

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INNOSCIENCE (ZHUHAI) TECHNOLOGY COMPANY AND

INNOSCIENCE AMERICA, INC.,

Petitioner

v.

EFFICIENT POWER

CONVERSION CORPORATION,

Patent Owner

Case No. IPR2023- 01381

U.S. Patent No. 8,350,294

**SUPPLEMENTAL REPLY DECLARATION OF JAMES
RICHARD SHEALY, PH.D.**

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I. INTRODUCTION

[01] I have been retained by Innoscience (Zhuhai) Technology Company, Ltd., and Innoscience America, Inc. (collectively “Innoscience”), as an independent expert for the above-identified inter partes review proceeding involving U.S. Patent No. 8,350,294 (“the ’294 patent”).

[02] I submitted a first declaration in this matter in connection with Innoscience’s Petition (Paper No. 1). My first declaration is marked as Ex. 1003. Since submitting my first declaration, Patent Owner (“EPC”) filed its Preliminary Response (Paper No. 8), and the Board instituted an *inter partes* review for the ’294 patent (Paper No. 11).

[03] Following institution, I was deposed on May 31, 2024. A transcript of my deposition is marked as Ex. 2012. And EPC submitted a response to the Board’s Institution Decision, which included a declaration by Dr. E. Fred Schubert. EPC’s Response is marked as Paper No. 18 and Dr. Schubert’s declaration is marked as Ex. 2009.

[04] I have reviewed the Board’s Institution Decision, EPC’s responses, and Dr. Schubert’s declaration. And based on my review of those materials, I offer the following supplemental remarks. My supplemental remarks address new claim constructions that EPC and Dr. Schubert raised with the Response and correct

misstatements in Dr. Schubert's declaration regarding my first declaration and the prior art.

[05] The new documents that I have reviewed and EPC's responses do not change the opinions I provided in my first declaration. The grounds 1A, 1B, 1C, and 2 as presented in my first declaration render claims 1-12 of the '294 patent invalid as obvious.

II. LEVEL OF ORDINARY SKILL IN THE ART

[06] Dr. Schubert proposed a level of ordinary skill for the '294 patent that differs from the one I proposed in my first declaration. Ex. 2009 ¶¶81-83. He defined a person of ordinary skill in the art as:

a graduate having a four-year degree in electrical engineering, physics, material science, or a closely related field, and three years of professional work experience in the epitaxial growth, design, and fabrication of semiconductor electronic devices, including those of GaN. Moreover, relevant graduate education could substitute for the professional work experience.

Ex. 2009 ¶82.

[07] This definition is different than the one I proposed of:

at least a four-year degree in electrical engineering, chemical engineering, physics, or material science or a closely related field and at least two years of experience in semiconductor device design or fabrication, including the processing of semiconductor materials, analysis of

device operation, or the development of new device topologies.

Ex. 1003 ¶¶52-54.

[08] The two definitions, however, are very similar. The different degrees and experiences listed in each definition largely overlap. The only discernable difference is that while in my definition I used “two years of experience,” Dr. Schubert uses “three years of professional work” in his definition. Such a difference between two and three years is minor.

[09] While I continue to find my definition more appropriate given the scope and description of the '294 patent, my analysis or my opinions would not depend on the differences between the two definitions. As Dr. Schubert seems to agree, the differences in the level of ordinary skill in the art between the two definitions would not change the outcome of the invalidity analysis in any material manner. Ex. 2009 ¶83.

III. CLAIM CONSTRUCTION

[010] EPC and Dr. Schubert proposed constructions for two terms “Compensated GaN Layer” and “a gate contact above the compensated GaN layer,” recited respectively in elements [1e] and [1f] of claim 1 of '294 patent. Ex. 2009 ¶¶89-101. Additionally, EPC and Dr. Schubert suggest that Claims 1-3 of the '294 patent should be interpreted as directed to an enhancement-mode

transistors. Ex. 2009 ¶¶108-113. For the reasons set forth below I disagree with the proposed constructions and interpretations.

A. I Disagree With EPC's Construction For "a Gate Contact Above the Compensated GaN Layer"

[011] Dr. Schubert and EPC proposed that "a gate contact above the compensated GaN layer" (element [1f]) should be construed as "a gate comprised of a gate contact and the compensated GaN layer." Ex. 2009 ¶89. I do not agree with such construction.

[012] The proposed construction would entirely rewrite [1f]. I find no support in the claims or the specification of the '294 patent to rewrite [1f] as EPC and Dr. Schubert propose. The terms "a gate contact" and "above" in [1f] would have been clear to a POSITA, they have an ordinary meaning. A POSITA would have readily understood what is a "gate contact." And a POSITA would have also readily understood what it means for the gate contact to be "above" a different layer using the ordinary meaning of "above"—i.e., being higher than.

[013] I do not find EPC and Dr. Schubert proposed rewriting of [1f] is warranted by the specification, or the embodiments it describes, because the specification does not change the meaning of "gate contact" or "above." And the specification does not deny the full scope of these terms. The specification instead describes the embodiments as examples, making clear that: "Modifications and

substitutions to specific process conditions can be made. Accordingly, the embodiments of the invention are not considered as being limited by the foregoing description and drawings.” Ex. 1001, 5:5-9.

[014] Based on the patent descriptions and the claim language, a POSITA would not have restricted the terms of “a gate contact above the compensated GaN layer” as EPC and Dr. Schubert propose in their construction.

B. I Disagree With EPC’s Revised Construction for “Compensated GaN Layer”

[015] I have been informed that EPC changed its proposed construction for “compensated GaN layer” since the time I wrote my first declaration.

[016] In the table below, I compare the first construction EPC proposed for “compensated GaN layer,” which I analyzed in my first declaration, and the revised construction EPC and Dr. Schubert now advance.

EPC initial construction	EPC revised construction
“A semiconductor GaN gate material in which one type of dopant, impurity, or imperfection (for example, donor) partially cancels the electrical effects of the other type of dopant, impurity, or imperfection (for example, acceptor).”	“a semiconductor GaN gate material in which one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor).”

[017] The new construction uses the same initial phrase of “A semiconductor GaN gate material” but then modifies the rest by removing certain terms like “imperfection” and “partially.”

[018] In my first declaration, I had noted how terms like “imperfection” and “partially” introduced ambiguity, particularly because those terms are not used in the claims or disclosed in the specification. Ex. 1003 ¶¶79. EPC and Dr. Schubert seem to have removed those terms from their proposed construction. But the updated construction still introduces ambiguous terms that are not described in the patent and suffers similar deficiencies as the ones I discussed for EPC’s previous construction. Ex. 1003 ¶¶77-84.

[019] The new EPC and Dr. Schubert construction still seeks to use “semiconductor GaN gate material” for the construction of “compensated GaN layer.” But a POSITA would not interpret the term that way. The term “layer” would have been readily understood by a POSITA and a POSITA would not have limited “GaN layer” to be “GaN gate material.” Neither the specification nor the claim language would restrict the term “layer” that way. As the Board concluded in its Institution Decision, the term “compensated GaN layer” should not be interpreted to require “gate material.” Paper No. 11, 15.

[020] EPC and Dr. Schubert revised construction is also incorrect because it introduces the ambiguities that I discussed in my previous declaration. The '294 patent never refers to, or defines, a “gate material.” And to a POSITA “gate material” would not have a readily ascertainable meaning or scope. For example, “gate material” could be referring to simply material that is contacting the gate, making it “gate material,” or it could also refer to the material within the gate electrode, also making it “gate material.” Because the patent does not define “gate material,” and indeed it does not even mention it, the proposed construction would introduce ambiguities that a POSITA would find confusing, or at least vague.

[021] Further, the new construction still seeks to define the claim term with “examples” that make the scope of the claim ambiguous. And the new construction still tries to introduce the undefined term “electrical effects.” As I noted in my previous declaration, “electrical effects” is not a term that is used or defined in the patent. Ex. 1003, ¶¶79-83. The lack of definition of this term introduces ambiguity because there is no ascertainable meaning or scope of what “electrical effects” are being considered or when they get canceled.

