final hearing is included in the record.

raised prior to institution of trial, but not made during trial, are not addressed necessarily in this Decision.

As discussed below, Micron has shown by a preponderance of the evidence that claims 1-8 of the ’533 patent are unpatentable.

A. Related Proceedings

Micron indicates that it is a named defendant in a pending district court case concerning the ’533 patent brought by the University and captioned *The Board of Trustees of the University of Illinois v. Micron Technology, Inc.*, Case No. 2:11-cv-02288 (C.D. Ill.). Pet. 1.

Also, Micron filed two additional petitions, which we granted, for *inter partes* reviews of two related patents: IPR2013-00006, regarding U.S. Patent No. 6,888,204, and IPR2013-00008, regarding U.S. Patent No. 5,872,387.

B. The ’533 Patent (Ex. 1002)

The ’533 patent, titled “Semiconductor Devices And Methods For Same,” is assigned to the University. Ex. 1002, 1. The ’533 patent issued from U.S. Application Serial No. 09/518,802, filed March 3, 2000. *Id*.

The ’533 patent “relates to methods for treating semiconductor devices or components thereof in order to reduce the degradation of semiconductor device characteristics over time.” Ex. 1002, col. 1, ll. 13-16. In particular, the ’533 patent discloses methods of treating a semiconductor device by passivation of (or annealing[5]) the device with deuterium, an isotope of hydrogen. *Id*. at col. 2, ll. 25-28; Prelim. Resp. 1. The ’533 patent explains:

[5] Micron’s witness testified that passivation is also referred to as annealing. Ex. 1001 (declaration of Michael L. Reed, Ph.D. (“Reed Decl.”)) ¶ 14.

> [T]reatment with deuterium provides a reduction in the depassivation or "aging" of semiconductor devices due to hot-carrier effects. Such aging is evidenced, for example, by substantial degradations of threshold voltage, transconductance, or other device characteristics. In accordance with the present invention, semiconductor devices are fabricated using deuterium to condition the devices and stably reduce the extent of these degradations.

Ex. 1002, col. 3, ll. 27-35.

Prior to the '533 patent, passivation with hydrogen[6] was "a well-known and established practice in the fabrication of semiconductor devices" to remove defects that affect the operation of the devices. Ex. 1002, col. 1, ll. 17-21; *see* Ex. 1001 (Reed Decl.) ¶¶ 13-14. According to the '533 patent, it was "discovered that semiconductor devices, for example including MOS[7] devices, can be advantageously treated with deuterium to improve their operational characteristics." Ex. 1002, col. 2, ll. 22-25.

C. Illustrative Claims

Claims 1 and 2 are the only independent claims of the '533 patent. They are illustrative of the claimed subject matter and read as follows:

> 1. A process for treating a semiconductor device including a semiconductor region and an insulating layer having an interface with the semiconductor region and a contact on said insulating layer overlying said interface, comprising the steps of forming said insulating layer with a thickness not exceeding about 55 Angstroms beneath said contact, and of annealing said semiconductor device, subsequent to completion of fabrication

[6] Our use of the term "hydrogen" and the symbol "H" in this Decision refers to naturally occurring hydrogen, which we understand to be predominantly protium, but may include trace amounts of deuterium.

[7] MOS refers to metal oxide semiconductor. Ex. 1002, col. 1, ll. 34-35; Ex. 1001 ¶ 9.

> of said device, in an ambient including deuterium to form a concentration of deuterium at the interface between said semiconductor region and said insulating layer region effective to substantially reduce degradation of said device associated with hot carrier stress.
>
> 2. A process for treating an insulated gate field effect transistor device structure including a channel region extending between source and drain regions, a gate insulating layer having an interface with said channel region, and contacts to said source and drain regions and on said gate insulator layer, comprising forming said gate insulator beneath the gate contact to have a thickness not greater than about 55 Angstroms and, subsequent to formation of said source, drain and gate contacts, annealing the device in an ambient including deuterium at a temperature above about 200º C. and below a decomposition or melting temperature of said structure to form a concentration of deuterium at said interface region effective to substantially reduce degradation of said device associated with hot carrier stress by increasing a practical lifetime at least about 10 times that provided by a corresponding passivation with hydrogen, where practical lifetime is taken as 20% transconductance degradation as a result of electrical stress.

