

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,
Petitioner,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner

Case IPR2018-01487
Patent 7,800,165

**PATENT OWNER'S PRELIMINARY RESPONSE
UNDER 37 C.F.R. §42.107**

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Pursuant to 37 C.F.R. §42.107, Patent Owner Godo Kaisha IP Bridge 1 (“Patent Owner”) submits this Preliminary Response to the above-captioned Petition for *Inter Partes* Review (“Pet.,” Paper 1) of U.S. Patent No. 7,800,165 (“the ’165 patent”) (Ex. 1003) challenging independent claim 13, 18 and 19, and dependent claims 14-17 (“challenged claims”), which should be denied institution in its entirety.

I. INTRODUCTION

The Petition fails to show that the prior art references teach each feature of the challenged claims, and thus institution should be denied. In particular, none of the Petitioner’s proposed grounds discloses or renders obvious both “a plurality of semiconductor regions of a first conductivity type” and impurity regions “of a second conductivity type formed in ... each of the plurality of semiconductor regions” as required by claims 13-17. Similarly, none of Petitioner’s proposed grounds discloses or renders obvious both a “first semiconductor region of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... the first semiconductor region” as required by independent claims 18 and 19. This deficiency is particularly noticeable given that these very limitations were added during prosecution, and were identified by Applicant as missing from the art raised by the Examiner. At best, all Petitioner has shown is that the prior art it has raised

in the Petition suffers from the same deficiencies as the art already considered during prosecution.

Moreover, the Petition also includes numerous instances where attorney argument or statements in the supporting Shanfield declaration (Ex. 1001) are presented without any “underlying facts or data” on which they are based, in violation of 37 C.F.R. § 42.65(a).

To justify institution of an *inter partes* review, Petitioner must show “that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. §314(a). Here, Petitioner has failed to meet its burden. If the Board nonetheless institutes trial on the challenged claims, Patent Owner will address in detail in its §42.120 Response the numerous substantive errors and shortcomings that underlie each of Petitioner’s arguments and its purported evidence, including the many reasons why Petitioner’s proposed combinations are not obvious as well as why Petitioner’s proposed combinations do not meet all of the claim limitations.

In this paper, however, where any testimonial evidence raising an issue of material fact “will be viewed in the light most favorable to the petitioner” (§42.108), Patent Owner addresses only Petitioner’s failure to demonstrate that the prior art of record discloses or renders obvious semiconductor region(s) of a first conductivity type and impurity regions of a second conductivity type formed in the semiconductor

region(s), as recited by the challenged independent claims. Institution should thus be denied pursuant to Section 314(a).

II. THE CLAIMED INVENTION OF THE '165 PATENT

The '165 patent is directed to a semiconductor transistor with a three-dimensional “fin” structure that exhibits superior electrical characteristics. The inventors studied the reasons why conventional three-dimensional fin-shaped field effect transistors (FETs) had sub-optimal performance. Ex. 1003, 3:3-7. As a result of their efforts, the inventors identified a fundamental problem with how traditional fabrication techniques would create a conductive material by introducing dopants primarily at the top of the fin structure of the transistor. *See id.*, 3:3-55. This problem is illustrated in the '165 patent by Figures 18A and 18B:

FIG. 18A
PRIOR ART

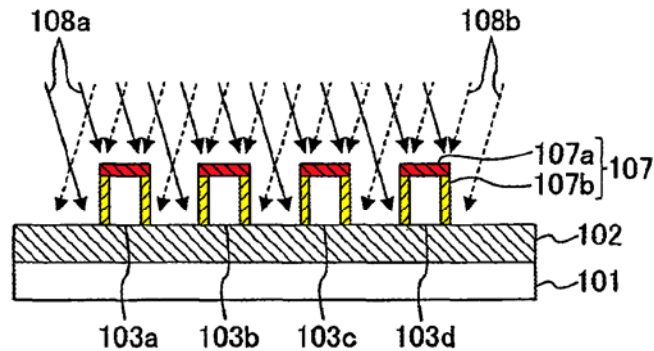
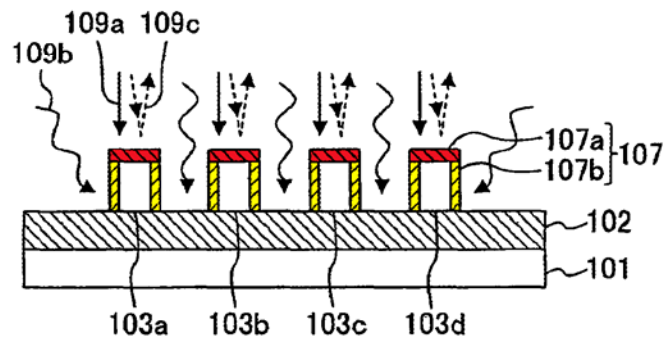


FIG. 18B
PRIOR ART



Id., Figs. 18A, 18B (highlighting added).¹

In the technique shown in Figure 18A, ion implantation is performed at multiple angles relative to the vertical direction in order to dope the sides of the fin-shaped region, in addition to the tops. *Id.*, 3:19-27. For example, the left side of each fin is doped by ions 108a angled to the right, and the right side of each fin is doped by ions 108b angled to the left. *Id.* This creates impurity region 107b (shown in yellow) on the sides of each fin. However, the upper surface of each fin is exposed

¹ All emphasis, annotations and color have been added unless otherwise noted.

to both sets of ions, creating impurity region 107a (shown in red). In Figure 18A the resulting “implantation dose of the first impurity region 107a is twice as large as the implantation dose of the second impurity region 107b.” *Id.*, 3:27-37.

Figure 18B illustrates how a similar phenomenon can occur when using plasma doping to create a conductive fin. *Id.*, 3:38-41. In conventional plasma doping, the implantation dose that creates the upper impurity region 107a (shown in red) “is dictated by the balance between implanted ions 109a, an absorbed species . . . 109b, and an impurity 109c that is desorbed from the fin-shaped semiconductor regions 103a to 103d by sputtering.” *Id.*, 3:41-49. By comparison, the side portions of the fin are shielded from the implantation and sputtering effects, and the implantation dose that creates the impurity region 107b (shown in yellow) is “mainly dictated by the absorbed species 109b.” *Id.*, 3:49-54. The inventors of the ’165 patent noted that, when this technique is used, “the implantation dose of the first impurity region 107a is higher than that of the second impurity region 107b by about 25%.” *Id.*, 3:54-57.