[022] Moreover, EPC and Dr. Schubert revised construction still seems to completely ignore the descriptions in the patent. The '294 patent does not describe any of the terminology in EPC's and Dr. Schubert's revised construction. Instead,

the patent provides a clearer guidance as to the scope of the term within its written description. As I explained in my first declaration Ex. 1003 ¶¶84-85, EPC's construction completely ignores the '294 patent description of "compensated GaN layer" that in the patent is described based on its formation with "[t]he critical step in the above process that differentiates the device of the present invention from the prior art device (FIG. 1) is the passivation of a p-type impurity using hydrogen" and that the passivation leads to "the compensated semiconductor layer 38." Ex. 1001, 3:43-53.

[023] Nonetheless, the changes EPC and Dr. Schubert made to EPC's originally proposed construction for the term do not change my analysis. As I further discuss below, each of the grounds 1A, 1B, 1C, and 2, detailed in my first declaration, still meet the "compensated GaN layer" under the updated EPC and Dr. Schubert construction for "compensated GaN layer."

C. Each of Grounds 1A-1C, and 2 Still Meet the "Compensated GaN Layer" Even If Interpreted With EPC's Revised Construction

[024] EPC and Dr. Schubert's modifications to the initial proposed construction do not alter my analysis or conclusions that all grounds meet the "compensated GaN layer" limitation. Each of the grounds I set forth in my first declaration as rendering the claims obvious meet the "compensated GaN layer" of [1e] under EPC's revised definition and also under Innoscience's definition. My

analysis for Innoscience's construction remains the same. My analysis for EPC's definition is similar to the one in my first declaration because EPC's changes to the construction do not alter my application of the prior art to the claim term.

1. Ground 1A meets “compensated GaN layer” under EPC’s updated construction

[025] In Ground 1A, *Smith*'s cap layer is “a semiconductor GaN gate material in which one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor),” as EPC and Dr. Schubert propose in their updated construction.

[026] As explained in my first declaration, *Smith*'s cap layer 34 is disclosed as formed with GaN, below, and in contact with the gate electrode and thus “gate material.” Ex. 1003, ¶¶112-115, 161. Additionally, as I also explained in my first declaration, a POSITA would have known that hydrogen is naturally incorporated in MOCVD-grown GaN layers and that hydrogen interacts with dopants, like magnesium, passivating those magnesium dopants and reducing the layer conductivity. Ex. 1003 ¶¶61-63. Because *Smith* explains cap layer 34 is formed with MOCVD, using p-type dopants, and with a controlled level of doping that prevents the layer from becoming conductive, a POSITA would have understood that *Smith*'s cap layer 34 to be “compensated GaN layer.” Ex. 1003 ¶¶154-155.

[027] Given *Smith*'s description of the cap layer and the knowledge of a POSITA at the time of the '294 patent, to a POSITA it would have been obvious that *Smith* cap layer has "one type of impurity (for example, donor)"—the hydrogen from MOCVD—that "cancels the electrical effects of the other type of impurity (for example, acceptor)"—the p-type dopants, like magnesium, whose "electrical effects" (as the term appears to be used in the construction) are canceled by hydrogen when forming the Mg-H complexes. Ex. 1003 ¶¶114, 154-155. In other words, to a POSITA it would have been obvious that because *Smith*'s cap layer is formed with MOCVD and doped with p-type dopants at a level that does not make the layer conductive (as specified in *Smith*'s [0085]-[0087]), the cap layer includes hydrogen that cancels "electrical effects" (as the term appears to be used in Dr. Schubert's construction) of the p-type dopants, making *Smith*'s cap a layer "in which one type of impurity cancels the electrical effects of the other type of impurity," meeting EPC's and Dr. Schubert's updated construction.

[028] Therefore, in my opinion, Ground 1A meets the "compensated GaN layer" under EPC and Dr. Schubert's revised construction under similar rationale as the one I described in my first declaration. Ground 1A based on *Smith* renders obvious all elements of the claims of the '294 patent under both of the proposed constructions.

2. Ground 1B meets “compensated GaN layer” under EPC’s updated construction

[029] In Ground 1B, *Kigami*’s hydrogenation technique is applied to *Smith*’s device. Ex. 1003 ¶¶128-133. And when *Kigami*’s technique is applied to *Smith*, *Smith*’s cap layer is “a semiconductor GaN gate material in which one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor),” as EPC and Dr. Schubert propose in their updated construction.

[030] As I explained in my first declaration, to a POSITA it would have been obvious to apply *Kigami*’s hydrogenation technique to *Smith*. Ex. 1003 ¶¶128-133. To a POSITA, applying *Kigami*’s technique to *Smith* would have been obvious because, as *Kigami* explains, its hydrogenation would locally lower dopant activation and—consistent with *Smith*’s goals—prevent the cap layer from becoming conductive. Ex. 1003 ¶132. This combination would have also been obvious to a POSITA because *Kigami* explicitly stated that his technique “is particularly useful in situations in which magnesium is used as a p-type impurity.” *Kigami* ¶[0012]. And that is the specific situation in *Smith*, who uses magnesium as a p-type impurity and has the goal that the “level of doping” does not make the layer conductive. Ex. 1003 ¶132.

[031] The Ground 1B combination meets the “compensated GaN layer” under EPC and Dr. Schubert’s proposed construction. In Ground 1B, *Smith*’s cap layer is “a semiconductor GaN gate material” because, as noted above, *Smith* discloses cap layer as being formed with GaN, below, and in contact with the gate electrode and thus “gate material.” Ex. 1003, ¶¶112-115, 161. Additionally, to a POSITA it would have been obvious that when *Kigami*’s hydrogenation method is applied to *Smith* (e.g., to control the level of doping and increase resistivity), in *Smith*’s cap layer “one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor).” Ex. 1003 ¶¶132-133, 161. To a POSITA it would have been obvious that in Ground 1B the cap layer has “one type of impurity (for example, donor)” —e.g., the hydrogen that is introduced with *Kigami*’s hydrogenation technique— that “cancels the electrical effects of the other type of impurity (for example, acceptor)” —e.g., the hydrogen cancels or inactivates “electrical effects” (as the term appears to be used in EPC’s construction) of *Smith*’s p-type dopants. This is confirmed in *Kigami*, who teaches how “magnesium that has formed a composite with the hydrogen atoms is inactivated.” *Kigami* ¶[0026].

[032] Therefore, in my opinion, Ground 1B meets the “compensated GaN layer” under EPC and Dr. Schubert’s revised definition of “compensated GaN

layer” under similar rationale as the one I described in my first declaration. Ground 1B based on *Smith* and *Kigami* also renders obvious all elements of the claims of the ’294 patent under both of the proposed constructions.

3. Ground 1C meets “compensated GaN layer” under EPC’s updated construction

[033] In Ground 1C, *Smith* is modified to include *Uemoto*’s hydrogen diffusion layer as I discussed in my first declaration. Ex. 1003 ¶¶134-140. When *Uemoto*’s hydrogen diffusion is implemented in *Smith*, *Smith*’s cap layer is “a semiconductor GaN gate material in which one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor),” as EPC and Dr. Schubert propose in their updated construction.

[034] As I explained in my first declaration, to a POSITA it would have been obvious to use *Uemoto*’s hydrogen diffusion layer in *Smith*. Ex. 1003 ¶¶134-140. To a POSITA the combination would have been obvious because, as *Uemoto* explains, using the hydrogen diffusion film would reduce the transistor gate leakage. Ex. 1003 ¶¶ 138-139. This combination is also motivated by *Uemoto* that explicitly discloses his design for reducing gate leakage “is useful for a nitride semiconductor transistor such as a power transistor with a high breakdown voltage, and for its fabrication method.” *Uemoto*, [0079]. A nitride semiconductor transistor is the specific device in *Smith*. Ex. 1003 ¶138.

[035] The Ground 1C combination meets the “compensated GaN layer” under EPC and Dr. Schubert’s proposed updated construction. In Ground 1C, *Smith*’s cap layer is “a semiconductor GaN gate material” because as noted above *Smith* discloses cap layer as being formed with GaN, below, and in contact with the gate electrode and thus “gate material.” Ex. 1003, ¶¶112-115, 161. Additionally, to a POSITA it would have been obvious that when *Uemoto*’s hydrogen diffusion film is applied to *Smith*’s magnesium-doped cap layer (e.g., seeking to reduce leakage), in *Smith*’s cap layer “one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor).” Ex. 1003 ¶¶157, 162. To a POSITA it would have been obvious that in Ground 1C *Smith*’s cap layer has “one type of impurity (for example, donor)—e.g., the hydrogen that is diffused from *Uemoto*’s hydrogen diffusion layer— that “cancels the electrical effects of the other type of impurity (for example, acceptor)—e.g., the hydrogen cancels or inactivates “electrical effects” (as the term appears to be used in the construction) of *Smith*’s magnesium p-type dopants. *Uemoto* also confirms that diffusing hydrogen allows “selectively inactivating impurities” and increasing the layer’s resistivity. *Uemoto* ¶¶[0062]-[0063].

