

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LITE-ON TECHNOLOGY CORPORATION

Petitioner

v.

SENSOR ELECTRONIC TECHNOLOGY, INC.,

Patent Owner.

Inter Partes Review No. 2022-00780

U.S. Patent No. 9,923,117

DECLARATION OF DR. DANIEL FEEZELL

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EXHIBIT LIST

Ex. No.	Description
Ex. 2001	Chambers Dictionary of Science and Tech., definition for “ <i>homogeneous</i> ”, 2007.
Ex. 2002	United States Patent No. 7,812,366.
Ex. 2003	E. Fred Schubert, “ <i>Light-Emitting Diodes</i> ”, pgs. 167-168, 2006.
Ex. 2004	United States Patent and Trademark Office, Director Memorandum, dated June 21, 2022.
Ex. 2005	<i>Sensor Electronic Tech., Inc. v. Lite-On Tech. Corp. et al.</i> , Case No. 6:21-cv-00322-ADA (W.D. Texas), Dkt. No. 1, Complaint with Jury Demand, dated April 2, 2021.
Ex. 2006	<i>Sensor Electronic Tech., Inc. v. Lite-On Tech. Corp. et al.</i> , Case No. 6:21-cv-00322-ADA (W.D. Texas), Dkt. No. 45, Amended Scheduling Order, dated June 22, 2022.
Ex. 2007	<i>Burley Licensing LLC v. Micro-Star International Co. Ltd.</i> , Case No. 6:21-cv-00862-ADA (W.D. Texas), Docket Report.
Ex. 2008	<i>Frac Shack Inc. v. Alaska Fuel Distributors Inc.</i> , Case No. 7:19-cv-00026-ADA-DTG (W.D. Texas), Docket Report.
Ex. 2009	<i>MicroPairing Technologies LLC v. General Motors LLC</i> , Case No. 6:21-cv-00761-ADA (W.D. Texas), Docket Report.
Ex. 2010	<i>ParkerVision, Inc. v. LG Electronics Inc.</i> , Case No. 6:21-cv-00520-ADA (W.D. Texas), Docket Report.
Ex. 2011	<i>TrackThings LLC v. Amazon.com, Inc. et al</i> , Case No. 6:21-cv-00720-ADA (W.D. Texas), Docket Report.
Ex. 2012	Docket Navigator, Motion Stay Success Rates Pending <i>Inter Partes</i> Review in W.D. Texas.
Ex. 2013	Ryan Davis, “ <i>Albright Says He’ll Very Rarely Put Cases On Hold For PTAB</i> ”, Law360, dated May 11, 2021.
Ex. 2014	<i>Sensor Electronic Tech., Inc. v. Lite-On Tech. Corp. et al.</i> , Case No. 6:21-cv-00322-ADA (W.D. Texas), Dkt. No. 36, Agreed Scheduling Order, dated February 24, 2022.
Ex. 2015	Docket Navigator, Time to Trial in W.D. Texas.
Ex. 2016	<i>Sensor Electronic Tech., Inc. v. Lite-On Tech. Corp. et al.</i> , Case No. 6:21-cv-00322-ADA (W.D. Texas), Defendants' Preliminary Invalidity Contentions, dated March 24, 2022.
Ex. 2017	Declaration of Etai Lahav in Support of Patent Owner’s Motion For <i>Pro Hac Vice</i> Admission

Ex. No.	Description
Ex. 2018	Declaration of Dr. Daniel Feezell in Support of Patent Owner's Contingent Motion to Amend
Ex. 2019	Deposition Transcript of Dr. James R. Shealy, taken on January 26, 2023.
Ex. 2020	U.S. Patent Application No. 14/984,156
Ex. 2021	Declaration of Dr. Daniel Feezell in Support of Patent Owner's Response to Petition

I. INTRODUCTION

1. My name is Dr. Daniel Feezell. I am an associate professor in the Electrical and Computer Engineering (ECE) Department at the University of New Mexico (UNM). I have been retained by Patent Owner Sensor Electronic Technology, Inc. (“Patent Owner” or “SETi”) as an expert witness in the above-captioned proceeding to offer certain opinions related to U.S. Patent No. 9,923,117 (“the ’117 Patent”). I am being compensated for the time I spend on this proceeding on an hourly basis at a rate of \$450. This declaration is based upon my knowledge, skill, experience, training, and education in my field of expertise, and upon information reviewed in connection with my retention as an expert witness in this matter. My compensation does not depend on any outcome or order in this proceeding.

2. I received a B.S. degree in Electrical Engineering from the University of California, Irvine in 2000. In September 2000, I began graduate studies at the University of California, Santa Barbara (UCSB). I was offered a position as a graduate research assistant in Prof. Larry Coldren’s group. In 2001, I received a M.S in Electrical Engineering from UCSB. In 2005, I received a Ph.D. in Electrical Engineering from UCSB, with emphasis in electronics and photonics. My dissertation was titled *Long-Wavelength Vertical-Cavity Surface-Emitting Lasers with Selectively Etched Thin Apertures*. My area of research was generally

in light-emitting photonic devices based on semiconductors with a focus on semiconductor lasers, including a vertical-cavity surface-emitting laser (VCSEL) platform using AlGaAsSb distributed Bragg reflectors (DBRs).