Moreover, in both conventional systems, the ions penetrate deeper into the top of the device, and the resulting “junction depth of the second impurity region 107b” on the side of the device “is shallower than that of the first impurity region 107a” on the top of the device. *Id.*, 3:64-66. Both of these effects—the greater implantation doses and the greater junction depths—lead to most of the current flowing through

the upper portion of the fin, rather than the sides, where the resistivity is higher than in the upper portions. *Id.*, 4:20-25. The inventors of the '165 patent recognized that this leads to inferior performance overall, reduced efficiency, and device degradation. *See e.g., id.*, 2:59-67, 4:20-25, 4:49-64, 5:8-15, 9:18-28.

The '165 patent addresses the undesirable consequences of conventional systems by forming a structure in which the resistivity of impurity region on the side of a fin structure is substantially equal to or smaller than the resistivity of the impurity region in the upper portion of the fin structure. *See, id.*, 4:43-64, 26:64-27:8, 28:11-23, 28:40-65. In this structure, the conductivity type of the impurity regions is opposite to the conductivity type of the semiconductor region where the impurity regions are formed. *See, e.g., id.*, 15:42-48. In an exemplary embodiment, the '165 patent achieves this by initially forming an “n-type fin-shaped semiconductor region 13b.” *See id.*, 13:31-33. Then, the fin-shaped semiconductor region 13b is doped with an opposite “p-type impurity” in a multi-step plasma doping process, alternating between a high concentration plasma for a short period of time, followed by a low concentration plasma for a long period of time. *See id.*, 13:52-55, 14:3-13, 14:38-46. Although this embodiment uses an underlying n-type fin-shaped semiconductor region with opposite p-type impurity regions, the '165 patent notes that a similar result can be achieved using a p-type fin-shaped

semiconductor with opposite n-type impurity regions. *Id.*, 15:42-48. The resulting device is illustrated by Figure 1:

FIG. 1C

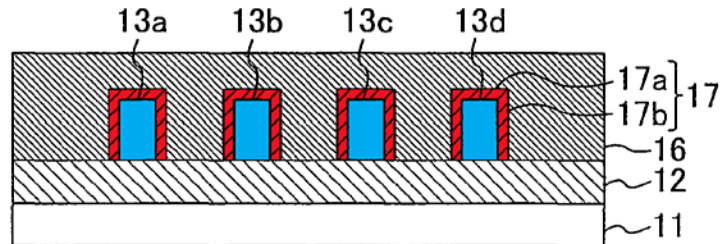
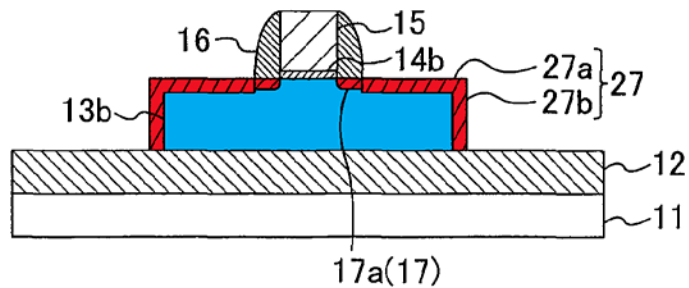


FIG. 1D



Id., Figs. 1C, 1D (highlighting added). Thus, as shown, impurity regions 17 and 27 of a second conductivity type (shown in red) are formed in each of the semiconductor regions 13a, 13b, 13c and 13d of a first conductivity type (shown in blue). *Id.*, 11:31-43. As a result, “the implantation dose of [an impurity region] formed in the side portion of the fin-shaped semiconductor region 13b is substantially equal to or greater than that of the [impurity region] formed in the upper portion of the fin-shaped semiconductor region.” *Id.*, 15:10-16, 15:23-33. Thus, the resistance of the impurity region on the side of the fin structure is less than or equal to the resistance of the impurity region on the top. *Id.*, 15:16-23, 15:34-41. The challenged claims cover this advantageous structure, and include one or more semiconductor regions

of a “first conductivity type” (regions 13a, 13b, 13c and 13d in blue) and one or more impurity regions of a “second conductivity type” (regions 17 and 27 in red) formed in the upper and side portions of each semiconductor region, with a resistance of the impurity region in the side portion being “substantially equal to or smaller” than the resistance of the impurity region in the upper portion of the semiconductor region. *Id.*, 26:64-27:8, 28:11-23, 28:40-65.

III. FILE HISTORY

The '165 patent was filed on February 4, 2008 as U.S. Application No. 12/025,504 (“the '504 application”). Ex. 1004, 95-97. The '165 patent is a continuation of PCT/JP2008/050253 filed January 11, 2008, and claims priority to JP 2007-011572 filed on January 22, 2007. Originally filed claim 1 required, among other things, a “first semiconductor region,” and impurity regions “of a first conductivity type.” *Id.*, 68. Similar limitations were recited by pending independent claims 13, 31, 32 (issued claim 13, 18, and 19). *Id.*, 70, 74-75. Notably, the original claims did not specify that the first semiconductor region had any particular conductivity type. *Id.*, 68, 70, 74-75.

The Patent Office issued a restriction requirement on July 20, 2009, identifying a first group of claims directed to a semiconductor device, and a second group of claims directed to a method of manufacturing a semiconductor device. *Id.*,

257-58. On August 17, 2009, Applicant elected to pursue the first group, consisting of pending claims 1-17, 32 and 33 (issued claims 1-17, 18, and 19). *Id.*, 260-61.

On December 29, 2009, the Patent Office rejected pending claims 1-17, 32, and 33 of the '504 application as being obvious in view of Matthew. *See id.*, 264-265. In response, Applicant amended independent claim 1 to specify that the “first semiconductor region” was “of a first conductivity type,” and that the impurity regions were of a “second conductivity type . . . and made of a semiconductor.” *Id.*, 285 (underlined language added by amendment). Similar modifications were made to independent claims 13, 32 and 33 (issued claims 13, 18 and 19). *See id.*, 288, 293-94. Moreover, Applicant argued that Matthew does not disclose a second conductivity type different than the first conductivity type, and thus, does not disclose the claimed impurity regions and semiconductor region of pending independent claims 1, 13, 32 and 33 (issued claims 1, 13, 18, and 19). *Id.*, 295-96.

The Patent Office subsequently allowed the claims on June 16, 2010, which are renumbered as claims 1-19 in the issued '165 patent. *See id.*, 310-12, 318.