[036] Therefore, in my opinion, Ground 1C meets the “compensated GaN layer” under EPC and Dr. Schubert’s revised definition of “compensated GaN

layer” under similar rationale as the one I described in my first declaration. Ground 1C based on *Smith* and *Uemoto* also renders obvious all elements of the claims of the ’294 patent under both of the proposed constructions.

4. Ground 2 meets “compensated GaN layer” under EPC’s updated construction

[037] In Ground 2, *Uemoto*’s region 15b is “a semiconductor GaN gate material in which one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor),” as EPC and Dr. Schubert propose in their updated construction for “compensated GaN layer.”

[038] As I explained in my first declaration, *Uemoto*’s region 15b is disclosed as being formed with GaN and, at least partially, below and in contact with the gate electrode, making it part of the “gate material.” Ex. 1003, ¶246-249. Accordingly, *Uemoto*’s region 15b is “a semiconductor GaN gate material.” Ex. 1003, ¶246-249.

[039] Additionally, *Uemoto* discloses that in region 15b hydrogen is introduced to selectively inactivate impurities. Ex. 1003 ¶243. Therefore, in Ground 2, *Uemoto*’s region 15b has “one type of impurity (for example, donor) cancels the electrical effects of the other type of impurity (for example, acceptor).” Ex. 1003 ¶246. To a POSITA, *Uemoto*’s region 15b has “one type of impurity (for example, donor)” —e.g., the hydrogen that is diffused from the hydrogen diffusion

layer— that “cancels the electrical effects of the other type of impurity (for example, acceptor)” —e.g., the hydrogen cancels or inactivates “electrical effects” (as the term appears to be used in EPC’s construction) of the magnesium that is in the layer 15. As *Uemoto* confirms, diffusing hydrogen allows “selectively inactivating impurities” and increasing the region’s resistivity. *Uemoto* ¶¶[0062]-[0063].

[040] Therefore, in my opinion, Ground 2 meets the “compensated GaN layer” under EPC and Dr. Schubert’s revised definition of “compensated GaN layer” under similar rationale as the one I described in my first declaration. Ground 2, based on *Uemoto* and *Smith*, renders obvious all elements of the claims of the ’294 patent under both of the proposed constructions.

D. I Disagree With EPC’s Interpretation of Claims 1-3 as Enhancement-mode Transistor

[041] In his declaration, Dr. Schubert argues that claims 1-3 of the ’294 patent are directed to enhancement-mode transistors. Ex. 2009 ¶¶108-113. I do not agree with Dr. Schubert’s proposed interpretation limiting these claims to enhancement-mode devices.

[042] The claim language does not support Dr. Schubert’s enhancement-mode interpretation because none of the claims 1-3 require an enhancement-mode. Instead, claim 1 is more broadly directed to a “column III Nitride transistor,”

which encompass enhancement- and depletion-mode devices. In my view, none of the terms in the claim would require enhancement-mode operation.

[043] Also, the specification does not inform a POSITA claims 1-3 are directed to enhancement-mode devices. The '294 patent specification expressly describes “the present invention” broadly, without limitation to enhancement- or depletion-mode operation. Ex. 1001, 2:13-19. And there is nothing in the specification that would limit claims to enhancement-mode devices. Rather, the specification expressly describes a depletion-mode embodiment. Ex. 1001, 4:55-60. The patent describes that “the device can be changed to a depletion mode device.” Ex. 1001, 4:55-57.

[044] Contrary to limiting its disclosure to enhancement-mode devices, the patent expressly describes the invention without a specific operation and describes embodiments that are not enhancement-mode but depletion-mode. Even Dr. Schubert acknowledges that the '294 patent is not limited to “enhancement-mode,” but that “[t]he '294 Patent describes improvements to conventional E-mode and D-mode GaN transistors.” Ex. 2009 ¶48. Here “D-mode” refers to depletion-mode.

[045] Therefore, I do not agree with EPC and Dr. Schubert interpretation that claims 1-3 are directed to enhancement-mode devices.

IV. DR. SCHUBERT'S INTERPRETATION OF *SMITH* IS INCORRECT**A. *Smith*'s Disclosure Covers Enhancement-mode Devices**

[046] In his declaration, Dr. Schubert argues that “Smith does not disclose an enhancement mode transistor,” that “[a]ny suggestion that Smith can operate as an enhancement mode transistor fails,” and that “a POSA would not be motivated to modify Smith to be an operational enhancement transistor.” Ex. 2009 §VII.A. I do not agree with Dr. Schubert interpretation of *Smith* for the following reasons.

1. *Smith* does not specify a unique operation and does not limit its transistors to depletion-mode

[047] As I noted in my first declaration, *Smith* discloses multiple designs for GaN-based transistors. Ex. 1003 ¶¶91. *Smith*'s designs include several different arrangements of semiconductor layers with different cross-sectional schematics and using a variety of materials, doping profiles, and gate contact types. Ex. 1003 ¶¶90-94. For example, some of *Smith*'s transistors have the so-called recess-gate, but some of them do not. Ex. 1003 ¶¶92. Also, *Smith*'s transistor have different layers and a different arrangement of layers, some including additional layers like the “protective layer 64” that is shown in Fig. 6, but not in Fig. 5B. *Smith* ¶[0100]. And *Smith* tells a POSITA not to limit its disclosure to just the figures or the specific arrangements in the figures. For example, regarding transistors with cap layers, *Smith* explains that “embodiments of the present invention should not be

construed as limited to structures having ohmic contacts recessed through the cap layer.” *Smith* ¶[0121]. *Smith* affirms the broad scope of its disclosure stating that his disclosure should not be limited HEMTs explaining that it is possible to include additional layers and altering the structure to make a “MISHEMT.” *Smith* ¶¶[0119]-[0120].

[048] *Smith* discloses multiple transistor designs and several combinations, and he never limits any of his transistor designs to a specific operation mode. *Smith* does not limit any of its transistors for depletion, enhancement, normally-on, or normally-off operation. Rather, *Smith* describes the multiple embodiments and combinations in a way that makes clear its disclosure covers devices that would operate in any of these operation modes.

[049] As I explained during my deposition, to a POSITA it would have been evident that the designs *Smith* describes can operate as enhancement-mode devices. A POSITA would have understood that with the correct doping, thicknesses, and layer arrangement—variations *Smith* describes in its different embodiments—*Smith*’s transistors can operate as enhancement-mode device (or also depletion-mode device).

[050] For example, the design *Smith* presents in FIG. 2A, which I reproduce below, can operate in enhancement-mode with the appropriate composition,

doping, and thickness for its layers (like cap layer 34 and barrier layer 22) and/or including additional layers (as it is also disclosed in *Smith*).

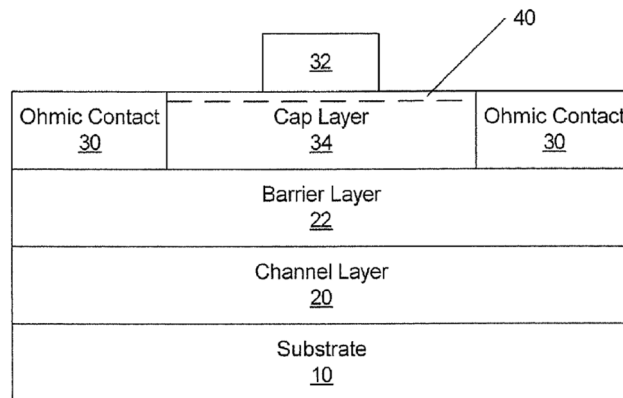


Figure 2A

[051] With an appropriate doping and thickness, and keeping in mind that *Smith* asks us to carefully tailor the “level of doping” in this specific cap layer, a POSITA would have understood *Smith*’s FIG. 2A device covers enhancement-mode operation. *Smith*’s disclosure that cap layer 34 can be p-type doped (e.g., with Mg) and that the doping should be “sufficiently high so as to reduce leakage current in embodiments without a recessed gate and be the dominant ‘surface’ state but not so high as to provide introduce traps or leakage paths by becoming a conductive layer” (*Smith* ¶[0087]) shows a POSITA that this device would operate in enhancement-mode with the adequate selection of the parameters *Smith* describes. The enhancement-mode operation would also be consistent with *Smith*’s

description of the transistor channel formation with the “two-dimensional electron gas (2DEG) [that] is formed at the heterojunction of two semiconductor materials with different bandgap energies, and where the smaller bandgap material has a higher electron affinity.” *Smith* ¶[0005].

