

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INNOSCIENCE (ZHUHAI) TECHNOLOGY COMPANY, LTD.,
AND
INNOSCIENCE AMERICA, INC.,
Petitioner,

v.

EFFICIENT POWER CONVERSION CORPORATION,
Patent Owner.

IPR2023-01381
U.S. Patent 8,350,294

**PETITIONER'S SUR-REPLY TO PATENT OWNER'S REPLY TO THE
OPPOSITION TO THE MOTION TO AMEND**

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Ex. 1001	U.S. Patent No. 8,350,294 B2 (“the ’294 patent”)
Ex. 1002	Prosecution History of the ’294 Patent (“ <i>Prosecution History</i> ”)
Ex. 1003	Declaration of Dr. James Richard Shealy (“ <i>Shealy</i> ”)
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Ex. 1005	U.S. Patent Application Publication No. US 2007/0164315 A1 to Smith (“ <i>Smith</i> ”)
Ex. 1006	U.S. Patent Application Publication No. US 2008/0087915 A1 to Uemoto (“ <i>Uemoto</i> ”)
Ex. 1007	Japanese Patent Publication No. JP2006-253224 A to Kigami.
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Ex. 1009	Translator’s Declaration for Certified English Translation of JP 2006-253224 A
Ex. 1010	Umesh K. Mishra et al., <i>AlGaIn/GaN HEMTs—An Overview of Device Operation and Applications</i> , Proceedings of the IEEE, vol. 90, no. 6 (June 2002), pp. 1022-1031 (“ <i>Mishra</i> ”)
Ex. 1011	Excerpts of Rüdiger Quay, <i>Gallium Nitride Electronics</i> , vol. 96, Springer Science & Business Media (2008) (“ <i>Quay</i> ”)
Ex. 1012	Excerpts of Stephen J. Pearton et al., <i>Gallium Nitride Processing for Electronics, Sensors and Spintronics</i> , Springer Science & Business Media (2006) (“ <i>Pearton</i> ”)
Ex. 1013	U.S. Patent Application Publication No. US 2004/0012015 A1 to Saxler (“ <i>Saxler015</i> ”)

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Ex. 1014	X. Hu et al., <i>Enhancement mode AlGaIn/GaN HFET with selectively grown pn junction gate</i> , Electronics Letters, vol. 36, no. 8 (2000), pp. 753-754 (“ <i>Hu</i> ”)
Ex. 1015	Excerpts of Chang Soo Suh, Enhancement-Mode GaN-Based HEMTs for High-Voltage Switching Applications (Dec. 2008) (Ph.D. dissertation, University of California, Santa Barbara) (“ <i>Suh</i> ”)
Ex. 1016	U.S. Patent Application Publication No. US 2005/0145874 A1 to Saxler (“ <i>Saxler874</i> ”)
Ex. 1017	Chris G. Van de Walle et al., “Hydrogen in III-V Nitrides,” <i>Semiconductors and Semimetals</i> , vol. 57 (1998), pp. 157-184 (“ <i>Van de Walle</i> ”)
Ex. 1018	Shuji Nakamura et al., <i>Hole Compensation Mechanism of P-Type GaN Films</i> ,” Japanese Journal of Applied Physics, vol. 31 (1992), pp. 1258-1266 (“ <i>Nakamura</i> ”)
Ex. 1019	Complainant’s Proposed Constructions & Respondents’ Proposed Constructions in related International Trade Commission investigation: <i>In the Matter of Certain Semiconductor Devices, and Methods of Manufacturing Same and Products Containing the Same</i> , Inv. No. 337-TA-1366, dated September 5, 2023 (“ <i>ITC Constructions</i> ”)
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Ex. 1024	Excerpts of Vasco Matias, Defect characterization of Europium implanted Gallium Nitride (2008) (Ph.D. dissertation, KU University, Belgium) (“ <i>Matias</i> ”)
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Ex. 1032	Exhibit RX-0255 in Inv. No. 337-TA-1366. Book: E. Fred Schubert. Doping in III-V semiconductors. AT&T Bell Laboratories, New Jersey. (1993)
Ex. 1033	Supplemental Reply Declaration of James Richard Shealy, Ph.D., Dated September 3, 2024.
Ex. 1034	Excerpts of Revised and Corrected Transcript, Open Sessions, Inv. No. 337-TA-1366
Ex. 1035	Taiwanese Patent Publication No. TW200414540 A to Sheu