IV. CLAIM CONSTRUCTION

The '165 patent will not expire until 2028. As such, the broadest reasonable interpretation of the claims in light of the specification should be applied in this IPR in accordance with 37 C.F.R. §42.100(b) (effective May 2, 2016). Patent Owner reserves further discussion of claim construction as may be appropriate for its 37

C.F.R. §42.120 Patent Owner Response if any trial is instituted, or as may arise in another proceeding.²

V. THE REFERENCES DO NOT DISCLOSE OR RENDER OBVIOUS SEMICONDUCTOR REGION(S) “OF A FIRST CONDUCTIVITY TYPE” AND IMPURITY REGIONS “OF A SECOND CONDUCTIVITY TYPE FORMED IN ... [THE] SEMICONDUCTOR REGION[S]”

As discussed above, as a result of Applicant’s amendment to overcome art during prosecution, independent claims 18 and 19 of the ’165 patent require a “first semiconductor region of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region.” Ex. 1003, 28:40-65. Similarly, independent claim 13 of the ’165 patent requires “a plurality of semiconductor regions of a first conductivity type” and impurity regions “of a second conductivity type formed in ... [the] semiconductor regions.” *Id.*, 28:11-23. Petitioner attempts to brush aside these limitations in its discussion of the prosecution history, simply asserting that Applicant’s election of claims directed to

² While the final rule issued by the Department of Commerce applies only to “IPR . . . petitions filed on or after the effective date” of November 13, 2018, should the recent change to the *Phillips* standard of claim interpretation impact this proceeding, Patent Owner reserves its right to argue claim constructions under the new standard. 83 Fed. Reg. 51,340 (October 11, 2018).

a semiconductor device “is notable because the Applicant chose to focus prosecution on minor structural attributes that allegedly improved upon the prior art considered by the Examiner.” Pet., 21. Petitioner’s attempt to downplay the limitations added during prosecution is notable because, as discussed below, these are the very limitations that are not disclosed or rendered obvious by the art in Petitioner’s grounds, and which Petitioner asserts are rendered obvious without any support beyond conclusory statements by its expert. Indeed, where the art in the Petition addresses the use of semiconductor regions of a first conductivity type and impurity regions of a second conductivity type, that art teaches that the impurity regions are **not** to be formed in the semiconductor regions, directly contrary to the claims.

Petitioner raises the following grounds:

Ground	Claims	Proposed Rejection
1	13-14, 16-19	§ 103: Doyle ’862 in combination with Chau
2	13-19	§ 103: Goktepli in combination with Chau

But none of the references relied on by Petitioner discloses or renders obvious one or more semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s].” Doyle ’862 and Goktepli fall prey to the same deficiency: the alleged “semiconductor region” identified by Petitioner does not have a conductivity type that is different from the conductivity type of the purported “impurity” regions,

which are thus not formed in semiconductor region(s) of the first conductivity type. Additionally, the Chau reference fails to disclose impurity regions of “a second conductivity type formed in ... semiconductor region[s]” of the first conductivity type, and in fact teaches that the impurity regions of a second conductivity type are to be formed in a region that is separate from semiconductor regions of a first conductivity type. Accordingly, the references do not disclose one or more semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s]” as required by independent claims 13, 18, and 19. Because all of the other challenged claims (*i.e.*, claims 14-17) depend from claim 13, the Petition should be denied based on the failure of the prior art to disclose this limitation.

A. Doyle '862 and Chau Do Not Disclose or Render Obvious One or More “Semiconductor Regions of a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”

Petitioner has not demonstrated that Doyle '862, alone or in combination with Chau, teaches or renders obvious both one or more semiconductor regions “of a first conductivity type,” and “impurity regions of a second conductivity type formed in” the semiconductor region(s) as recited by independent claims 13, 18, and 19 of the '165 patent. Ex. 1003, 28:11-23, 28:40-65. Petitioner's theories of how Doyle '862 in combination with Chau renders obvious these limitations depend on either Doyle '862 rendering obvious these features of independent claim 13 or

disclosing these features in claims 18 and 19 (though Petitioner never even attempts to show that Doyle '862 actually discloses these features) (Pet., 35, 38, 40, 54) or Chau disclosing or rendering obvious these features in the context of independent claim 13.³ *Id.*, 35. The failure of Doyle '862 to disclose or render obvious one or more semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s]” and the failure of Chau to disclose or render obvious impurity regions “of a second conductivity type formed in ... each of the plurality of semiconductor regions” is thus fatal to Petitioner’s first ground with respect to all challenged claims.

1. Doyle '862 Does Not Disclose or Render Obvious Semiconductor Regions of “a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”

With respect to claims 18-19, Petitioner’s arguments that Doyle '862 discloses the “conductivity type” limitations fail because Petitioner never attempts to show that Doyle '862 actually discloses these limitations. Rather, Petitioner merely points back to its analysis of claim 13, where Petitioner asserts only that Doyle '862 renders obvious these limitations. Pet., 54 (citing Pet., 33-34, 38, 40).

³ Petitioner does not rely on Chau in connection with independent claims 18 and 19. Pet., 54-56. Even if Petitioner had relied on Chau for the impurity region limitations, it would have failed for the same reasons.

Petitioner's obviousness arguments with respect to claim 13 also fail. With respect to the "first conductivity type" limitation in claim 13, Petitioner asserts that Doyle '862 alone renders obvious that the silicon fin 115 (the alleged "semiconductor region") is of a first conductivity type. *Id.*, 35. Petitioner then asserts that Doyle '862 discloses that "source and drain regions are typically doped" with p-type or n-type impurities, and asserts that "[a] POSITA would have known that **before** doping the source-drain regions with P-type or N-type impurities, the silicon fin would first be lightly doped with the **opposite** impurity type to create a channel region of the opposite conductivity type." *Id.*, 35 (emphasis in original). But the only material cited to support this assertion (Section VI.A.4 of the Petition, and paragraph 200 of the Shanfield declaration (Pet., 35)) does not actually support Petitioner's statement that Doyle '862 alone renders obvious the alleged first semiconductor region being "of a first conductivity type," as discussed in more detail below.

Moreover, with respect to the "second conductivity type" limitation in claim 13, because Petitioner has failed to show that Doyle '862 discloses or renders obvious the first semiconductor region of a first conductivity type, it has also failed to show both that the alleged impurity regions in Doyle '862 have a second conductivity type (*i.e.*, a conductivity type different than the conductivity type of the semiconductor region) and that these impurity regions are "formed in" a

semiconductor region of the first conductivity type. Petitioner makes similar conclusory statements that “Doyle ’862 renders obvious these first and second impurity regions are of a second conductivity type,” and repeats the assertion that “a POSITA would have known that the fin was initially lightly doped with ions of a first conductivity type, followed by doping of the source-drain regions with ions of a second conductivity type.” Pet., 40; *see also* Pet., 38. But here, Petitioner again cites Section VI.A.4 of the Petition itself, cross-references its prior discussion of the “semiconductor region” limitation, and points to paragraph 206 of the Shanfield declaration (Pet., 38), none of which supports Petitioner’s assertion of obviousness, as discussed below.