[052] *Smith*’s operation as enhancement-mode is also consistent with Dr. Schubert’s declaration. There he defined enhancement-mode devices, stating that “if a p-type gate material is present over the barrier layer, it can deplete the 2DEG under the gate to create an enhancement mode.” Ex. 2009 ¶31. The configuration Dr. Schubert describes as creating an enhancement-mode is the same configuration *Smith* discloses in FIG. 2A. In *Smith*’s FIG. 2A, cap layer 34 is below the gate, is p-type doped throughout, and present over barrier layer 22. *Smith* ¶¶[0085]-[0087]. *Smith*’s cap layer 34 is “p-type gate material present over the barrier,” which as Dr. Schubert agrees, “deplete the 2DEG under the gate to create an enhancement mode.” Ex. 2009 ¶31.

[053] In my opinion, *Smith* disclosure covers enhancement-mode devices, and I disagree with Dr. Schubert’s interpretation of *Smith* as not disclosing enhancement-mode devices.

2. *Smith's* FIG. 2A is a schematic drawing, a POSITA would not have interpreted *Smith* as limited by features in the FIG. 2A

[054] In his declaration, Dr. Schubert argues that *Smith* cannot be interpreted as an enhancement-mode device. Without considering *Smith's* written description, Dr. Schubert focuses his analysis on FIG. 2A and presents two arguments, one related to the operability of the schematic in FIG. 2A and one related to its manufacturability. Specifically, Dr. Schubert argues that: (1) FIG. 2A is “non-functional as an enhancement mode transistor;” and (2) FIG. 2A “cannot actually be manufactured as depicted in the figure.” Ex. 2009 ¶116. But Dr. Schubert’s analysis of the operability based on FIG. 2A is based on an unwarranted interpretation of a schematic that ignores *Smith's* written description. And Dr. Schubert’s analysis about the manufacturability of FIG. 2A actually support my interpretation that it is a cartoon, not a precise implementation.

a. *Smith's* FIG. 2A does not show *Smith* could not operate in enhancement-mode

[055] Dr. Schubert seems to argue that FIG. 2A would not operate as enhancement-mode because FIG. 2A shows the cap layer “in direct contact with both ohmic contacts 30.” Ex. 2009 ¶117. Dr. Schubert considers this feature would prevent enhancement-mode operation because the cap layer would “deplete the 2DEG the entire length between the ohmic contacts.” Ex. 2009 ¶118. But I

disagree with Dr. Schubert analysis of FIG. 2A for two reasons. First, Dr. Schubert's analysis of the operability of *Smith* based on FIG. 2A is misguided because FIG. 2A is a schematic, not a precise implementation, and *Smith* is not limited to FIG. 2A. Indeed, *Smith* explicitly states the features shown in FIG. 2A do not limit that specific embodiment. *Smith* ¶[0121]. Second, Dr. Schubert is technically incorrect because even if a device were to be implemented exactly as shown in FIG. 2A (an assumption I disagree with), with correct parameters (e.g., applied voltage, thickness, and doping) it would still be operable in enhancement-mode.

[056] First, Dr. Schubert's analysis of *Smith*'s operation as enhancement-mode focuses on the feature shown in FIG. 2A that cap layer 34 abuts the ohmic contacts 30. Ex. 2009 ¶117. Dr. Schubert seems to infer that in *Smith*'s design cap layer 34 would be directly electrically connected to both ohmic contacts 30. Ex. 2009 ¶¶117-118. However, I do not think that is how a POSITA would interpret *Smith*'s FIG. 2A.

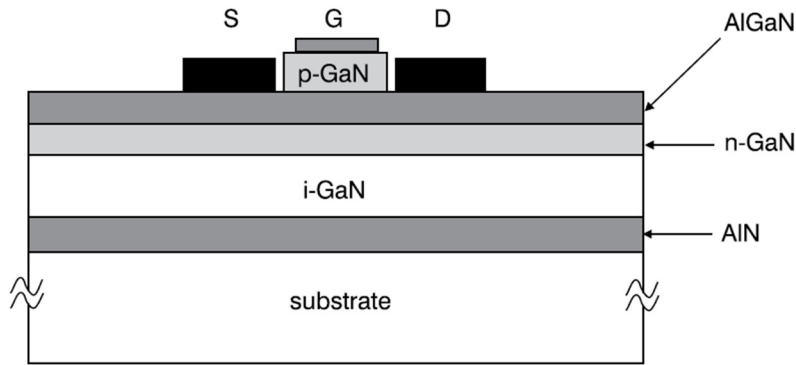
[057] As *Smith* explicitly states, FIG. 2A is a "cross-sectional schematic." *Smith* ¶[0041]. A POSITA would have understood FIG. 2A as a schematic cartoon, with the purpose of describing the general design and the overall arrangement of layers. A POSITA would not have understood as an exact design or a precise

implementation. A POSITA would not have used FIG. 2A as an explicit design to be implemented but as a conceptual drawing showing the different layers and their organization. For example, the drawing is not at scale and it does not show all elements of a transistor (e.g., the transition layers are not shown). A POSITA would not have understood FIG. 2A to be a precise implementation.

[058] And while *Smith* shows cap layer 34 abutting both ohmic contacts, *Smith*'s description specifies such direct contact is not required. *Smith* explains that the cap layer arrangement in FIG. 2A between the Ohmic contacts is only an example. *Smith* explains that the ohmic contacts could be positioned differently, expressly stating that "embodiments of the present invention should not be construed as limited to structures having ohmic contacts recessed through the cap layer." *Smith* ¶[0121].

[059] Based on such disclosure a POSITA would have known that *Smith*'s device was clearly not limited to having the cap layer in direct contact with the ohmic contacts as shown in FIG. 2A. Particularly because by the time of the '294 patent a POSITA knew of multiple cap layer arrangements, some without direct cap-layer to ohmic contact. For example, by the time of the '294 patent POSITA knew, for almost a decade, of designs like the one in Ex. 1014 (published in 2000,

reproduced below) or the admitted prior art, that use a similar arrangement as *Smith* FIG. 2A but with the cap layer (p-GaN) not contacting ohmic contacts.



[060] I find Dr. Schubert's challenge to the operability of *Smith* based on the schematic in FIG. 2A is an overly narrow interpretation of *Smith* that neglects *Smith*'s written description and the ability of a POSITA. It is like arguing that a house represented by a blueprint is nonviable because the walls appear too thin on paper to support the structure. Like an architect interpreting a house blueprint, a POSITA would have understood *Smith*'s schematics as representations to be interpreted when fabricating the device. And by the time of the '294 patent, the structure for the III-Nitride enhancement-mode devices had been known for almost a decade. It would have been well within the scope of the POSITA knowledge to interpret *Smith*'s figures, and related descriptions, for the formation of a functional device.

[061] In my opinion, Dr. Schubert is taking an overly narrow interpretation of a cartoon to challenge the operability of *Smith* as enhancement-mode. I disagree with his argument of direct contact between cap layer and the ohmic contacts is an overly narrow read of *Smith*—particularly when *Smith* specifically teaches the drawing is not limiting and describes alternative options.

[062] Second, even assuming a POSITA would have interpreted *Smith* FIG. 2A as Dr. Schubert proposes requiring the cap layer to be directly contact the ohmic contacts—an assumption I strongly disagree with—I still do not think a POSITA would have seen *Smith* as non-functional in enhancement-mode.

[063] Dr. Schubert seems to argue that *Smith* would not work in enhancement-because, in his opinion, “the 2DEG is only reconstituted generally under the gate, which is insufficient to turn the device ON because the 2DEG is not continuous between the ohmic contacts.” Ex. 2009 ¶118. But that is an unwarranted assumption that lacks technical merit.