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Ex. 1036	Certified English Translation of Taiwanese Patent Office Publication No. TW200414540A (“ <i>Sheu</i> ”)
Ex. 1037	Translator’s Declaration for Certified English Translation of TW200414540A
Ex. 1038	C. S. Suh et al., “p-GaN/AlGaIn/GaN Enhancement-Mode HEMTs,” 2006 64th Device Research Conference, June 2006, pp. 163-164 (“ <i>Suh2006</i> ”)
Ex. 1039	Supplemental Declaration of James Richard Shealy, Ph.D. in Support of Petitioner’s Opposition to Patent Owner’s Motion to Amend (“ <i>ShealyOpp.</i> ”), dated September 4, 2024
Ex. 1040	U.S. Patent Publication No. 2006/1045189 A1 to Beach et al. (“ <i>Beach189</i> ”)
Ex. 1041	Beach Jr, Robert Andrew. Column III nitride growth, characterization and devices. California Institute of Technology, 2001 (“ <i>BeachThesis</i> ”)
Ex. 1042	Transcript of Conference Call with the Board, taken on November 14, 2024
Ex. 1043	Meneghini, M., et al. “GaN-based lateral and vertical devices.” Springer Handbook of Semiconductor Devices (2022): 525-578.
Ex. 1044	Hidayat, H. et al. “Exploring the impact of AlGaIn barrier thickness and temperature on normally-on GaN HEMT performance.” Engineering Research Express 6.2 (2024): 025307
Ex. 1045	Excerpts of Daintith, John, ed. <i>A dictionary of chemistry</i> . Sixth Edition. OUP Oxford, 2008: p. 290
Ex. 1046	Excerpts of McGraw-Hill Dictionary of Chemistry, 2nd ed.; McGraw-Hill: New York, 2003; p. 26

Exhibit	Description
Ex. 1047	Excerpts of S. Hamady, “New concepts for normally-off power gallium nitride (GaN) high electron mobility transistor (HEMT),” Ph.D. dissertation, Dept. Micro Nanotechnol./Microelectron., Universite Toulouse III Paul Sabatier, Toulouse, France, 2015
Ex. 1048	Excerpts of Modolo, Nicola. “Physics-Based Compact Model for p-GaN/AlGaN/GaN Application: Understanding of Degradation After Gamma-Ray Irradiation.” Universita Degli Studi Di Padova, Padova, Italy (2019).

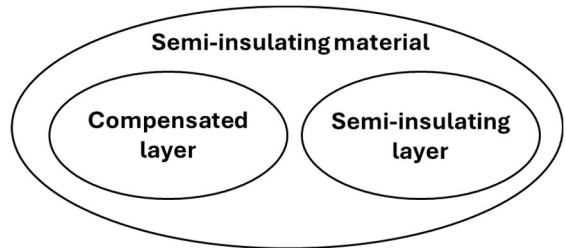
***Emphasis added herein unless otherwise noted**

I. THE NEW CLAIMS DO NOT COMPLY WITH THE WRITTEN DESCRIPTION REQUIREMENT

The '294 patent's description does not support the newly claimed "semi-insulating III-N layer [that] comprises a compensated GaN layer." Paper 27 § II.B.

The Board asked "how a layer that is composed entirely of a semi-insulating material would not also be a semi-insulating layer." Paper 29, 8. Patent Owner ("PO") argued "a compensated GaN layer is a semi-insulating III-N layer." Paper 31, 3. The patent itself resolves the Board's question and contradicts PO's interpretation.

In the patent, a "compensated layer" is not a "semi-insulating layer." Paper 27, 3-7. These two layers have different characteristics.