As the Federal Circuit has repeatedly emphasized, “references to ‘common sense’—whether to supply a motivation to combine or a missing limitation—cannot be used as a wholesale substitute for reasoned analysis and evidentiary support, especially when dealing with a limitation missing from the prior art references specified.” *DSS Tech. Mgmt., Inc. v. Apple Inc.*, 885 F.3d 1367, 1374 (Fed. Cir. 2018) (citation omitted) (holding that Petitioner’s expert testimony does not constitute substantial evidence capable of supporting a Board finding of obviousness); *see also Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1363 (Fed. Cir. 2016), *cert. denied sub nom. Google Inc. v. Arendi S.A.R.L.*, 137 S. Ct. 1329, 197 L. Ed. 2d 517 (2017) (“In cases in which ‘common sense’ is used to supply a missing

limitation, as distinct from a motivation to combine, moreover, our search for a reasoned basis for resort to common sense must be searching. And, this is particularly true where the missing limitation goes to the heart of an invention.”).

(a) **The Shanfield Declaration Does Not Establish That Doyle ’862 Renders Obvious a “Semiconductor Region of a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”**

The portions of the Shanfield declaration relied on by Petitioner for the assertion that Doyle ’862 renders obvious that the silicon fin 115 is of a first conductivity type, or that the impurity regions would be of a second conductivity type formed in a semiconductor region of the first conductivity type, are a collection of conclusory statements unrelated to Doyle ’862 and unsubstantiated by any supporting evidence. Accordingly, these portions of the declaration should be given no weight. *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01587, Pap. 8 at 27 (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”); 37 C.F.R. §42.65(a) (same).

Moreover, Petitioner’s reliance on conclusory statements from expert testimony—rather than disclosure in the prior art references—is precisely the type of “evidence” that the Federal Circuit has rejected as insufficient, and is explicitly discounted by the Board’s own regulations. *See, e.g., Arendi*, 832 F.3d at 1366

(noting “conclusory statements and unspecific expert testimony” were insufficient to support a finding that a missing limitation was obvious); *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016) (“To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements.”); *In re Am. Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1368 (Fed. Cir. 2004) (“[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration warrants discounting the opinions expressed in the declarations.”).

For example, in *Fedex Corp. v. Intellectual Ventures II LLC*, the Board denied institution where the petitioner relied on its expert declaration to show that a missing limitation not explicitly disclosed by the art was “common and well-known,” and therefore obvious. IPR2017-00750, Pap. 7 at 15. The Board noted that the expert “merely repeat[ed] [the Petitioner’s] argument in his testimony, without explaining sufficiently the basis for it,” and his opinion was therefore entitled to little weight. *Id.* Moreover, the Board reaffirmed this decision when denying rehearing, noting that the Federal Circuit has warned common sense “cannot be used as a wholesale substitute for reasoned analysis and evidentiary support, especially when dealing with a limitation missing from the prior art references specified,” and similar to *Arendi* and *K/S Himpp v. Hear-Wear Techs., LLC*, 751 F.3d 1362 (Fed. Cir. 2014) the conclusory testimony provided by the expert “does not rise to the level of a

‘searching’ reasoned basis” needed to supply a missing limitation through common sense alone. *FedEx Corp.*, IPR2017-00750, Pap. 9 at 6-7.

Similarly, here, Petitioner cites only paragraph 200 of the Shanfield declaration for the assertion that Doyle ’862 renders obvious the first semiconductor region is of a first conductivity type. Pet., 35. Paragraph 200 discusses the fin (*i.e.*, the purported semiconductor region) disclosed by Doyle ’862, and states in its entirety that:

As previously discussed, bulk doping was a common method for addressing the problem of leakage current in FinFETs. In order to bulk dope, the entire fin was first implanted with the opposite type dopant as the final transistor type. For example, for an NMOS FinFET, the entire fin is first implanted with a p-type dopant. Thus, the silicon fin is formed of a first conductivity type. The purpose of the initial doping is to prevent current leakage from source/drain regions formed later in the process. Any such current leakage could leak into the substrate and affect nearby FinFETs formed on the same substrate.

Ex. 1001, ¶200. Dr. Shanfield provides no support for the assertions made in this paragraph, and thus, his opinions are entitled to little or no weight.

To the extent that Dr. Shanfield is referring back to his discussion of “bulk doping” in paragraphs 43-44 of his declaration with his vague references in paragraph 200, these paragraphs, like paragraph 200, merely make bald assertions without any support. In particular, in these paragraphs, Dr. Shanfield makes the unsupported assertions that “[l]eakage current can be a problem in FinFETS” and that “[o]ne common method for addressing the problem of leakage current, as well

as setting the doping type in the channel region, is ‘bulk’ doping. ... For example, to form an NMOS FinFET, before the source and drain regions are doped with n-type dopants, the entire fin is first doped with p-type dopant.” Ex. 1001 ¶¶43-44. And the discussion simply concludes by asserting, without evidence, that “[a]ll of the structures and concepts described up above were well known in the art by January 22, 2007.” *Id.*, ¶45. In short, Dr. Shanfield offers pure argument, with no supporting evidence, and thus his opinions are entitled to little or no weight.

With respect to the impurity regions of the second conductivity type, Petitioner relies only on paragraph 206 of Dr. Shanfield’s declaration. Pet., 40. But paragraph 206 is similarly devoid of substantiating evidence. *See* Ex. 1001, ¶206. In particular, the only support Dr. Shanfield provides for his assertion that “Doyle ’862 further renders obvious that the first and second impurity regions are of a second conductivity type” formed in a semiconductor region(s) of the first conductivity type is his assertion that “[a]s previously discussed, a POSITA would have known that the fin would first be doped to a first conductivity type. The first and second impurity regions would then be doped to a second conductivity type, of the same type as the overall transistor.” *Id.* Again, this appears to be a reference to the “bulk doping” discussion in paragraphs 43-44 of Dr. Shanfield’s declaration, which, as discussed above, provides no support for the assertion that the source and drain regions would have a different conductivity type than the silicon fin 115 that Petitioner alleges to

be the first semiconductor region. Accordingly, Dr. Shanfield's assertions in paragraph 206 of his declaration are similarly entitled to little or no weight.

Because the portions of the Shanfield declaration cited by the Petition are simply bare assertions, unsupported by underlying facts, they are insufficient to support Petitioner's assertion that Doyle '862 renders obvious that the silicon fin 115 would be of a first conductivity type, or that the alleged impurity regions would be of a second conductivity type formed in semiconductor region(s) of the first conductivity type.