ANALYSIS

A. Claim Construction

In an *inter partes* review, "[a] claim in an unexpired patent shall be given its broadest reasonable construction in light of the specification of the patent in which it appears." 37 C.F.R. § 42.100(b). That construction must be consistent with the specification, and the claim language should be read in light of the specification, as it would be interpreted by one of ordinary skill in the art. *In re Suitco Surface, Inc.*, 603 F.3d 1255, 1260 (Fed. Cir. 2010). Thus, we give claim terms their ordinary and customary meaning. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir.

2007) ("The ordinary and customary meaning is the meaning that the term would have to a person of ordinary skill in the art in question.") (internal quotation marks omitted).

In instituting trial, we gave each claim term its broadest reasonable interpretation, as understood by one of ordinary skill in the art and consistent with the disclosure of the '533 patent, as neither party had argued persuasively that any claim or term should be construed otherwise.[8] For purposes of institution, we found it useful to set forth, expressly, constructions for two claims terms.

First, we construed the term "subsequent to completion of fabrication of said device," appearing in claim 1, to mean after the contacts on the device are formed. This is the broadest reasonable interpretation consistent with the disclosure of the '533 patent. *See* Ex. 1002, col. 4, ll. 41-43 ("subsequent to the fabrication of device 11 (e.g. subsequent to fabricating the gate, source and drain contacts))"; col. 4, ll. 52-53 ("after fabrication is completed (i.e. after the metal contacts are completed)").

Second, we noted the term "above about 200º C. and below a decomposition or melting temperature of said structure," appearing in claim 2, includes temperatures of up to about 1,000º C. *See* Ex. 1002, col. 5, ll. 1-7 ("The annealing process can be conducted . . . preferably at a temperature of at least about 200º C. up to the melting point or decomposition

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[8] Micron generally asserted that the claims should be "treated as product-by-process claims[.]" Pet. 5-6. Each of the claims, however, is explicitly a "process" or "method," and Micron did not provide any basis or reasons for construing them as product-by-process claims. Hence, we rejected Micron's request to treat them as product-by-process claims.

temperature of other components of the device, more preferably in the range of about 200º C. to about 1000º C., and most typically in the range of about 200º C. to about 800º C.”).

During trial, neither party argued for different constructions. As such, we adopt our prior constructions.

B. Prior Art References In Trial

1. Lisenker (Ex. 1006)

Lisenker discloses “a method for producing semiconductor devices in which hydrogen-containing bonds in silicon dioxide are replaced with deuterium containing bonds. Specifically Si-H bonds are replaced with Si-D bonds and Si-OH bonds are replaced with Si-OD bonds.” Ex. 1006, 5, l. 36 – 6, l. 3. Lisenker further discloses how the method may be carried out, stating:

> a silicon wafer is contacted with a deuterium containing material to form Si-D and Si-OD bonds in a silicon dioxide layer and on a silicon surface at an interface with the silicon dioxide layer. Typical silicon dioxide layers suitable for treatment according to the present invention include isolation oxides, gate oxides, and various other oxide layers commonly used with semiconductor devices. According to the invention, deuterium or a deuterium-containing material is directed onto the device by, for example, annealing in a deuterium containing atmosphere, and/or cleaning with a deuterium compound such as D_2O, D_2SO_4, and DCl. In general, any hydrogen containing material used in VLSI[9] fabrication can be replaced with corresponding deuterium containing material.

Id. at 4, ll. 20-34. Finally, Lisenker discloses the benefits of the method and how those benefits are purportedly obtained, stating:

[9] VLSI refers to “very large scale integration.” Ex. 1011 (THOMAS E. DILLINGER, VLSI ENGINEERING 4 (Prentice Hall, 1988)).

> The stability of oxide layers is improved in the present invention because the bond energy of the Si-H and Si-OH bonds is increased by replacing the hydrogen atoms with deuterium atoms. The Si-D and Si-OD bonds thus formed provide completed silicon dangling bonds that are less likely to break when exposed to electrical stresses. Therefore, the deuterium containing devices of the present invention have improved stability, quality, and reliability.

Id. at 4, l. 35 – 5, l. 5.

2. Ito (Ex. 1005)

Ito is titled "Process For Producing A Semiconductor Device Having A Silicon Oxynitride Insulative Film." Ito states that "[t]he gate insulation film should have a thickness of from approximately 30 to 3000 angstroms." Ex. 1005, col. 9, ll. 41-43.

3. Deal (Ex. 1009)

Deal is titled "Complementary Insulated Gate Field Effect Transistor Structure And Process For Fabricating The Structure." It discloses much of the subject matter of claims 1-8, including, in particular, post-metal annealing, albeit in hydrogen. Ex. 1009, col. 9, ll. 33-51. Deal does not disclose using deuterium.