Id., 7. The patent explicitly differentiates them, specifying the semi-insulating layer is used "in place of" the compensated layer. Ex. 1001, 3:56-57. In the patent, semi-insulating and compensated layers can both be "semi-insulating material" (*id.*, 3:43-61)—but they are not the same. The diagram above illustrates how, a layer composed entirely of semi-insulating *material* is not necessarily a "semi-insulating *layer*" in the patent. It can be something else (e.g., the "compensated layer").

PO points to dependent claims to contend it improper to limit "semi-insulating layer" to a specific doping. Paper 31, 4. But Petitioner's lack of written description argument does not seek to limit the "semi-insulating layer" to a specific doping. Instead, Petitioner argues the patent does not support a "semi-insulating layer" that

is, or comprises, a “compensated layer.” That dependent claims specify doping types in the “semi-insulating layer” cannot broaden the term to include a “compensated layer” because the patent clearly describes “semi-insulating” and “compensated” layers as distinct. When the specification is clear, as here, it would be improper to interpret claims inconsistently with specification based on dependent claims, the “dependent claim tail cannot wag the independent claim dog.” *Barkan Wireless Access Techs., L.P. v. Cellco P’ship*, 748 F. App’x 987, 992-93 (Fed. Cir. 2018).

II. THE NEW CLAIMS BROADEN THE SCOPE OF THE ORIGINAL

PO argues the amendments are not broadening because a “compensated GaN layer is a specific type of semi-insulating III-N layer.” Paper 31, 6. But the ’294 patent makes clear the “compensated layer” is not a specific “semi-insulating layer”—these layers are different; one layer is used “in place of” the other. Ex. 1001, 3:55-61. The new claims broaden the scope of the original “semi-insulating layer” to encompass something the specification clearly excludes—the “compensated layer.” *Id.* While the new claims add limitations, the new claims still broaden the scope of the original semi-insulating layer, and “a claim is broadened if it is broader *in any respect* than the original claim, even though it may be narrowed in other respects.” *In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1283 (Fed. Cir. 2015).

III. THE PATENT DOES NOT ENABLE THE NEW CLAIMS

A. Merely Stating Goals Does Not Provide Direction on How to Make the New Claims

PO admits experimentation beyond the specification's disclosure is required to enable the new claims, but wrongly argues the "patent provides adequate guidance as to the direction of experimentation." Paper 31, 10. According to PO, two scant disclosures give "direction": (1) the background's description that in enhancement mode "the 2DEG region is depleted" (Ex. 1001, 1:47-50); and (2) the description that "the high doping level of compensated layer 38 leads to enhancement mode" (*id.*, 3:16-17). Paper 31, 7-8. PO argues that "a POSITA would understand ... the Mg acceptor concentration must be sufficiently high to deplete the 2DEG." *Id.*, 10.

But conveying a goal like "sufficiently high to deplete" is not enough to meet the enablement requirement. Enablement "requires a description of an invention, not an indication of a result that one might achieve" *Regents of the Univ. of Cal. v. Eli Lilly & Co.*, 119 F.3d 1559, 1568 (Fed. Cir. 1997) "[T]he specification of a patent must teach those skilled in the art *how to make* and use the full scope of the claimed invention without undue experimentation." *Baxalta Inc. v. Genentech, Inc.*, 81 F.4th 1362, 1365 (Fed. Cir. 2023). The cited disclosures provide no meaningful direction and "amount to little more than [a] research assignment[]," leaving the POSITA "forced to engage in 'painstaking experimentation' to see what works That is not enablement." *Amgen Inc. v. Sanofi*, 598 U.S. 594, 614 (2023); Ex. 1039 ¶¶56-71 (Dr. Shealy noting the new claims require a "very difficult process to achieve (if even possible) and would require much experimentation.").

PO asserts a POSITA would have understood that doping “must be sufficiently high” and that the Mg’s density must exceed the 2DEG’s. Paper 31, 7. But even if the patent conveyed these goals, the patent does not teach how to implement or determine “sufficiently high” doping. The patent fails to describe Mg or 2DEG densities or how to make one exceed the other. Critically, the patent is silent as to how to balance parameters to achieve the contradictory requirements of “semi-insulating layer” and “no 2DEG.” Ex. 1039 ¶¶56-71.