[064] The reconstitution of the 2DEG cannot be determined from the cartoon in FIG. 2A because the 2DEG formation would depend on many factors including doping of the layers, their thickness, and applied operation voltage. Dr. Schubert does not consider any of these factors in his analysis. Yet, a POSITA would have known how to manipulate doping, thicknesses, layer composition,

device dimensions, and voltages for an enhancement-mode operation. Dr.

Schubert's argument that the 2DEG could not be reconstituted is inaccurate and fails to consider the knowledge and ability a POSITA when the '294 patent was filed.

[065] Instead, I agree with the explanation Dr. Michael Lebby provided, which Dr. Schubert seems to criticize in his declaration. Ex. 2009 ¶122. I agree with Dr. Lebby's explanation that applying sufficient voltage would affect the entire channel, not only below the gate as Dr. Schubert argues. And a POSITA would have known how to select the voltage to permit reconstituting the entire 2DEG channel. Dr. Schubert argues Dr. Lebby's explanation "is scientifically inaccurate." Ex. 2009 ¶122. But he does not explain why. I agree with Dr. Lebby that when applying a voltage to the gate electrode, the electric field would not be limited to below the gate it would reach other regions. And the larger the gate voltage applied, the greater magnitude and reach of the electric field emanating from the gate electrode for inducing a 2DEG.

[066] Applying a larger gate voltage would alter the energy band diagram at the cap layer / barrier layer interface and can induce a 2DEG not only under the gate—as Dr. Schubert seems to assume—but throughout the length. Further, the formation of the 2DEG would also be a function of the drain voltage, something

Dr. Schubert fails to consider. As Dr. Lebby mentioned, such voltages selection would require some engineering to adjust other variables, like leakage and breakdown. But those optimizations and design choices would have been well within the scope of the capabilities of the POSITA because as reference Ex. 1015 (dissertation from December 2008) explained, by the time of the '294 patent POSITA knew about the “design space of a p-GaN capped AlGaIn/GaN.” Ex. 1015, 31.

[067] I do not agree with Dr. Schubert’s allegations that Dr. Lebby’s description of how the device would operate at higher gate voltages is “scientifically inaccurate.” Even if a POSITA had interpreted FIG. 2A narrowly, as Dr. Schubert proposes, which I disagree with, a POSITA would have not found *Smith* cannot operate as enhancement-mode.

b. Manufacturability of *Smith*’s FIG. 2A confirms *Smith* would operate in enhancement-mode

[068] For his second argument, Dr. Schubert argues that the *Smith* transistor “cannot actually be manufactured as depicted in the figure.” Ex. 2009 ¶¶116, 123. I do not necessarily agree with Dr. Schubert. Dr. Schubert quotes a portion of one of my deposition where I testified that I would not know how you build a device with a cap layer abutting the ohmic contacts in FIG. 2A. Ex. 2009 ¶123. But while I have not built a device like that one in the past, I do not think it is impossible to

manufacture it either. There are techniques that could result in the a cap layer abutting the ohmic contacts.

[069] But regardless of the manufacturability of FIG. 2A as shown, instead of supporting Dr. Schubert's lack of operability argument, Dr. Schubert's conclusion that FIG. 2A cannot be manufacture as depicted in the figure confirms that a POSITA would have understood FIG. 2A as a cartoon, not as literal implementation of a device. If Dr. Schubert is right and it is not possible to manufacture the device as depicted in FIG. 2A, that only shows that a POSITA would have understood FIG. 2A as a cartoon conveying the design, a cartoon that need not be (and according to Dr. Schubert could not be) manufactured as depicted in the figure.

[070] Dr. Schubert also seems to quote some of my deposition where I explained that if cap layer is conductive, and in electric contact with ohmic contacts, the current would always be flowing from source to drain and that "would be a disaster." Ex. 2009 ¶123. And that remains correct. If you have a conductive layer contacting ohmic contacts of source and drain, the transistor would have large drain-source leakage and would not operate correctly.

[071] But again, Dr. Schubert's analysis does not make *Smith* a non-functional enhancement-mode device, it instead confirms that a POSITA would

have understood FIG. 2A could operate as enhancement-mode because *Smith* specifies cap layer 34 is not conductive. *Smith* ¶[0087]. As Dr. Schubert seems to agree, a POSITA would have realized that having a layer contacting the ohmic contacts and potentially creating an alternative current path would not be desirable for the transistor operation. But such observation does not foreclose *Smith*'s enhancement-mode operation. First because a POSITA would not have interpreted the drawings to literally require electric contacts, but as a cartoon with a general concept. And second because *Smith* specifies its cap layer is not conductive.

[072] *Smith* explicitly explains that the level of doping in the cap layer must be controlled so the layer is not conductive when p-doped. *Smith* ¶[0087]. Even if *Smith* was limited to devices in which cap layer directly contacts both ohmic contacts, a POSITA would have still understood *Smith* covers enhancement-mode device based on *Smith* explicit disclosure that the doping in cap layer cannot make the layer conductive. *Smith* ¶[0087]. Relatedly, this is why a POSITA would have found it obvious to use hydrogen passivation in the cap layer—to prevent it from becoming conductive. Even if a POSITA considers *Smith* FIG. 2A requires direct contact, which I do not agree with, because *Smith* specifies cap layer's doping is controlled so the layer is not conductive, it could still operate as enhancement-mode and *Smith* motivates the use of the hydrogen passivation techniques.

B. *Smith*'s "Level of Doping" Depends on Dopant Passivation

[073] In his declaration, Dr. Schubert argues that I misunderstood what *Smith* meant by "level of doping" in paragraphs [0086]-[0089]. Dr. Schubert argued that I confused "'level of doping' with the level of compensation of dopant." Ex. 2009 ¶139. He argues that "[p]assivation is therefore independent of the level of doping and may cause unexpected, counterintuitive results." Ex. 2009 ¶140.

[074] I disagree with Dr. Schubert because *Smith* discloses the "level of doping" affected the layer's conductivity. Thus, a POSITA would not have taken level of doping as independent from passivation. And far from being "counterintuitive" passivation of dopants was (and is) a common technique that, as the prior art documents show, was widely used for tailoring electrical characteristics of III-V semiconductor layers.

[075] *Smith* associates the "level of doping" with conductivity, not their mere concentration. *Smith* ¶[0087]. Therefore, *Smith*'s level of doping corresponds to the active dopants, not the total concentration of dopants, because conductivity is proportional to the active dopant concentration. *Smith* ¶[0087]. For example, *Smith* describes that the "level of doping" needs to be in a "sweet spot" because if the level of doping is too low, the dopants are not dominant causing gate leakage,

but if the doping level is too high, the dopants make the layer conductive also causing gate leakage. Specifically, *Smith* teaches that:

The level of doping should be sufficiently high so as to reduce leakage current in embodiments without a recessed gate and be the dominant ‘surface’ state but not so high as to provide introduce traps or leakage paths by becoming a conductive layer.

Smith ¶[0087]

A POSITA reading *Smith*’s description of the “level of doping,” as being in a “sweet spot” (not too high and not too low) and controlling the layer’s conductivity and the resulting leakage, would have understood that *Smith*’s “level of doping” is not merely the dopant concentration, but also depends on the dopant’s state as passivated or active.

[076] By the time of *Smith*’s publication a POSITA knew that the dopant effects *Smith* describes, like surface effects and conductivity, not only depended on the dopant concentration but hinged on the dopant state. Ex. 1003 ¶¶60-64. This had been known for decades. As Dr. Nakamura explained in his seminal paper from 1992, in GaN the dopants that are neutralized do not contribute to the layer conductivity. Ex. 1018, 9. Because *Smith* associates the “level of doping” with the conductivity, a POSITA would not have understood *Smith*’s “level of doping” as mere concentration independent of hydrogen passivation, but as the doping effects.

[077] Dr. Schubert argues that “passivation with hydrogen affects to what extent the dopants in a p-GaN layer are compensated, not the level of doping (which is based on the concentration of dopants in the layer).” Ex. 2009 ¶140. But that contradicts *Smith* description of the “level of doping” in the cap layer and the “sweet spot” that *Smith* describes as desirable.