C. Claims 1-8 As Obvious Over Lisenker Alone

As discussed below, Micron has shown a prima facie case that the subject matter of claims 1-8 would have been obvious over Lisenker.

1. Claim 1

Lisenker, as discussed above and below, teaches the subject matter of claim 1 except for the step of "forming said insulating layer with a thickness not exceeding about 55 Angstroms beneath said contact."

The Supreme Court has held that the obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). In that regard, we credit the testimony of Micron's witness, Dr. Reed, that, at the time of filing the '533 patent, it would have been apparent to one of ordinary skill in the art to reduce the thickness of the gate insulating film of Lisenker to 55 Angstroms or less, consistent with the general, decades-long trend of device miniaturization in the semiconductor industry. Ex. 1001 ¶ 38.

We also credit Dr. Reed's testimony that, at the time of filing the '533 patent, others already had made gate insulating films having thicknesses of 55 Angstroms or less. Ex. 1001 ¶¶ 39, 43. The combination of familiar elements according to known methods to achieve predictable results, such as reducing the thickness of the gate insulating film of Lisenker to 55 Angstroms or less, would have been obvious. *See KSR*, 550 U.S. at 416.

We further note that the University does not argue, or direct us to evidence, to show criticality of the thickness limitation, such that we might conclude that obviousness has not been shown. *See generally* PO Resp.; *see* Prelim. Resp. 2. Rather, the University's prior art-based arguments are directed exclusively to Lisenker.

The University makes the following three assertions regarding Lisenker: "[o]ne of ordinary skill would have ignored Lisenker"; "[o]ne of ordinary skill would read Lisenker as limited to pre-metallization passivation"; and the limitation "'[s]ubstantially reduce degradation . . .' is not inherent in Lisenker." PO Resp. 9, 11, 12 (emphasis removed). We disagree with each of these assertions, as discussed below.

a) One Of Ordinary Skill Would Not Have Ignored The Teachings Of Lisenker

The University argues that the fundamental theory underlying Lisenker's teachings is that "the Si-D bond is significantly stronger than the Si-H bond." PO Resp. 9 (providing no citation to Lisenker).[10] But, according to the University, Lisenker erroneously relies on energy values for bonds not at the interface. PO Resp. 9. The University further argues that a person of ordinary skill in the art at the time of the invention would have known that "the energies for Si-D and Si-H bond disassociation *at the silicon surface* are identical or substantially identical." PO Resp. 10 (emphasis added). Therefore, the University reasons, such a person "would have concluded that the teachings of Lisenker were immaterial to the problem facing the inventors of the ['533] patent, *i.e.*, how to solve for hot carrier effects involving bonds at the silicon substrate." PO Resp. 10 (citing *In re Young*, 927 F.2d 588 (Fed. Cir. 1991)).

Contrary to the implication of the University's argument, however, the scope of the prior art is not limited to solutions that are directed to the problem the patentees set out to solve. *KSR*, 550 U.S. at 419 ("In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. What matters is the objective reach of the claim. If the claim extends to

[10] Lisenker states that "[t]he stability of oxide layers is improved in the present invention because the bond energy of the Si-H and Si-OH bonds is increased by replacing the hydrogen atoms with deuterium atoms." Ex. 1006, 4, l. 35 – 5, l. 1.

what is obvious, it is invalid under § 103.”). Additionally, we disagree with the further implication that Lisenker is not concerned with solving for hot carrier effects involving bonds at the silicon surface (or silicon-silicon dioxide interface). *See* Ex. 1006, 4, ll. 2-12 (discussion by Lisenker of problems caused by hot electrons at the silicon-silicon dioxide interface), Fig. 1 (illustrating an improved silicon-silicon dioxide interface in accordance with the Lisenker invention).