3. Immediately following my doctoral research work, I accepted a Postdoctoral Researcher position at UCSB in the group of Prof. Shuji Nakamura, 2014 Nobel Laureate in Physics. My projects focused on developing a GaN-based VCSEL with SiO₂/Ta₂O₅ dielectric DBRs. At this time, I also worked on other GaN-based semiconductor laser platforms and GaN-based light-emitting diodes (LEDs).

4. In 2007, I began work as the first employee at Soraa, Inc., an GaN-based LED and laser start-up company founded by UCSB professors Shuji Nakamura, Steven DenBaars, and James Speck. At Soraa, Inc., I was responsible for design and fabrication of high-efficiency GaN-based LEDs.

5. In 2010, I joined UCSB as a Project Scientist, working with Prof. Shuji Nakamura in the Solid-State Lighting and Energy Center (SSLEC). In this capacity, I was responsible for managing and advising graduate students working on projects related to GaN-based LEDs and lasers. I also performed my own research on GaN-based VCSELs at the time, including epitaxial growth, fabrication, and characterization.

6. In 2012, I joined the faculty in the Electrical and Computer Engineering (ECE) Department at the University of New Mexico (UNM), first as an Assistant Professor and later promoted to tenured Associate Professor. I also have an affiliation with the Center for High Technology Materials (CHTM) at UNM and I am currently the General Chair of the Optical Science and Engineering (OSE) program. My group's research is focused on epitaxial growth and fabrication of GaN-based optoelectronic devices, including VCSELs and high-efficiency and high-speed LEDs; nanoscale selective-area epitaxy; and wide-band-gap power electronics. I received a Defense Advanced Research Projects Agency (DARPA) Young Faculty Award in 2013 with a Director's Fellowship Extension in 2015 and a National Science Foundation Faculty Early Career Development (CAREER) Award in 2015. In 2020, I was selected for the honorary title of UNM Regents' Lecturer. My UNM research projects have been funded by the National Science Foundation (NSF), the Department of Energy (DOE), DARPA, the Department of Defense (DoD), the Advanced Research Projects Agency – Energy (ARPA-E), the Defense Threats Reduction Agency (DTRA), and private industry. I am a Senior Member of IEEE and have authored or co-authored over 150 journal and conference publications related to semiconductor optoelectronics, electronics, and materials. I am a named inventor on around 25 U.S. patents. I have around 18

years of experience working with GaN-based materials and devices. My CV has been attached as an appendix.

7. I have reviewed the specification and file history of the '117 Patent and the exhibits and filings in this proceeding, including Lite-On's Petition and the declaration of its expert, Dr. James Shealy.

II. SUMMARY OF OPINIONS

8. The grounds on which Petitioner Lite-On Technology Corporation ("Lite-On" or "Petitioner") has challenged the claims are below.

Ground	References	Basis
1	Ohmae (Ex. 1004)	Anticipated under 35 USC § 102, Obvious under 35 USC §103
2	Ban (Ex. 1005)	Anticipated under 35 USC § 102, Obvious under 35 USC §103
3	Shur (Ex. 1006)	Anticipated under 35 USC § 102, Obvious under 35 USC §103
4	Saxler (Ex. 1007)	Anticipated under 35 USC § 102, Obvious under 35 USC §103

9. For the reasons set forth below, it is my opinion that claim 1 is not unpatentable over the prior art of record.

10. This declaration is based on the information currently available to me. To the extent that additional information becomes available, I reserve the right to continue my investigation based on the additional information.

III. LEGAL STANDARDS

11. I have been informed by counsel that the following legal standards apply. I have applied them in my analysis.

A. Claim Construction

12. I understand that claim terms are generally given their ordinary and customary meaning as understood by a person of ordinary skill in the art at the time of the invention when read in the context of the specification and prosecution history unless a patentee sets out a different definition or clearly disavows claim scope. I further understand that extrinsic evidence such as expert or inventor testimony, dictionaries, and learned treatises can help determine the meaning of claim terms, although that evidence is less significant than the claims, specification, and prosecution history.

13. I understand that claims are to be interpreted from the perspective of a person of ordinary skill in the relevant art at the time of invention. I understand that, to assess the level of ordinary skill in the art, that one may consider factors such as the education level of the inventor, the type of problems encountered in the

art, prior art solutions to those problems, rapidity with which innovations are made, sophistication of the technology, and educational level of those in the field.