[078] Indeed, *Smith*’s use of terms in his description contradicts Dr. Schubert’s assessment that “level of doping” refers to concentration ranges because *Smith* uses two different terms: one for “level of doping” (for the active dopants influencing effects like conductivity) and one for “dopant concentration” (for the concentration ranges). *Smith* uses a “dopant concentration” different from “level of doping,” and *Smith* consistently relates the “level of doping” to the effects of the dopants, not merely their concentration. *Smith* ¶¶[0086]-[0089]. A POSITA would not have understood the “level of doping” as mere dopant concentration but as the active dopants.

[079] Because *Smith* relates “level of doping” with the dopant effects like its influence in the conductivity, trapping, current paths, and surface states, *Smith*’s level of doping is not merely the dopant concentration as Dr. Schubert argued. Instead, *Smith*’s level of doping, and its goal of having the “level of doping” in a “sweet spot,” is related to the active (unpassivated) dopants and dependent on the

dopant passivation. As I explained in my first declaration, to a POSITA it would have been obvious to use the known hydrogen passivation and/or incorporation techniques in the formation of the cap layer to control its “level of doping.” Ex. 1003 ¶¶110-111, 125.

C. *Smith*’s Disclosure of How The Cap Layer is Formed, With MOCVD and a Level of Doping That Makes the Layer Non-conductive, Describes a “Compensated GaN Layer”

[080] In his declaration, Dr. Schubert argues that in Ground 1A *Smith* does not disclose a “compensated GaN layer” because the “mere presence of hydrogen is not enough, and the mere fact that a layer is something less than conductive is not enough.” Ex. 2009 ¶126. But Dr. Schubert misunderstood the *Smith* disclosure and the obviousness Ground 1A.

[081] *Smith* describes the cap layer is grown with an epitaxy process (like MOCVD), has p-type dopants (like Mg), and has a level of doping that makes the layer nonconductive. *Smith* ¶¶[0085]-[0087]. *Smith*’s disclosure of the layer’s formation and its characteristics render obvious the “compensated GaN layer,” under any of the proposed constructions. A POSITA would have understood that because *Smith*’s cap layer is formed with MOCVD, is doped with Mg dopants, and the doping is controlled so the layer is not conductive, it would have been obvious

that the cap layer is a “compensated GaN layer” under both EPC and Innoscience proposed constructions. See above §III.C.

[082] In his declaration Dr. Schubert accuses of “playing rhetorical games” equating as-grown GaN with p-type GaN. But I am not making that equivalence. Instead, I have pointed out how a POSITA knew that when GaN is grown as described by *Smith* (e.g., with MOCVD) it would include hydrogen that would passivate the p-type dopants *Smith* discloses for cap layer 34 (e.g., Mg). Ex. 1003 ¶¶62-63, 113-114; *Smith* ¶[0087].

V. DR. SCHUBERT MISUNDERSTOOD THE COMBINATION IN GROUND 1B OF *SMITH* AND *KIGAMI*

A. In Ground 1B I Do Not Propose Replacing a Layer in *Smith* With One From *Kigami*, but the Use of *Kigami*’s Hydrogenation to Control the Cap Layer Level of Doping

[083] Dr. Schubert misunderstood or misstated the combination that I proposed in Ground 1B. Dr. Schubert argued that it would not have been obvious to combine *Kigami* and *Smith* alleging that *Kigami* discloses a different device, that in *Kigami* the layer with hydrogen corresponds to a buffer and/or a transition layer with regard to claims 1-3, and that *Kigami*’s layer with hydrogen would not be suitable “in place of” *Smith*’s cap layer. Ex. 2009 ¶¶ 151-154.

[084] But in Ground 1B I did not propose any substitution of *Kigami*’s layers “in place of” *Smith*’s cap layer. That is not the combination that I proposed.

Instead, the combination I proposed is applying known *Kigami*'s hydrogenation technique for the tailoring of dopants in *Smith*'s device cap layer.

[085] As I noted in my first declaration, *Kigami* teaches a technique in which hydrogen is locally incorporated in a doped GaN layer to inactivate the dopants and make the layer more resistive, which *Kigami* describes as resulting in an insulating layer. Ex. 1003 ¶¶99-101, 118-119; *Kigami* ¶[0011]. *Kigami* describes how the technique it teaches, which uses ionized hydrogen diffusion and implantation, is useful to locally passivate acceptors (and specifically magnesium). Ex. 1003 ¶¶117-118; *Kigami* ¶[0026]. *Kigami* teaches that its technique allows adjusting where the hydrogen gets added (e.g., by using additional layers that facilitate or impede the flow of hydrogen). *Kigami* ¶[0026]. And *Kigami* teaches that its technique is useful particularly in cases that use magnesium as the dopant. *Kigami* ¶[0012].

[086] In Ground 1B, I proposed applying this *Kigami* hydrogenation technique, which *Kigami* describes as versatile and allowing to locally control dopants, for the formation of *Smith*'s cap layer. Ex. 1003 ¶¶128-133. In Ground 1B I do not propose a substitution of *Kigami*'s layer "in place of" one in *Smith*, as Dr. Schubert misunderstood. Ex. 2009 ¶154. What I propose is the use of *Kigami*'s known hydrogenation technique to the known *Smith* device. Ex. 1003 ¶¶128-133.

[087] To a POSITA such a combination would have been obvious. To a POSITA it would have been obvious to apply *Kigami*'s known technique (e.g., ionized hydrogen introduction) to *Smith*'s known device (e.g., the transistor in FIG. 2A) when seeking to improve *Smith* by permitting a better control of the "level of doping" to control leakage. And a POSITA would have performed the proposed combination with the expected results of increasing the resistivity in *Smith*'s cap layer, a POSITA would have expected that applying *Kigami*'s technique to *Smith* would passivate dopants and prevent the cap layer from becoming conductive. Ex. 1003, ¶125-133. As I explained in my first declaration, a POSITA would have understood that applying *Kigami*'s hydrogenation would allow implementing the level of doping tailoring *Smith* calls for in seeking the level of doping "sweet spot." *Smith*, [0087]; Ex. 1003 ¶132.

B. Applying *Kigami*'s Technique to *Smith* Does Not Render *Smith* Inoperable and Passivating Dopants Has Never Been Considered Counterintuitive

[088] Apparently based on his misunderstanding of the Ground 1B combination, Dr. Schubert also argues that the passivation in the *Kigami* and *Smith* combination "would void [the dopants] purpose in Smith, rendering the Smith device inoperable for its stated purpose" and that the passivation would be "highly counterintuitive." Ex. 2009 ¶155. But the combination in Ground 1B is not

replacing any layers and it would not render *Smith* inoperable, it would instead further *Smith*'s objectives of achieving the level of doping "sweet spot."

[089] The Ground 1B combination is the application of *Kigami*'s hydrogenation technique to *Smith*'s device. And using *Kigami*'s technique in *Smith* far from being counterintuitive would be complementary because it would further *Smith*'s goal of achieving the level of doping "sweet spot." Ex. 1003 ¶¶131-132.

[090] *Smith* itself asks to control the dopants in cap layer because while the level of doping need to be sufficient to become the dominant state, the level of doping cannot be too high because that would "introduce traps or leakage paths by becoming a conductive layer." *Smith* ¶[0087]. When applying *Kigami*'s technique to *Smith*, the hydrogenation and passivation of dopants in *Smith*'s cap layer would not "void their purpose," as Dr. Schubert alleges. Instead, applying *Kigami*'s technique would control the level of doping (e.g., locally inactivating some of the *Smith* dopants). Applying *Kigami*'s technique to *Smith* would prevent the layer from becoming a conductive, furthering *Smith* goal of a "sweet spot" level of doping to gain the advantages from some doping (e.g., dominate surface effects) but minimize the harmful effects of too much doping (e.g., making the layer conductive). *Smith* ¶[0087]. Indeed, a POSITA would have recognized *Kigami*'s technique as highly desirable to achieve *Smith*'s "sweet spot" because it allows

tailoring of the level of doping post-fabrication and after the placement of the gate electrode. *Kigami* discloses that with its technique “hydrogen ions can pass through the gate electrode 58 and the gate-insulating film 52” and “the region into which the hydrogen atoms are to be introduced, the concentration distribution of the hydrogen atoms to be introduced, and the like can be adjusted.” *Kigami* ¶[0026]. A POSITA would have recognized these characteristics of *Kigami*’s technique highly beneficial when seeking *Smith*’s level of doping “sweet spot.” A POSITA would have recognized that *Kigami*’s technique ability to control the passivation even after the device is fabricated and a gate electrode is formed, would facilitate achieving the “sweet spot” level of doping *Smith* asks for (e.g., allowing iterative hydrogenation and testing).