Also, the University’s reliance on *In re Young* is not persuasive. *Young* does not support the proposition that a prior art reference may be ignored. *Young*, 927 F.2d at 591 (“Even if tending to discredit [the] Carlisle [patent], [the] Knudsen [article] cannot remove Carlisle from the prior art. Patents are part of the literature of the art and are relevant for all they contain.”). In *Young*, the court held that, “[w]hen prior art contains apparently conflicting references, the Board must weigh each reference for its power to suggest solutions to an artisan of ordinary skill.” *Id*. Here, the University has presented evidence conflicting, allegedly, with Lisenker’s underlying theory of operation. But, the University has not provided a reference conflicting with Lisenker’s express teaching that “deuterium containing devices of the present invention have improved stability, quality, and reliability.” Ex. 1006, 5, ll. 4-5. Accordingly, we are not persuaded that a person of ordinary skill in the art would have ignored Lisenker.

b) Lisenker Is Not Limited To Pre-Metallization Passivation

Lisenker is not limited to annealing in, or passivation with, deuterium prior to formation of the metal contacts. Rather, it “can be implemented throughout the VLSI fabrication procedure.” Ex. 1006, 8, ll. 29-30. The University characterizes this as an “isolated passage from Lisenker.” PO

Resp. 12. But, it is not. Lisenker includes numerous additional teachings that undermine the University's argument that Lisenker's use of deuterium is limited to pre-metallization passivation, including the following:

> "In general, any hydrogen containing material used in VLSI fabrication can be replaced with corresponding deuterium containing material." Ex. 1006, 4, ll. 32-34.
>
> "In one aspect of the present invention, VLSI fabrication flows employ deuterium contained compounds in many or all of the fabrication steps that would normally employ hydrogen or a hydrogen containing compound." *Id*. at 5, ll. 6-9.
>
> "The formation of Si-D and Si-OD bonds is accomplished in the present invention by contacting a silicon wafer with deuterium or a deuterium containing compound before, during, and/or after formation a device oxide layer." *Id*. at 6, ll. 10-14.
>
> "A typical fabrication procedure will include various doping, etching, annealing, deposition, cleaning, passivation, and oxidation steps. In each instance in which hydrogen or a hydrogen containing compound is employed, deuterium or a deuterium containing compound can be used in its place." *Id*. at 8, ll. 30-35.

The University, citing a 1995 publication, previously conceded that "post metal hydrogen annealing had been in widespread use in the semiconductor industry for many years[.]" Ex. 1013 ¶ 15; *see also* Ex. 1001 ¶ 15 (Micron's witness Dr. Reed testifying that it was "standard practice" in the industry). Thus, as Lisenker teaches the substitution of deuterium "[i]n each instance" in which hydrogen is otherwise used, and "throughout the VLSI fabrication procedure," it teaches that substitution during post-metal annealing. Ex. 1006, 8, ll. 29-37.

To support its argument that Lisenker is limited to pre-metallization passivation, the University cites the following deposition testimony of Micron witness Dr. Reed, taken during his cross-examination:

> Q. So Lisenker is teaching that one should not anneal the deuterium until after metallization?
>
> MR. RIFFE: Objection, form.
>
> THE WITNESS: That's not the way I read this.

PO Resp. 13 (citing Ex. 2013, 88, ll. 13-17). This testimony does not support the University's argument. As is evident on its face, counsel for the University asked Dr. Reed whether Lisenker was *limited* to post-metallization passivation, and he answered in the negative. That answer is consistent with the disclosure of Lisenker. *See, e.g.*, Ex. 1006, 8, ll. 29-30 ("The present invention can be implemented throughout the VLSI fabrication procedure.").

c) Lisenker Teaches The Claimed "substantially reduc[ing] degradation of said device associated with hot carrier stress"

The University argues that this limitation is not met in Lisenker because it lacks deuterium at the interface. PO Resp. 11-12. More specifically, the University argues that Lisenker is limited to deuterium passivation that is performed only pre-metallization (i.e., before the metal contacts on the device are formed) and, thus, the deposited deuterium migrates away from the interface during subsequent processing. *Id*. As discussed above, however, Lisenker is not limited to pre-metallization deuterium passivation.

Contrary to the University's assertions, Lisenker expressly states that deuterium is retained at the interface.

> The regions where the deuterated bonds provide the greatest benefit in terms of device performance is at the interface of silicon-silicon dioxide layers. Thus, the semiconductor devices of this invention will have at this interface a ratio of Si-OD plus Si-D bonds to Si-OH plus Si-H bonds that is substantially greater than ratio of naturally occurring deuterium to hydrogen.

Ex. 1006, 10, ll. 29-35. Lisenker also includes claims to such devices, including, for example, a semi-conductor device having an interface between a silicon dioxide layer and a silicon surface "wherein the ratio of Si-OD plus Si-D bonds to Si-OH plus Si-H bonds is greater than about 99:1." *Id*. at 12, ll. 3-9 and 15-17.