(b) **Section VI.A.4 of the Petition Does Not Establish That Doyle '862 Renders Obvious a "Semiconductor Region of a First Conductivity Type" and Impurity Regions "of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]"**

Section VI.A.4 of the Petition also fails to support Petitioner's assertions that Doyle '862 renders obvious that the silicon fin 115 would be of a first conductivity type, or that the impurity regions would be of a second conductivity type formed in semiconductor region(s) of the first conductivity type. Section VI.A.4 of the Petition simply provides a general background discussion of PMOS and NMOS transistors, and reiterates the unsupported language in paragraphs 43-44 of the Shanfield declaration about the use of "bulk doping" in FinFET manufacturing being well known. Pet., 11-12. As with paragraphs 43-44 of the Shanfield declaration, the Petition does not cite any evidence that demonstrates that bulk doping was a well-

known practice. *Id.* Rather, Section VI.A.4 points only to the unsubstantiated background section of the Shanfield declaration (and in particular, paragraphs 43-44). *Id.* Thus, Section VI.A.4 of the Petition also does not support Petitioner's assertion that Doyle '862 renders obvious that the silicon fin 115 would be of a first conductivity type, or that the impurity regions would be of a second conductivity type different than the first conductivity type and formed in semiconductor region(s) of the first conductivity type. Pet., 35, 38. Accordingly, Petitioner has failed to show that Doyle '862 renders obvious a semiconductor of a first conductivity type and impurity regions of a second conductivity type formed in the semiconductor region(s) of the first conductivity type.

2. Chau Does Not Disclose or Render Obvious Impurity Regions of “a Second Conductivity Type Formed in ... Each of the Plurality of Semiconductor Regions” of a First Conductivity Type

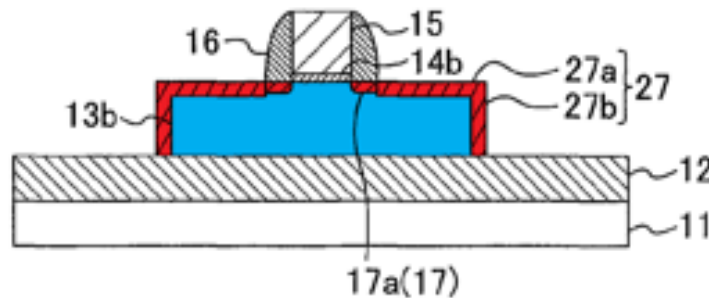
As discussed above, Petitioner does not rely on Chau for claims 18-19. *See* Pet., 54-56. Instead, Petitioner relies on Chau to address claim 13's requirements of a plurality of semiconductor regions. Regardless, Chau fails to fill in the gaps in Petitioner's arguments with respect to all of the challenged claims. With respect to claim 13, Petitioner does not assert that Chau discloses impurity regions of “a second conductivity type formed in ... each of the plurality of semiconductor regions,” but instead asserts only that “[a] POSITA would have found it obvious that each of the plurality of semiconductor regions disclosed by Chau would have a [first/second]

impurity region as disclosed by Doyle '862,” where those impurity regions are “source/drain regions.” Pet. 38, 41. Thus, Petitioner’s obviousness theory depends on the final structure obtained by combining Chau and Doyle '862 having the source/drain regions located in the semiconductor region of a first conductivity type. But, as discussed below (and as Petitioner admits), Chau discloses that the “source/drain regions” are not “formed in” semiconductor regions “of a first conductivity type” because the semiconductor regions “of a first conductivity type” in Chau are located only **between** the “source/drain” regions in Chau. See Pet., 35 (“a POSITA reading Chau would have understood that the region of the semiconductor fin located between the source and drain regions is initially doped to a first conductivity type, where the source and drain are later doped to a second, or opposite conductivity type”).

The difference between the claimed conductivity types and the conductivity types in Chau is shown in the following example illustrations. As illustrated in Figure 1D of the '165 patent, the semiconductor region of a first conductivity type (in blue) is located both below where the source and drain regions of the second conductivity type (in red) are formed, as well as in the channel region between the source and drain regions. Thus, as shown, the source and drain regions 27 include an impurity region 27a “formed in” the top of the semiconductor region of the first

conductivity type, and an impurity region 27b “formed in” the side of the semiconductor region of the first conductivity type.

FIG. 1D



Ex. 1003, Fig. 1D (highlighting added), Ex. 1003, 11:31-43; 15:42-48. By comparison, in the embodiment of Chau relied on by Petitioner, only a channel region 350 of a semiconductor body 308 located “between source region 330 and drain region 332” is “doped to the opposite conductivity type of the source region 330 and drain region 332.” Ex. 1008, ¶24; see Pet., 35. These elements are depicted in Chau’s Figures 3 and 4B, for example:

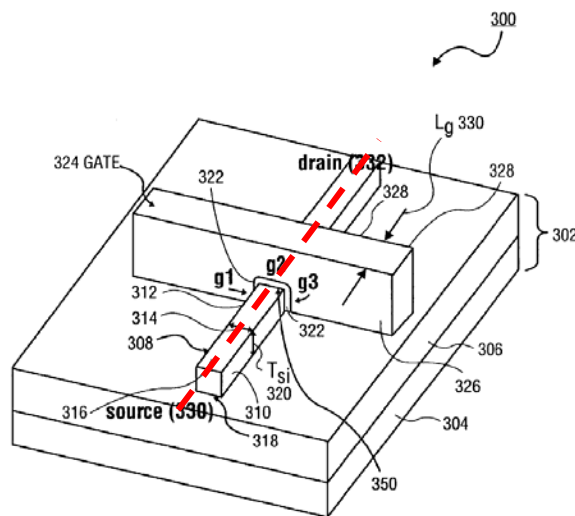


FIG. 3

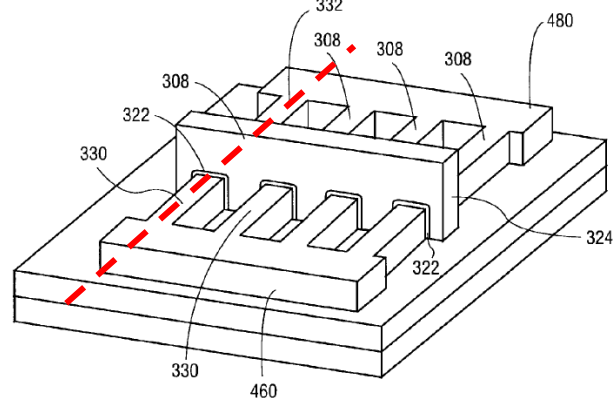
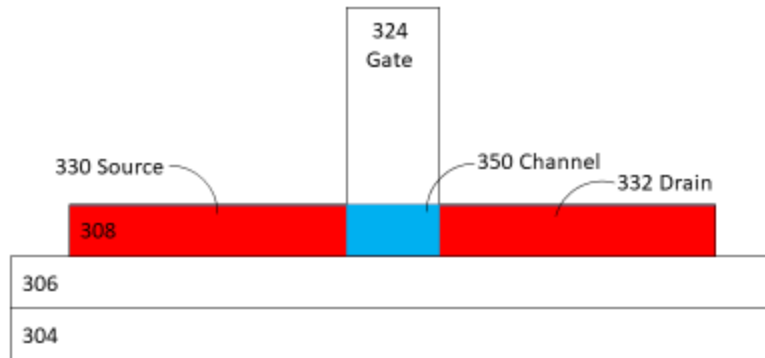