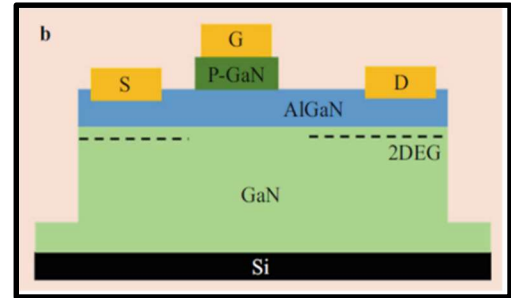
B. PO’s “Energy Gains” Theories Do Not Enable the Claims

Without enabling disclosures in the patent, PO relies on extrinsic publications to concoct a theory of enablement based on “two energy gains.” Paper 31, 7-8. PO alleges the new claims would be enabled because “the p-GaN layer ... accept[s] electrons from the 2DEG” and the “Mg atom ... [would] rather accept an electron from the conduction band (or 2DEG) than a hydrogen atom.” *Id.*, 7. But PO’s theory, based entirely on extrinsic evidence, cannot enable the new claims.

First, none of the “energy gains” information PO relies upon for enablement is in the patent. The patent never mentions the purported “two energy gains” or any energy comparisons. *See* Ex. 1001. The patent never suggests “Mg acceptors in the p-GaN will preferentially deplete the 2DEG, with remaining Mg acceptors being passivated by hydrogen,” as PO contends. Paper 31, 8. And the patent never describes an Mg density that exceeds 2DEG (*id.*, 10); the patent does not mention a

density at all. The patent fails to disclose parameters, values, or methods to determine energies or densities, compare these values, or use such them to make the new claims. Ex. 1039 ¶¶43-71. If PO's "energy gains" theory enables the new claims, the patent necessarily fails to meet the enablement requirement.

Second, PO's "energy gains" theory does not enable the claims because it is incorrect. The p-GaN layer cannot "accept electrons from the 2DEG" because an electron barrier separates the



2DEG from the p-GaN. In the GaN HEMTs at issue, the 2DEG forms at the interface of the **GaN channel** and **AlGaN barrier**, *below* the barrier. Ex. 1043, 7, Fig. 15.17 (reproduced above). The **p-GaN** sits on *top* of the barrier, the opposite side from the 2DEG. *Id.*, 17. The barrier ("barrier layer" in the new claims) separates 2DEG from p-GaN. It is not possible for "the p-GaN layer [to] accept electrons from the 2DEG," as PO contends (Paper 31, 7), because the barrier lies between them. 2DEG electrons cannot reach the p-GaN because the "AlGaN layers ... create[] a very high-energy barrier for 2DEG electrons," a barrier the electrons cannot cross. Ex. 1043, 5.

PO's theory that electrons cross the barrier contradicts basic HEMT operation. In HEMTs, the barrier must confine electrons to form the 2DEG. Ex. 1043, 6-7. This is key for device operation because the "AlGaN barrier in GaN HEMT *is employed to keep electrons contained* in a ... (2DEG)." Ex. 1044, 2. If the barrier failed to

contain electrons, there could be no 2DEG, and the device would not work. Ex. 1043, 7. PO's theory contradicts this principle with a barrier that does not block electrons.

PO advanced its flawed theory in the ITC investigation, and it was conclusively debunked. Ex. 2017, 1145:1-1146:8 (Prof. Doolittle explaining three reasons why PO's theory is "impossible" and defies physics). PO's theory is scientifically incorrect because the barrier creates an electric field that pushes electrons away from the p-GaN, keeping them below the barrier. Ex. 2027, 1147:16-23 ("the force is pushing the electrons down"). As Prof. Doolittle explained, "we call it a barrier layer because it's an electron and hole barrier layer. It doesn't allow the flow of electrons ..., it blocks them from the pGaN." Ex. 2017, 1145:24-1146:2. The barrier is fatal to PO's theory because electrons would need to defy the laws of physics to cross the barrier—PO's theory would require "magic electrons." *Id.*, 1152:15-19. ("You would have to have an electron that has a different magic character that somehow it can oppose an electric field It's just not happening.").