Thus, Lisenker teaches devices having increased amounts of deuterium at the interface relative to other prior art devices. It is inherent that the increased deuterium at the interface substantially reduces degradation associated with hot carrier stress. The University does not dispute that fact, and, indeed, it is the basis of the claims of its patent. PO Resp. 2; *see also King Pharms., Inc. v. Eon Labs, Inc.*, 616 F.3d 1267, 1276 (Fed. Cir. 2010) ("Because the '128 patent discloses no more than taking metaxalone with food, to the extent such a method increases the bioavailability of metaxalone, the identical prior art method does as well."). Additionally, Lisenker expressly recognizes the improvement. Ex. 1006, 5, ll. 4-5 ("Therefore, the deuterium containing devices of the present invention have improved stability, quality, and reliability.").

2. Claim 2

Independent claim 2 requires:

> annealing the device in an ambient including deuterium at a temperature above about 200º C. and below a decomposition or melting temperature of said structure to form a concentration of deuterium at said interface region *effective to substantially reduce degradation of said device associated with hot carrier stress by increasing a practical lifetime at least about 10 times that provided by a corresponding passivation with hydrogen, where practical lifetime is taken as 20% transconductance degradation as a result of electrical stress*.

(emphasis added).

Lisenker discloses conducting the deuterium annealing preferably at about 500º C. Ex. 1006, 9, l. 20. This is within the claimed temperature range, which we have construed to include from about 200º C. to at least about 1,000º C.

The italicized portion of the above-quoted limitation is the inherent result of the claimed process, which process also is taught by Lisenker. *See King Pharms.*, 616 F.3d at 1276.

3. Claim 3

Claim 3 depends from claim 2 and additionally recites "wherein said temperature is about 400º C." Lisenker discloses conducting the deuterium annealing "preferably" at about 500º C but notes that other acceptable conditions would be apparent to a person of skill in the art. Ex. 1006, 9, ll. 20-25. Dr. Reed testified that post-metal anneals are generally conducted at about 400º C. to about 500º C. Ex. 1001 ¶¶ 15-16.

4. Claim 4

Claim 4 depends from claim 1 and additionally recites "wherein said deuterium-enriched ambient comprises deuterium gas and one or more inert gases." Lisenker discloses this additional limitation with nitrogen used as the inert gas. Ex. 1006, 8, l. 37 – 9, l. 1.

5. Claim 5

Claim 5 depends from claim 4 and additionally recites "wherein said ambient includes 1% to 100% by volume deuterium gas." Lisenker discloses this additional limitation with specific examples of 50% deuterium and "pure" (100%) deuterium. Ex. 1006, 6, ll. 16-22.

6. Claim 6

Claim 6 depends from claim 1 and additionally recites that the "ambient comprises deuterium gas and one or more of hydrogen, nitrogen, argon, and helium gas." Lisenker discloses this additional limitation wherein the ambient is a mixture of deuterium gas (D_2) and nitrogen gas (N_2). Ex. 1006, 8, l. 37 – 9, l. 1.

7. Claim 7

Claim 7 depends from claim 1 and additionally recites "wherein said insulative layer comprises an oxide or nitride of silicon." Lisenker discloses this additional limitation wherein the insulative layer is silicon dioxide. Ex. 1006, 4, ll. 20-27.

8. Claim 8

Claim 8 depends from claim 1 and additionally recites "annealing said device at a temperature of at least about 400º C." Lisenker discloses this additional limitation wherein the temperature is about 500º C. Ex. 1006, 9, l. 21.

D. Claims 1-8 As Obvious Over Lisenker In View Of Ito

Micron relies on Ito as providing an express teaching of the thickness limitations required by independent claims 1 and 2. Pet. 21. Dr. Reed testified that, at the time of filing the ’533 patent, it would have been apparent to a person of ordinary skill in the art to employ insulating layers as small as 30 Angstroms in Lisenker, as taught by Ito. Ex. 1001 ¶¶ 43-44. The University does not dispute that testimony but merely argues that “Ito’s teachings regarding thickness do not solve for the deficiencies associated with the afore-discussed deficiencies of the Lisenker reference.” PO Resp. 16.

Micron has made a prima facie case that the subject matter of claims 1-8 would have been obvious over Lisenker in view of Ito.

E. Claims 1-8 As Obvious Over Deal In View Of Lisenker

Micron asserts that Deal teaches the subject matter of claim 1 except that Deal employs hydrogen for the post-metal anneal instead of deuterium. Pet. 25-27. We agree, *see* Ex. 1009, col. 9, ll. 46-51, and we note that the University has not disputed the asserted teachings of Deal. PO Resp. 16-17.