FIG. 4B

Ex. 1008, Figs. 3, 4B (red dotted line added to indicate location of cross-section below). While neither Chau nor Petitioner illustrates the cross-section of these images across the gate 324, the image below depicts such a cross-section after doping the channel, source and drain:



See Ex. 1008, Figs. 3, 4B, ¶24 (“In an embodiment of the present invention, when the channel region is doped it is typically doped to the opposite conductivity type of the source region 330 and the drain region 332.”). Petitioner asserts that “a POSITA reading Chau would have understood that the region of the semiconductor fin located between the source and drain regions is initially doped to a first conductivity type” (shown in blue) and that “the source and drain are later doped to a second, or opposite conductivity type” (shown in red). Pet., 35. Because only the channel region of the semiconductor body (in blue) is doped to a first conductivity type, it is the only “semiconductor region of a first conductivity type” disclosed in Chau. Thus, the source and drain regions (in red) are not “formed in” the semiconductor region of the different conductivity type disclosed in Chau. Petitioner’s description is

consistent with the disclosure of Chau, given that Chau discloses only the region **between** the source and drain regions is ever doped to the first conductivity type.

To the extent that Petitioner is asserting that the entire semiconductor body 308 is doped with the first conductivity type, there is no disclosure in Chau that supports this. For example, Petitioner's reliance on claim 14 of Chau does not fill this hole in Petitioner's argument. *See* Pet., 35. Claim 14 of Chau merely states that "said single crystalline silicon body is doped to a first conductivity type with a concentration of between 1×10^{16} - 1×10^{20} atoms/cm." Ex. 1008, Claim 14. Petitioner makes no attempt to show, how, if at all, claim 14 of Chau relates to paragraph 24 of Chau relied on by Petitioner. Moreover, claim 14 does not disclose that impurity regions of an opposite conductivity type are formed in an upper portion and a side portion of the single crystalline silicon body. Indeed, the only embodiment of Chau that discusses a single crystalline structure with a "conductivity type" is in paragraph 28 of Chau, which is a different embodiment from the embodiment of paragraph 24 of Chau, upon which Petitioner relies for its invalidity theory. In the embodiment described in paragraph 28 of Chau, the single crystalline structure has "the **same** conductivity type as the source region 330 and drain region 332," and thus cannot have a channel region of an **opposite** conductivity type like the embodiment discloses in paragraph 24 of Chau (and cannot have opposite conductivity as required by the challenged claims). *Id.* ¶28, Fig. 4A.

The portion of the Shanfield declaration relied on by Petitioner also does not support an assertion that Chau discloses that the semiconductor bodies 308 (*i.e.*, the purported semiconductor regions) is of a first conductivity type where the source/drain regions are formed. Rather, the sole paragraph relied on by Petitioner (Ex. 1001, ¶201) consists of a conclusory statement that the “fin is of a first conductivity type” followed by a confirmation that Chau discloses only the channel region between the source and drain regions is of a first conductivity type. Indeed, paragraph 201 of the Shanfield declaration states in its entirety that:

Chau likewise discloses that the fin is of a first conductivity type. Chau discloses that the channel region and source/drain regions are doped with dopants of opposite conductivity types. This is done to prevent the electrical state of a nearby FET from affecting the threshold voltage (*i.e.*, “backgating”). If opposite doping was not used, the electrical state of nearby FETs would cause changes in the device threshold voltage.

Ex. 1001, ¶201. The first sentence is the only statement from this paragraph that supports the position that Chau discloses that the fin (beyond just the channel region) is of a first conductivity type, but Dr. Shanfield provides no support for this statement. Rather, Dr. Shanfield goes on to clarify this statement and simply confirms that Chau discloses the channel region is of a first conductivity type, and source and drain regions are of a second conductivity type. The remaining discussion by Dr. Shanfield that there are advantages to doping the channel in Chau simply confirms that the purported semiconductor region of a first conductivity type is located only between the source and drain regions, and that the source and drain

regions are not formed in the semiconductor region of a first conductivity type. Accordingly, the Shanfield declaration does not support Petitioner's assertion that a POSITA would have found it obvious to form source/drain regions of Doyle '862 in the semiconductor region of a first conductivity type found in Chau.

While Petitioner cites back to Section VI.A.4 of the Petition, this Section also fails to support an assertion that Chau discloses that the portions of the semiconductor fin where the source/drain regions are formed are of a first conductivity type. As noted above, Section VI.A.4 of the Petition simply provides a general background discussion of PMOS and NMOS transistors, and reiterates the unsupported language in paragraphs 43-44 of the Shanfield declaration about the use of "bulk doping" in FinFET manufacturing being well known. Pet., 11-12; see §V.A.1.b. Thus, Section VI.A.4 of the Petition also does not support the assertion that Chau discloses or renders obvious that the portions of semiconductor bodies 308 where the source/drain regions are formed would be of a first conductivity type. Nor does it support Petitioner's assertion that "[a] POSITA would have found it obvious that each of the plurality of semiconductor regions disclosed by Chau would have a [first/second] impurity region as disclosed by Doyle '862," where those impurity regions are "source/drain regions." Pet., 38, 41.

* * *

For at least these reasons, Petitioner has failed to demonstrate that Doyle '862, alone or in combination with Chau, teaches or renders obvious semiconductor region(s) “of a first conductivity type,” and impurity regions “of a second conductivity type” formed in the semiconductor region(s), as recited by independent claims 13, 18, and 19 of the '165 patent. Ex. 1003, 28:11-23, 28:40-65. Accordingly, Petitioner has failed to show that the cited references in Ground 1 disclose or render obvious all limitations of independent claims 13, 18, or 19 of the '165 patent, and Petitioner's first ground therefore fails with respect to all challenged claims.