Even PO's new exhibits fail to support its theory because they do not describe a p-GaN accepting 2DEG electrons or the purported "energy gains." Exs. 2026-2028 do not describe a p-GaN accepting 2DEG electrons. Indeed, they do not mention a 2DEG at all. And they do not describe the purported 1.5 and 3.2 eV "energy gains" from bonding to H or "accepting electrons" as PO contends. Paper 31, 7-8. They instead describe "a direct bandgap of 3.4 eV" (Ex. 2026, 1), a "Mg ionization energy

of about 200 meV” (Ex. 2027, 1), and a 1.5 eV “dissociation barrier for the Mg-H complex” (Ex. 2028, 14). But these values do not apply to HEMTs and fail to describe “energy gains”—they refer to different phenomena. Ex. 2027’s ionization energy is the “minimum energy required to remove an electron from a specified atom or molecule,” not an energy gain from accepting an electron. Ex. 1045, 7. Ex. 2028’s “disassociation barrier” is the “energy required for complete separation of the atoms of a molecule,” not an energy gain from bonding to H. Ex. 1046, 13.

PO’s theory contradicts thoroughly studied and published mechanisms of 2DEG depletion. 2DEG electrons do not magically cross the electron barrier into the p-GaN. Ex. 2017, 1157:10-16. Instead, the literature consistently explains the p-GaN’s fixed negative charge pushes electrons from conduction depleting the 2DEG:

- Ex. 1043, 15: Explaining that “[a]t zero gate bias, the p-GaN layer is depleted leaving back a fixed negative charge which in turn depletes the channel.”
- Ex. 1047, 49: Explaining the barrier “discontinuity creates a negative bound charge at the p-GaN/AlGaN interface, which ... causes normally-off operation.”
- Ex. 1048, 10: Explaining “the effect introduced by the p-GaN layer is to push down the Fermi level in the channel, causing the device to become normally-off.”

Electrons crossing the barrier do not deplete the 2DEG; that is impossible. There is not a single publication (and PO did not point to any) that describes depletion where “the p-GaN layer ... accept[s] electrons from the 2DEG.” Paper 31, 7. The

literature, instead, describes 2DEG depletion from the p-GaN's fixed negative charge. But ultimately, the Board need not determine which mechanism depletes the 2DEG to resolve enablement. Regardless of how the p-GaN depletes the 2DEG, it is undisputable that the '294 patent does not describe any mechanism for the 2DEG depletion or the purported "energy gains." If enablement of the new claims hinges on 2DEG depletion, the patent fails to meet the enablement requirement.

C. No Reasonable Experimentation Permits Making the Invention

PO's theory fails to cure the patent's lack of guidance. And without guidance, no reasonable experimentation would lead to the newly claimed device. PO argues it was routine to increase doping and "a POSITA would experimentally increase the p-type doping concentration until the 2DEG is depleted." Paper 31, 9. But merely increasing doping cannot enable the new claims because they require competing limitations: (1) "no 2DEG" and (2) "semi-insulating layer." Increasing doping alone would make the layer conductive, the opposite of "semi-insulating," and the patent offers no guidance on how to balance these competing effects. Ex. 1039 ¶¶54-55.

Even PO has argued that striking such balance would *not* be routine, alleging the invention required "years of diligent research and endured numerous failures" and that "counterintuitive results ... precipitated the invention." Paper 18, 2, 37. Yet the patent does not describe any of the "diligent research" or explain how to achieve these "counterintuitive results." PO's claim that "routine experimentation" enables

the new claims (Paper 31, 10) is fundamentally incompatible with PO's assertion the invention was "counterintuitive" (Paper 18, 37)—these positions are irreconcilable.