Micron next asserts that it would have been obvious for a person of ordinary skill in the art at the time of the invention of the ’533 patent to modify Deal to employ deuterium instead of hydrogen as taught by Lisenker. Dr. Reed testified:

> At the time of the priority date of the ’533 patent, the benefits of substituting deuterium for hydrogen were known. As I have discussed previously, Lisenker teaches the substitution of deuterium for hydrogen and states that such a substitution results in “bonds that are less likely to break when exposed to electrical stresses,” which improves device “stability, quality, and reliability.” [Ex. 1006, 5, ll. 2-5.] It would have been

> apparent to incorporate the teachings of Lisenker with the ’380 patent [Deal] because both references are directed to improving the quality of the Si/SiO_2 interface, which has a direct impact on the device quality. Lisenker suggests that “any hydrogen containing material used in VLSI fabrication can be replaced with corresponding deuterium containing material,” [Ex. 1006, 4, ll. 32-34] which would include the ’380 patent’s post-metallization anneal.

Ex. 1001 ¶ 50.

In opposing this ground of unpatentability, the University merely relies on its prior arguments regarding Lisenker. PO Resp. 16-17. However, the argument that Lisenker is limited to pre-metal annealing and, thus, results in no increase in deuterium at the interface is misplaced here (in addition to being erroneous). It is Deal, and not Lisenker, that is relied on for its teaching of post-metal annealing. That teaching is undisputed. And, as Dr. Reed testified, Lisenker suggests to the person of ordinary skill in the art to modify Deal’s post-metal anneal by substituting deuterium for hydrogen.

Micron has made a prima facie case that the subject matter of claims 1-8 would have been obvious over Deal in view of Lisenker.

F. Claims 1-8 As Obvious Over Deal In View Of Ito and Lisenker

Micron relies on Ito as providing an express teaching of the thickness limitations required by independent claims 1 and 2. Pet. 43. Dr. Reed testified that, at the time of filing the ’533 patent, it would have been apparent to a person of ordinary skill in the art to employ in Deal (as modified by Lisenker above) insulating layers as small as 30 Angstroms, as taught by Ito. Ex. 1001 ¶¶ 47-48. In opposition, the University does not dispute that testimony but merely argues that “[f]or the reasons set forth []

above, this combination does not render the subject claims obvious." PO Resp. 17.

Micron has made a prima facie case that the subject matter of claims 1-8 would have been obvious over Deal in view of Ito and Lisenker.

G. Objective Indicia

The University argues that certain objective indicia, or secondary considerations, demonstrate non-obviousness of the claims. *See Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966) ("Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy."). In particular, the University argues that the claimed invention of the '533 patent yielded unexpected results and that others failed to eliminate hot carrier effects. PO Resp. 4-8.

The University's evidence of unexpected results is not persuasive because it does not compare the results of the claimed invention of the '533 patent to the closest prior art, which is Lisenker. *See* PO Resp. 4-7; *In re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed. Cir. 1991) ("[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art."). Lisenker expressly discloses that "deuterium containing devices of the present invention have improved stability, quality, and reliability" relative to those containing hydrogen. Ex. 1006, 5, ll. 4-5. Thus, when properly considering Lisenker, the beneficial results of substituting deuterium for hydrogen are expected. *See In re Skoner*, 517 F.2d 947, 950 (CCPA 1975) ("Expected beneficial results are evidence of obviousness of a claimed invention. Just as unexpected beneficial results are evidence of unobviousness.")

With respect to the alleged failure of others, the University argues that the "continued use [in the prior art] of hydrogen passivation reflects a systemic failure in the art to solve the problem faced by the inventors of the '533 patent[.]" PO Resp. 8. Thus, the University fails to account for the prior art teachings of Lisenker, which had proposed already the substitution of deuterium for hydrogen during passivation, and indeed, throughout the VLSI fabrication process.

Having considered all of the evidence, including Patent Owner's secondary considerations evidence, we conclude that the claims would have been obvious.

CONCLUSION

Petitioner, Micron, has demonstrated by a preponderance of the evidence that claims 1-8 of the '533 patent are unpatentable under 35 U.S.C. § 103: (1) as obvious over Lisenker; (2) as obvious over Lisenker in view of Ito; (3) as obvious over Deal in view of Lisenker; and (4) as obvious over Deal in view of Lisenker and Ito.

ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1-8 of the '533 patent are CANCELLED.

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