B. Goktepli and Chau Do Not Disclose or Render Obvious One or More “Semiconductor Regions of a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”

Petitioner has not demonstrated that Goktepli, alone or in combination with Chau, teaches or renders obvious both one or more semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in” the semiconductor region(s) as recited by independent claim 13, 18, and 19 of the '165 patent. Ex. 1003, 28:11-23, 28:40-65. Petitioner's theories of how Goktepli in combination with Chau renders obvious these limitations depend on either Goktepli rendering obvious these features of independent claims 13, or disclosing these features in claims 18, and 19 (though Petitioner never even attempts to make this showing) (Pet., 59, 63-64, 82-85) or Chau rendering obvious these

features in the context of independent claim 13.⁴ *Id.*, 59, 64. The failure of Goktepelı to disclose or render obvious one or more semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s],” and the failure of Chau to disclose or render obvious impurity regions “of a second conductivity type formed in ... each of the plurality of semiconductor regions” is thus fatal to Petitioner’s second ground with respect to all challenged claims.

1. Goktepelı Does Not Disclose or Render Obvious Semiconductor Regions of “a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”

Similar to Doyle ’862, with respect to claims 18-19, Petitioner’s arguments that Goktepelı discloses the “conductivity type” limitations fail because Petitioner never attempts to show that Goktepelı actually discloses these limitations. Rather, Petitioner merely points back to its analysis of claim 13, where Petitioner asserts only that Goktepelı renders obvious these limitations. Pet., 82 (citing Pet., 59, 61-63).

Petitioner’s obviousness arguments with respect to claim 13 also fail. With respect to the “first conductivity type” limitation in claim 13 Petitioner asserts that

⁴ Petitioner does not rely on Chau in connection with independent claims 18 and 19. Pet., 54-56.

Goktepelı alone renders obvious that the fin 20 (the alleged “semiconductor region”) is of the first conductivity type. *Id.*, 59. Petitioner does not identify anywhere that Goktepelı supports this assertion, but instead states that “[a]s previously discussed, before doping with P-type or N-type impurities, the silicon fin would first be lightly doped with the opposite impurity type, to prevent electrical interaction between adjacent FETs..” Pet., 59. But the material cited to support this assertion (Section VI.A.4 of the Petition and paragraph 249 of the Shanfield declaration (Pet., 59)) does not support Petitioner’s assertion that Goktepelı alone renders obvious the alleged first semiconductor region being “of a first conductivity type.” See §V.A.1.

Moreover, with respect to the “second conductivity type” limitation in claim 13, because Petitioner has failed to show that Goktepelı discloses or renders obvious the first semiconductor region of a first conductivity type, it has also failed to show both that the alleged impurity regions in Goktepelı have a second conductivity type (*i.e.*, a conductivity type different than the conductivity type of the semiconductor region), and that these impurity regions are “formed in” a semiconductor region of the first conductivity type. Petitioner makes a similar conclusory statement that “Goktepelı renders obvious the first impurity region is of a second conductivity type and made of a semiconductor. (See Section X.B.1.c.)” Pet., 62. Section X.B.1.c of the petition discusses the limitation “a second impurity region of a second

conductivity type,” and makes another conclusory statement that “Goktepelı renders obvious the first and second impurity regions are of a second conductivity type.” Pet., 63. Again, the material cited to support this assertion (Section VI.A.4 of the Petition and paragraph 255 of the Shanfield declaration (Pet., 63-64)) does not support Petitioner’s assertion that Goktepelı renders obvious the alleged impurity regions being “of a second conductivity type” or that the impurity regions are formed in a semiconductor region of the first conductivity type.

(a) **The Shanfield Declaration Does Not Establish That Goktepelı Renders Obvious a “Semiconductor Region of a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”**

The portions of the Shanfield declaration relied on by Petitioner for the assertion that Goktepelı “renders obvious” that the fin 20 is of the first semiconductor type, or that the impurity regions would be of a second conductivity type formed in a semiconductor region of the first conductivity type, are a collection of conclusory statements unrelated to Goktepelı and unsubstantiated by any supporting evidence. Accordingly, these portions of the declaration should be given no weight. *Becton, Dickinson* Pap. 8 at 27; 37 C.F.R. §42.65(a); see §V.A.1.a.

Petitioner cites only paragraph 249 of the Shanfield declaration for the assertion that Goktepelı renders obvious the alleged first semiconductor region is of a first conductivity type. Pet., 65. Paragraph 249 contends that Goktepelı renders

the first and second impurity regions obvious, and repeats the assertion that “a POSITA would have known that the fin would first be doped to a first conductivity type. The first and second impurity regions would then be doped to a second conductivity type, of the same type as the overall transistor.” Ex. 1001, ¶249. No evidence is provided to support these statements, and like the portions of the Shanfield declaration relied upon for these limitations in connection with Doyle ’862, these opinions by Dr. Shanfield are similarly entitled to little or no weight.

To the extent that paragraph 249 is intended to reference paragraph 248 of the Shanfield declaration, this paragraph does not show that Goktepli renders obvious that the alleged first semiconductor region is of a first conductivity type. Pet., 65. Paragraph 248 of the Shanfield is a cut-and-paste copy of paragraph 200 of the Shanfield declaration. *Compare* Ex. 1001, ¶248 *with* Ex. 1001, ¶200. And as with paragraph 200 of the Shanfield declaration (as discussed above in §V.A.1.a), paragraph 248 merely includes a number of conclusory statements about “bulk doping” with no support. Moreover, as with paragraph 200, paragraph 248 appears to cross reference an earlier discussion at paragraphs 43 to 44, where Dr. Shanfield makes a number of unsubstantiated claims about bulk doping being known in the field. *See supra* Section V.A.1.(a). Because Dr. Shanfield provides no support for the assertions made in this paragraph, his opinions are entitled to little or no weight.

Paragraph 255 of the Shanfield declaration contends that Goktepelı renders the first and second impurity regions obvious, and repeats the assertion that “a POSITA would have known that before doping with p-type dopants, the fin would first be bulk doped with dopants of the opposite conductivity type, in order to create a contrast in the conductivity type of the source-drain regions.” Ex. 1001, ¶255. As with Dr. Shanfield’s opinions relating to the first semiconductor region, Dr. Shanfield’s opinions about the doping of impurity regions are simply conclusory statements without any evidence to support them, and thus these opinions are entitled to little or no weight.

Because the portions of the Shanfield declaration cited by the Petition are simply bare assertions, unsupported by underlying facts, they are insufficient to support Petitioner’s assertion that Goktepelı renders obvious that the fin 20 would be of a first conductivity type, or that the alleged impurity regions would be of a second conductivity type formed in semiconductor region(s) of the first conductivity type.