[091] Using *Kigami*’s technique in *Smith* would not render *Smith*’s devices inoperable at all, let alone produce a cap layer with opposite dopant configuration. Instead, using *Kigami*’s technique in *Smith* it would be consistent with *Smith*’s level of doping “sweet spot.” As *Kigami* explains, its hydrogenation technique locally lowers “activated p-type impurity” and permits adjusting the region and distribution of introduced hydrogen. *Kigami* ¶¶[0007], [0026].

[092] Importantly, contrary to Dr. Schubert’s suggestion, when applying *Kigami*’s technique to *Smith*, the cap layer remains with its original doping

configuration because the hydrogen acts as a passivation agent, it does not change the doping configuration. For example, if *Smith* is p-type doped, as described in paragraph [0087], applying *Kigami*'s hydrogenation would not change the doping to the opposite configuration (n-type). Rather, *Kigami*'s hydrogenation would only reduce the active p-type dopants by locally inactivating some of the p-type dopants. Introducing hydrogen using *Kigami*'s method in *Smith* would not change it to an opposite dopant configuration (in the example before the doping of the cap layer would remain p-type) but it would decrease doping levels, raise layer resistivity, and facilitate control of doping to achieve *Smith*'s level of doping "sweet spot."

[093] Moreover, I do not agree with Dr. Schubert's assessment that "doping of a gate semiconductor followed by the cancellation of the effects of the dopant to be highly counterintuitive." Ex. 2009 ¶155. The prior art and the academic literature show this process was not counterintuitive but instead common. The prior art shows a POSITA frequently doped semiconductors and then followed that process with the cancellation or inactivation of dopants seeking to, for example, increase resistivity in the layer and/or improve control of the local level of doping in certain areas.

[094] For example, while Dr. Schubert argues that doping followed by inactivation of dopants would be “highly counterintuitive” that is precisely what *Kigami* teaches. *Kigami* teaches a technique of doping a semiconductor with p-type dopants followed by the local passivation of, at least some, of the dopants, and *Kigami* explains these active dopant adjustments are desirable. *Kigami* ¶¶ [0024]-[0026]. Indeed, *Kigami* specifies the doping followed by passivation of dopants would be desirable specifically in HEMTs, the same type of devices in *Smith*. *Kigami* ¶ [0011]. *Kigami* shows a POSITA did not consider doping followed by passivation of dopants as “counterintuitive.”

[095] Another example of the process Dr. Schubert alleges as “highly counterintuitive” is in *Uemoto*. *Uemoto* teaches fabricating a transistor first with a p-type doping and then inactivating, at least some, of the dopants. *Uemoto* ¶¶ [0033], [0063]. *Uemoto* explains that this process is not “counterintuitive,” as Dr. Schubert alleges, but it is desirable to locally control doping levels and reduce gate leakage. *Uemoto* ¶ [0063]. *Uemoto* thus shows a POSITA did not consider doping followed by passivation of dopants was counter intuitive, but desirable.

[096] And I have also considered Dr. Schubert’s own book on doping in III-V semiconductors. His book is from 1993, so about sixteen years before the ’294 patent. There Dr. Schubert was describing the effect of hydrogen in III-V

semiconductors—GaN is a III-V semiconductor. Dr. Schubert explained that introducing hydrogen can be incorporated into III-V semiconductors (like GaN), and that this process was “widely used to render III-V semiconductors highly resistive.” Ex. 1032, 402. He also noted that the introducing hydrogen “provides high flexibility to tailor the electrical properties of thin films.” Ex. 1032, 402. I agree with Dr. Schubert’s statements in his book, and I disagree with Dr. Schubert’s statements in his declaration. The technique of passivating dopants using hydrogen after doping was frequently used to manipulate the active acceptor dopants and as a result tailor the electrical characteristics in III-V semiconductors. The technique is not “counterintuitive” as Dr. Schubert now alleges.

[097] The prior art, and Dr. Schubert’s own book, shows that the inactivation of dopants after doping was not “counterintuitive.”

VI. DR. SCHUBERT’S ANALYSIS OF UEMOTO’S IS INCORRECT

A. *Uemoto* is Not Similar to the Admitted Prior Art

[098] In his declaration, Dr. Schubert argued that *Uemoto* “describes a device that is substantially similar to the prior art enhancement-mode device shown in Figure 1 of the ’294 Patent.” Ex. 2009 ¶179. I do not agree with Dr. Schubert’s assessment of *Uemoto*.

[0099] While *Uemoto* shares some characteristics with the admitted prior art, they are not substantially similar because they have different layers and a different design. For example, *Uemoto* clearly distinguishes from the admitted prior art because the admitted prior art does not have any high resistive region like *Uemoto*'s region 15b. This difference is important because, as noted in my first declaration and above, *Uemoto*'s region 15b meets the "compensated GaN layer" requirement under any of the proposed constructions. This difference alone makes the two designs different. In addition to different layers, the two transistors also have a different configuration. For example, while the contacts in the admitted prior art seem to be designed to be on top of the barrier layer, the contacts in *Uemoto* go through the barrier. Another difference that shows *Uemoto* and the prior art are not similar.

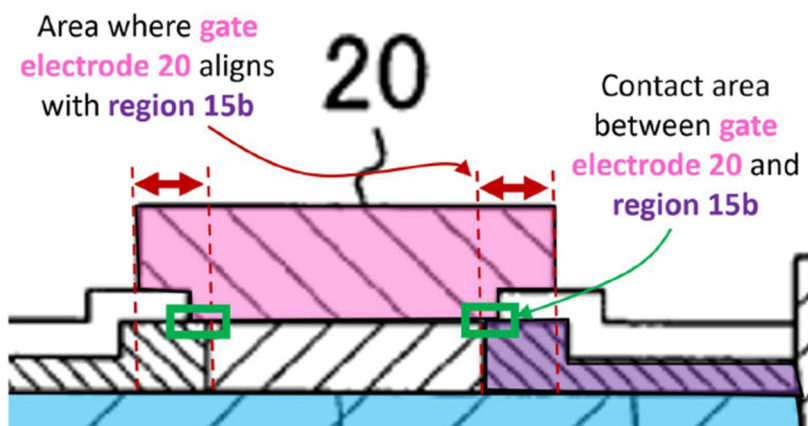
[0100] Because *Uemoto* and the admitted prior art have key differences, particularly with respect to the claims of the '294 patent, I do not agree with Dr. Schubert's assessment that *Uemoto* is "substantially similar" to the admitted prior art.

B. *Uemoto*'s Region 15b Does Affect the Gate Capacitance

[0101] In his declaration, Dr. Schubert notes that *Uemoto* discloses region 15b reduces gate leakage current. Ex. 2009 ¶180. But Dr. Schubert argues that

“[e]ven if high resistive region 15b could reduce gate leakage, it still will not impact gate capacitance, because it is not a part of the gate structure.” Ex. 2009 ¶180. I do not agree with Dr. Schubert’s assessment of *Uemoto*’s region 15b because in *Uemoto* region 15b would also impact the gate capacitance and it is, at least partially, part of the gate.

[0102] *Uemoto*’s region 15b would impact the gate capacitance. The gate capacitance is the capacitance of the gate terminal and is generally a function of the gate area, the permittivity of the layer(s) below the gate, and the thickness of the layer(s) below the gate. As I noted in my declaration, the gate electrode 20 is above region 15b. Additionally, as noted in the image below, the region 15b is part of the gate structure because it is (at least partially) immediately below and in contact with the gate electrode 20. Accordingly, the region 15b permittivity, lateral overlap with the gate metal, and thickness will impact the gate capacitance.



[0103] Even the portions of *Uemoto*'s region 15b that are not immediately below gate electrode 20 also affect the gate capacitance. Portions of region 15b not immediately below and in contact with the gate electrode 20 (e.g., the region 15b in the far right) would still have an impact on the gate capacitance because they will affect what is known as the fringing capacitance of the gate. Portions of region 15b not immediately below and in contact with the gate electrode 20 will also influence the capacitance between the gate and the drain/source electrodes.