The '294 patent lacks the necessary guidance, and routine experimentation cannot fill the gap. Although enablement tolerates experimentation, "courts cannot detract from the basic statutory requirement that a patent's specification describe the invention 'in such full, clear, concise, and exact terms as to enable any person skilled in the art' to 'make and use' the invention." 598 U.S. at 605 (citing § 112(a)). The patent fails to describe the new claims in the required "full, clear, and exact terms."¹

D. *Wands* Factors Show No Enablement

The *Wands* factors confirm the '294 patent fails to enable the new claims, they show the patent fails to enable a device with "semi-insulating layer" and "no 2DEG."

1. Factors 1 and 8: Quantity of experimentation & claim scope

Factors 1 and 8 favor non-enablement. Because the patent lacks guidance on how to make the new claims, they require unreasonable testing to find a combination of doping, thicknesses, and materials that achieves the competing conditions in the new claims—if it exists at all. Ex. 1039 ¶64. PO argues a "POSITA would experimentally increase the p-type doping." Paper 31, 9. But as explained above,

¹ PO argues that CNIPA's decision support its enablement arguments. It does not. The CNIPA decision is inapposite CNIPA not only applied a different law, it evaluated different claims. *See* IPR2013-00097, Paper 76, 3 (Feb. 24, 2014).

nothing in the patent teaches how to “increase the p-type doping concentration until the 2DEG is depleted” while keeping a “semi-insulating layer.” *Id.* The patent fails to teach how to determine when the 2DEG is depleted or the doping for a semi-insulating layer. Without guidance, a POSITA would face undue experimentation to make the new claims in an “unguided brute force trial-and-error of multiple variables in an inherently expensive and complex process.” Ex. 1039 ¶¶59-71.

2. Factors 2 and 3: Examples and direction in the patent

Factors 2 and 3 heavily weigh in favor of non-enablement. First, the patent provides no examples for the new claims. The patent states that a “high doping level ... leads to enhancement mode” (Ex. 1001, 3:16-17) but provides no example doping levels. The patent also entirely lacks examples of layer thickness or passivation configurations and does not describe any working examples. Second, the patent provides no direction to make the new claims. PO argues that by describing a “high doping level” and “enhancement mode” the patent provides the required direction. Paper 31, 10. But such disclosure woefully fails to enable the new claims because it provides no guideposts or pathways to make them. Making the new claims would require balancing a combination of variables to meet competing requirements of “no 2DEG” and “semi-insulating” layer. Ex. 1039 ¶53. Yet, the patent does not describe variables or ranges, or even an experimental pathway to achieve them. *Id.* ¶64.

3. Factors 4 to 7: Nature of the invention, predictability, level of skill, and state of art

For *Wands* factors 4-7, the competing expert testimony on the basic principles of operation show that these factors also favor no enablement. PO's "energy gains" theory is scientifically incorrect because it fails to account for the electron barrier. But even if accepted, at a minimum, the record shows the experts disagree on basic principles, the nature of the passivation, and what would be required to achieve the contradictory requirements in the new claims. Ex. 1039 ¶¶54-55 (Dr. Shealy); Ex. 2024 ¶27 (Dr. Schubert); Ex. 2017, 1145:1-1146:8 (Prof. Doolittle testifying PO's theory "is not possible"). The experts (all having the required level of skill) disagree, at a minimum demonstrating that without any guidance the purported invention is unpredictable and complicated in nature. Indeed, PO has contended the invention was "entirely unexpected" and based on "counterintuitive results." Paper 18, 1, 37.

IV. THE NEW CLAIMS ARE UNPATENTABLE OVER THE PRIOR ART

A. The New Claims Are Unpatentable Over *Smith*

The Board raised two questions regarding *Smith*. The Board questioned whether a POSITA would have: (1) modified *Smith* to passivate dopants in cap layer 34 (based on *Smith*, *Kigami*, or *Uemoto*); and (2) found *Smith* discloses a sufficient non-passivated dopants to result in no 2DEG. Paper 29, 11-13. PO argued *Smith* fails to disclose enhancement mode and challenged the combinations. Paper 31, 12-18. But the record shows a POSITA would have passivated *Smith*'s dopants to control conductivity—*Smith*, other prior art, and *KSR* rationales all support this. Paper 26,

18-21. And *Smith* is not limited to enhancement or depletion mode; *Smith*'s architecture can operate in both. *Id.*, 9-12. PO's contentions to the contrary fail.