(b) Section VI.A.4 of the Petition Does Not Establish That Goktepelı Renders Obvious a “Semiconductor Region of a First Conductivity Type” and Impurity Regions “of a Second Conductivity Type Formed in ... [the] Semiconductor Region[s]”

As discussed above, Section VI.A.4 of the Petition does not establish that it would have been obvious to form “a semiconductor region of a first conductivity

type” or impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s]” as required by the challenged claims. *See supra* Section V.A.1.(b). Because the discussion in Section VI.A.4 of the Petition is a generic discussion that fails to provide any support for Petitioner’s obviousness analysis under either ground, Petitioner’s reliance on Section VI.A.4 of the Petition also fails to show that Goktepli renders obvious these limitations.

2. Chau Does Not Render Obvious Impurity Regions of “a Second Conductivity Type Formed in ... Each of the Plurality of Semiconductor Regions” of a First Conductivity Type

As discussed above, Petitioner does not rely on Chau for claims 18-19. *See* Pet., 82-85. Instead, Petitioner relies on Chau to address claim 13’s requirements of a plurality of semiconductor regions. Regardless, once again, Chau fails to fill in the gaps in Petitioner’s arguments with respect to all of the challenged claims. In the context of Ground 2, instead of asserting that Chau discloses semiconductor regions of “a first conductivity type” or impurity regions of “a second conductivity type formed in ... each of the plurality of semiconductor regions,” Petitioner asserts only that Chau renders obvious these limitations. Pet., 59, 64. However, while Petitioner asserts that Chau only renders obvious these limitations in the context of Ground 2 (as opposed to Chau actually disclosing the semiconductor regions of a “first conductivity type” in the context of Ground 1), Petitioner’s assertions about why Chau renders obvious this limitation in the context of Ground 2 are *identical* to

its assertions about why it discloses this same limitation in the context of Ground 1.

Compare Pet., 59-60 with Pet., 35.

In the context of Ground 1, Petitioner presents a theory of obviousness based on a POSITA finding it obvious to use the source/drain regions of Doyle '862 in Chau. In the context of Ground 2, Petitioner replaces source/drain regions of Doyle '862 with the source/drain regions of Goktepli. Pet., 62, 65. But as discussed above, Chau discloses (or renders obvious) that only the channel region **between** the source and drain regions has one conductivity type, and the source and drain regions have a different conductivity type. Petitioner has failed to demonstrate that, if the source/drain regions in Goktepli are used in Chau, the resulting structure would include “impurity region[s] of a **second conductivity type** formed in ... [the] semiconductor regions” of a first conductivity type as required by the challenged claims. *See supra*, Section V.A.2.

In connection with its position regarding the conductivity type of the semiconductor bodies in Chau, Petitioner cites paragraph 250 of the Shanfield declaration. Pet., 59-60. But Paragraph 250 of the Shanfield declaration merely repeats the assertion from Paragraph 200 that “Chau likewise discloses that the fin is of a first conductivity type. Chau discloses that the channel region and source/drain regions are doped with dopants of opposite conductivity types.” *Compare* Ex. 1001, ¶250 with Ex. 1001, ¶200. While Dr. Shanfield provides a

different explanation for why the channel region between the source and drain regions must be of a different conductivity type than the source drain region in paragraph 250, he still confirms that Chau merely discloses the conductivity type of the channel region to be of an opposite type as the source and drain regions. As before (see Section V.A.1.a), the Shanfield declaration does not support Petitioner's assertion that a POSITA would have found it obvious to form source/drain regions of Goktepli in the semiconductor region of a first conductivity type found in Chau.

In Ground 2, Peitioner further asserts that Chau itself renders obvious "the first and second impurity regions are of a first [*sic*] conductivity type."⁵ Pet., 64. But this discussion of Chau is identical to the Petition's discussion of Chau in connection with the semiconductor region limitation, but with the introductory sentence replacing the limitation allegedly rendered obvious by Chau. *Compare* Pet., 64 *with* Pet., 59-60. Again, this discussion merely confirms the disclosure of Chau that the semiconductor region of a first conductivity type (*i.e.*, the opposite type from the source and drain doping) is formed only in the channel between the source and drain regions, and not where the impurity regions are formed. The only support that

⁵ Petitioner presumably intended to state that the impurity regions are of a "second" impurity type.

Petitioner points to for this discussion is paragraph 256 of the Shanfield declaration, which states, in its entirety, that:

Chau likewise renders obvious that the first and second impurity regions are of a second conductivity type. Chau explains that the channel region, i.e., the portion of the fin located beneath the gate, is doped to the opposite type as the source-drain regions. A POSITA would have understood that the purpose of doping a channel region to the opposite type as the source-drain regions is to create a more abrupt transition from the channel region doping to the opposite type source-drain doping. This abrupt transition further enhances the ability of the extension region to reduce short channel effects.

Ex. 1001, ¶256. As before, this merely confirms that the channel region in Chau has an opposite conductivity type from the source and drain regions, and that the source and drain regions are not “formed in” a semiconductor region of a first conductivity type. Nowhere does Dr. Shanfield suggest that the first and second impurity regions in Chau are “formed in” a semiconductor region of a first conductivity type.

* * *

For at least these reasons, Petitioner has failed to demonstrate that Goktepli, alone or in combination with Chau, teaches or renders obvious semiconductor regions “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region[s],” as recited by independent claims 13, 18, and 19 of the '165 patent. Ex. 1003, 28:11-23, 28:40-65. Accordingly, Petitioner has failed to show that the cited references in Ground 2 disclose or render

obvious all limitations of independent claims 13, 18, or 19 of the '165 patent, and Petitioner's second ground therefore fails with respect to all challenged claims.

VI. CONCLUSION

Petitioner has failed to demonstrate that any of the cited references teach or render obvious a semiconductor region “of a first conductivity type,” and impurity regions “of a second conductivity type formed in ... [the] semiconductor region” as required by each of the challenged claims. Moreover, Petitioner has tried to paper over this deficiency by relying on arguments presented in their expert declaration, devoid of any substantiating evidence, and entitled to little or no weight. The Petition should thus be denied and no trial instituted because there is no “reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a).

Dated: November 27, 2018

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

The undersigned certifies that the foregoing PATENT OWNER'S PRELIMINARY RESPONSE UNDER 37 C.F.R. §42.107 complies with the type-volume limitation in 37 C.F.R. §42.24(b)(1). According to the word-processing system's word count, the brief contains 8,629 words, excluding the parts of the brief exempted by 37 C.F.R §42.24(c).

Dated: November 27, 2018

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