[0104] *Uemoto*'s region 15b will have an impact in the gate capacitance, both based on the portions that are in contact and immediately below the gate, and also based on the portions that are not. Therefore, I do not agree with Dr. Schubert's argument that *Uemoto*'s region 15b will have no impact on the gate capacitance.

VII. DR. SCHUBERT'S OPINIONS ON SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS ARE NOT DIRECTED TO THE UNIQUE CHARACTERISTICS OF THE CLAIMS

[0105] In his declaration, Dr. Schubert argues "secondary considerations of non-obviousness for the '294 patent." Ex. 2009 §XI. He argues that, in his opinion, the "'294 patent provided a very significant technological advancement over prior known GaN transistors having conductive p-type gate materials." Ex. 2009 ¶192. But Dr. Schubert's opinions fail to show the alleged advancement is related to the

unique features of the claims of the '294 patent and therefore does not change my analysis regarding the invalidity of the claims.

[0106] For example, Dr. Schubert argues that “the invention of the '294 patent is an enhancement-mode GaN transistor” and discusses some benefits for enhancement-mode operation. Ex. 2009 ¶¶193-194. As I note above, however, the claims are not directed to enhancement-mode transistors and the patent is not directed to enhancement-mode devices, the patent also describes depletion-mode devices. Indeed, Dr. Schubert seems to contradict himself because he also pointed out how the “'294 Patent describes improvements to conventional E-mode and D-mode GaN transistors,” not only enhancement-mode. Ex. 2009 ¶48.

[0107] Further, the benefits Dr. Schubert points to, like the alleged technique that “allowed the device to be an enhancement-mode device” focuses on the enhancement-mode operation, something that is not a feature of the claims, and is not unique to the claims. Dr. Schubert argues that “EPC’s enhancement-mode GaN devices were a significant technological leap over the prior generation technology, for example, depletion mode devices.” Ex. 2009 ¶195. But as the '294 patent admits, enhancement-mode devices had already been invented before the '294 patent. Ex. 1001, 1:55-56, Fig. 1. Dr. Schubert’s arguments that the '294 patent “allowed the device to be an enhancement-mode” and were a “technological

leap” over depletion-mode devices cannot be related to claimed invention or its features because the ’294 patent does not claim enhancement-mode transistors. And the ’294 patent certainly did not “allow” enhancement-mode devices because, as the patent admits, enhancement-mode transistors already existed.

[0108] I also disagree with Dr. Schubert description of the device in the ’294 patent as a “significant improvement” and “technological leap” (Ex. 2009, ¶¶194-195) because the hydrogen compensated GaN approach in the ’294 patent has inefficiencies and robustness issues. And, to my knowledge, the industry did not adopt the use of hydrogen for commercial devices. As the ’294 patent recognized, relying on hydrogen passivation to fabricate transistors causes performance issues because of the sensitivity of the hydrogen process. For example, the patent acknowledges that “the performance of the device of the second embodiment [using a semi-insulating layer instead of a compensated layer] is not as sensitive to future processing steps involving hydrogen and/or high temperatures.” Ex. 1001, 3:67-4:2. The performance sensitivity of the compensated layer approach will cause robustness and operability issues that are undesirable in commercial devices. At least these admitted performance sensitivity shortcomings of the hydrogen passivation approach described in the ’294 patent support my conclusion that it is not “significant improvement” or a “technological leap.”

[0109] Dr. Schubert also argues that the '294 patent permitted technical advantages like “reduced gate leakage” and “greater switching efficiency.” Ex. 2009 ¶194. But these features are not unique characteristics of the claims. Neither of these characteristics are recited in the claims. And they are not unique to the claims because they are also features identified in prior art devices. Devices in the prior art were also enhancement-mode GaN devices and had reduced gate leakage and improved switching efficiency. For example, *Uemoto* is an enhancement-mode GaN that has reduced gate leakage. *Uemoto*, [0044], [0059]. *Kigami* is an enhancement-mode GaN that has improved switching efficiency. *Kigami*, [0059]. The technical advantages Dr. Schubert points are as showing non-obviousness are not reflected in the claims—e.g., the claim does not recite them—and they are not unique to the claims—e.g., they are disclosed in the prior art devices.

[0110] Instead of focusing on the unique features of the claim, Dr. Schubert seems to have focused on the device commercialization and the alleged introduction of the “first commercial enhancement-mode GaN transistors in 2009.” Ex. 2009 ¶194. But this first commercialization is not based on the unique features of the claims. This is confirmed with the documents Dr. Schubert cited. For example, Exs. 2020 and 2021 discuss supply chain, packing limitations, and low-

cost fabrication. They do not even mention a “Compensated Gate MISFET” as in the patent. These leads me to conclude that the commercialization Dr. Schubert relies on is not linked to the unique features of the claims but to other features like production costs and supply chain issues. Dr. Schubert also cites to “some of the industrial praise EPC gathered over the years.” Ex. 2009 ¶197. But this alleged industrial praise has nothing to do with the unique features of the ’294 patent claims.

[0111] Dr. Schubert’s opinions and his analysis does not change my opinion regarding secondary considerations. I am still not aware of any evidence of secondary considerations that would support a determination of non-obviousness of the claimed subject matter in the ’294 patent.

VIII. UPDATED MATERIALS CONSIDERED

[0112] In forming my opinions, I read and considered the ’294 patent and its prosecution history, the exhibits listed in the Exhibit List filed with the petition for *inter partes* review of the ’294 patent, as well as any other materials referenced herein. I have reviewed the following at least the following documents:

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,350,294 B2 to Lidow et al. (“the ’294 patent”)
Ex. 1002	Prosecution History of the ’294 Patent (“ <i>Prosecution History</i> ”)

Exhibit	Description
Ex. 1005	U.S. Patent Application Publication No. US 2007/0164315 A1 to Smith et al. (“ <i>Smith</i> ”)
Ex. 1006	U.S. Patent Application Publication No. US 2008/0087915 A1 to Uemoto et al. (“ <i>Uemoto</i> ”)
Ex. 1007	Japanese Patent Publication No. JP2006-253224 A to Kigami et al.
Ex. 1008	Certified English Translation of Japanese Patent Publication No. JP2006-253224 A (“ <i>Kigami</i> ”)
Ex. 1009	Translator’s Declaration for Certified English Translation of JP 2006-253224 A to Kigami et al.
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> ”)
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)

Exhibit	Description
	(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> ”).
Ex. 1020	U.S. Patent No. 5,985,687 to Bowers et al. (“ <i>Bowers</i> ”)
Ex. 1021	U.S. Patent Application Publication No. 2002/0167023 A1 to Chavarkar et al. (“ <i>Chavarkar</i> ”)
Ex. 1022	U.S. Patent Application Publication No. 2003/0102482 A1 to Saxler (“ <i>Saxler482</i> ”)
Ex. 1023	Shuji Nakamura – Biographical, NobelPrize.org, Nobel Prize Outreach AB 2023, www.nobelprize.org/prizes/physics/2014/nakamura/biographical/ (last visited Aug. 28, 2023) (“ <i>Biographical Nakamura</i> ”)
Ex. 1024	Excerpts of Vasco Matias, Defect characterization of Europium implanted Gallium Nitride (2008) (Ph.D. dissertation, KU University, Belgium) (“ <i>Matias</i> ”).

Exhibit	Description
Ex. 1026	<i>Merriam-Webster Dictionary</i> (excerpt) (2022)
Ex. 1027	Prepositions of Place in English Grammar, LanGeek.co, Prepositions and Conjunctions, https://langeek.co/en/grammar/course/69/prepositions-of-place (last visited Jan. 15, 2024)
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)

[0113] I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

IX. CONCLUSION

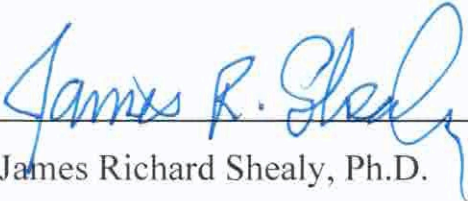
[0114] For the reasons set forth above, in my opinion, a person of ordinary skill in the art would have found claims 1-12 of the '294 patent obvious.

[0115] In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

[0116] I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: September 3, 2024

By: _____


James Richard Shealy, Ph.D.