1. A POSITA would have passivated *Smith*'s dopants

A POSITA would have passivated *Smith*'s dopants because *Smith* teaches the doping must be "sufficiently high ... but not so high." *Smith*, [0087]; Paper 26 §V.C. As the Board notes, *Smith* teaches that dopants in the cap layer "screen the channel region from surface states, pin the surface energy level at a predictable and desired level to reduce and/or minimize trapping effects and to reduce leakage currents." Paper 29, 12 (citing *Smith*, [0087]). But *Smith* also explains the "level of doping should be ... not so high as to provide introduce traps or leakage paths by becoming a conductive layer." *Smith*, [0087]. *Smith*'s teachings that doping should be high but not too high would have motivated a POSITA to use passivation. Ex. 1033 ¶79.

Passivating the cap layer's dopants would further have been obvious in view of *Kigami* and *Uemoto*, which use passivation to address the same problem as *Smith*—doping without making the layer conductive. Paper 26, 18-21. *Kigami* and *Uemoto* teach localized passivation techniques to form a nonconductive p-doped layer. *Kigami*, [0011-0012]; *Uemoto*, [0049]. And they explicitly motivate passivating devices that, like *Smith*, use Mg doping and seek to reduce leakage. *Kigami*, [0012] (suggesting its technique for "situations in which [Mg] is used"); *Uemoto*, [0059] (suggesting its technique "to decrease the leakage"). *Smith* teaches

doping throughout cap layer 34. *Smith*, [0087]. But *Smith* also teaches to control that doping so the layer is not conductive. *Id.* This doping “sweet spot” is why a POSITA would have passivated cap layer dopants, particularly with techniques like *Kigami*’s and *Uemoto*’s.

2. If increasing p-type doping until the 2DEG is depleted is “routine” for enablement, the claims are necessarily obvious

The Board questioned how a POSITA “could conclude that sufficient non-passivated acceptors are present ... to completely remove the 2DEG layer” noting that “although [Dr. Shealy] identifies the cap layer thickness and doping concentrations disclosed in *Smith*, he does not explain sufficiently why these parameters demonstrate ... no 2DEG.” Paper 29, 11. However, when identifying the different ranges in *Smith*, Dr. Shealy did not seek to demonstrate that *Smith* has no 2DEG—he did not present *Smith* as anticipating this feature. Rather, he explained why and how *Smith*’s information makes this feature obvious. Ex. 1039 ¶¶112-114.

Smith details the characteristics of its device providing specific ranges and examples. *Id.* Dr. Shealy explains how and why with this information, the POSITA would have experimented to form a device depleting the 2DEG at 0V. *Id.* Even PO’s expert believes such experimentation would be “routine,” stating that “a POSITA would experimentally increase the p-type doping concentration until the 2DEG is depleted.” Ex. 2024 ¶28. If, as PO argues, increasing doping to deplete the 2DEG was a “routine procedure” for a POSITA (Paper 31, 9), it necessarily follows that

increasing doping in *Smith* to deplete the 2DEG was obvious. “[I]t is possible for a claim to be obvious because of various prior art references while still non-enabled given severe deficiencies in the claim specification.” *DNT, LLC v. Sprint Spectrum, LP*, 750 F. Supp. 2d 616, 624 (E.D. Va. 2010). Here, the severe deficiencies in the ’294 patent contrast the prior art. And finding the patent enables the “no 2DEG” limitation requires finding the new claims were obvious. If, increasing doping until depleting the 2DEG was “routine,” the new claims are necessarily obvious over the prior art. Finding enablement without finding obviousness would be incongruent.

3. *Smith* is not limited to depletion-mode devices

PO challenges obviousness arguing that “even if Smith’s transistor were modified so that no 2DEG exists ..., it would still not work as enhancement mode.” Paper 31, 14. Abandoning its argument that *Smith*’s “cap layer ... is in **direct contact** with both ohmic contacts” (Paper 18, 25) PO now admits gaps can exist but contends they would be too small. Paper 31, 13. PO’s new argument is still irrelevant—obviousness references need not be enabling—and *Smith* does not require “small gap[s].” PO modified *Smith*’s Fig. 2A to show a “small gap” and argues *Smith* would not work because the “2DEG would only replenish generally directly beneath the gate.” *Id.* But nothing in *Smith* limits the gaps to be “small;” PO arbitrarily **chose** to draw “small gap[s].” Larger gaps would be consistent with *Smith*’s cap layer descriptions. *Smith*, [0085]. And *Smith*’s drawings are cartoons, not in scale; a

POSITA would have interpreted them for a working device. Ex. 1033 ¶57. Also, PO's argument is incorrect. The 2DEG is not replenished only below the gate because "the electric field would not be limited to below the gate." *Id.* ¶¶65-67.

B. The New Claims Are Unpatentable Over *Sheu*

Sheu is prior art to the '294 patent under 35 U.S.C. § 102(b) because it published August 1, 2004, over a year before the '294 patent claimed priority.

The Board questioned *Sheu/Kigami* noting it understood "Sheu's teaching of 'enhanc[ing] the resistance value' as a teaching to lower gate insulating layer 318's resistance value." Paper 29, 15. But the Board's preliminary understanding of *Sheu* was incorrect. When *Sheu* "enhanc[es] the resistance" of layer 318, it increases resistance. *Sheu*, 10. *Sheu* dopes to achieve "good lattice matching" and "good **insulation** characteristics." *Id.*, 6, 10. *Sheu* does not dope to lower resistance. *Id.* *Kigami*'s technique likewise increases resistance, as the Board noted (Paper 29, 15), complementing *Sheu*. Paper 27, 36. And *Kigami* expressly motivates using its technique in devices like *Sheu* to improve leakage, threshold, and switching speed. *Kigami*, [0029]. The combination was obvious. Paper 27, 35-37.

PO incorrectly argues *Sheu* is directed to depletion mode and the combination would not have been obvious. Paper 31, 18-23. But nothing limits *Sheu* to depletion mode—*Sheu* does not even mention depletion operation—and a POSITA would have recognized the combination results in an enhancement mode device. Ex. 1039

¶¶188, 142-147. Indeed, *Sheu/Kigami* have the same structure PO’s expert identified as characteristic of enhancement mode where “a p-type gate material is present over the barrier layer, it can deplete the 2DEG.” Ex. 2009 ¶31; Ex. 1039 ¶189.

Further, PO’s arguments against *Sheu/Kigami* are unsupported and contradict the record. Nothing supports PO’s speculation that “the gate insulating layer may be originally n-type” or that “[p]assivating those dopants ... would negate the purpose.” Paper 31, 22. *Sheu* does not disclose any n-type doping of layer 318. Instead, layer 318 is doped with “carbon, magnesium, iron or [their] combination” (Ex. 1036, 10), which are p-type or deep dopants, not n-type (Ex. 1001, 3:10-61). And passivating dopants does not negate the purpose of doping. PO repeats this with no support. Paper 31, 22. But the record shows Mg dopant passivation was a common, well-known tool to control conductivity of a doped layer. Paper 26, 20.

Finally, PO’s criticisms of *Sheu/Kigami* based on structural differences fail. They are misdirected because the combination does not substitute *Sheu*’s layer with *Kigami*’s. The combination instead applies *Kigami*’s technique to *Sheu*. Paper 27, 37; *Kigami*, [0026]. Further, *Kigami* and *Sheu* do not have “entirely different gate layer structure[s].” Paper 31, 22. Far from it. They have very similar structures with a gate, on an insulating layer, on a barrier. *Kigami* Fig. 7; *Sheu*, Fig. 6.

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR § 42.6(e)(4), the undersigned certifies that on November 27, 2024, a complete and entire copy of this Petitioner's Sur-Reply to Patent Owner's Reply to Opposition to Motion to Amend was provided by email to the Patent Owner by serving the correspondence email address of record as follows:

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