B. Anticipation

14. It is my understanding that if each and every element of a claim is disclosed in a single prior art reference, then the claimed invention is anticipated. In order for an invention in a claim to be anticipated, all of the elements and limitations of the claim must be disclosed in a single prior reference, arranged as in the claim. A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. To anticipate, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the art.

15. It is my understanding that in order for a reference to inherently disclose a claim limitation, that claim limitation must necessarily be present in the reference. Inherency may not be established by probabilities or possibilities.

16. I understand that, for anticipation, that the prior art references must be viewed from the perspective of a person of ordinary skill in the relevant art, at the time the invention was made.

C. Obviousness

17. It is my understanding that obviousness is a basis for invalidity. I understand that where a prior art reference does not disclose all of the limitations of a given patent claim, that patent claim is invalid if the differences between the claimed subject matter and the prior art reference are such that the claimed subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the relevant art. I understand that obviousness can be based on a single prior art reference or a combination of references that either expressly or inherently disclose all limitations of the claimed invention. In an obviousness analysis, it is not necessary to find precise teachings in the prior art directed to the specific subject matter claimed because inferences and creative steps that a person of ordinary skill in the art would employ can be taken into account.

18. I understand that obviousness must be analyzed from the perspective of a person of ordinary skill in the relevant art, at the time the invention was made. In analyzing obviousness, I understand that it is important to understand the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any secondary considerations.

19. I understand that assessing which prior art references to combine and how they may be combined to match the asserted claim may not be based on

hindsight reconstruction or ex-post reasoning. Hindsight reconstruction is using the patent itself as a road map for recreating the invention. In assessing obviousness, only what was known before the invention was made can be considered.

20. I understand that one important guard against such hindsight reconstruction is a determination whether a person having ordinary skill in the art would have been motivated, taught, or suggested to combine the relevant teachings of the prior art to duplicate the patent claims at the time of the patented invention.

21. I understand that determining the scope and content of the prior art requires consideration of whether the prior art was reasonably relevant to the particular problem the inventors faced in making the invention covered by the patent claims.

22. I understand that determining whether there are any material differences between the scope and content of the prior art and each challenged claim of the patent under review requires consideration of the claimed invention as a whole to determine whether or not it would have been obvious in light of the prior art. If the prior art discloses all the steps or elements in separate references, consideration should be given to whether it would have been obvious to combine those references. I understand that a claim is not obvious merely because all of the steps or elements of that claim already existed.

23. I also understand that when prior art teaches away from combining prior art references, the discovery of a successful way to combine them is less likely to be obvious. Prior art teaches away from an invention when a person of ordinary skill would be discouraged or diverted from following the path leading to the invention because of the prior art.

24. I understand that in order to rely on inherency in an obviousness analysis for establishing the existence of a claim limitation in the prior art, the missing descriptive material must necessarily be present in the prior art and not merely probably or possibly present.

D. Written Description and Enablement

25. It is my understanding that a patent must contain a written description of the claimed invention. The written description must clearly convey to those skilled in the art that, as of the filing date sought, the applicant was in possession of the invention claimed.

26. I have further been advised that a claimed invention must be enabled. A claimed invention is not enabled and, therefore, unpatentable if the specification does not teach those of ordinary skill in the art how to make and use the invention as it is claimed, without undue experimentation. Undue experimentation is based on the level of skill in the art as of the effective filing date of the patent.

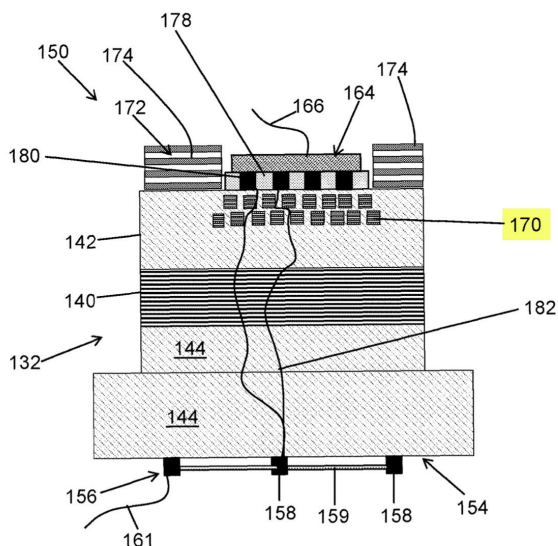
IV. THE '117 PATENT

A. Overview of the '117 Patent

27. The '117 Patent improves upon issues with deep-UV LEDs caused by “light trapping within the device, light absorption in the semiconductor layers, as well as light absorption in the contact regions.” Ex. 1001, 1:53-55. It does so by providing a semiconductor layer that includes a plurality of inhomogeneous regions. The inhomogeneous regions have “one or more attributes that differ from a material forming the semiconductor layer,” such as a region “configured based on radiation having a target wavelength,” a transparent region, a reflective region, and/or a region having “higher conductivity than a conductivity of the radiation-based regions.” Ex. 1001, 2:5-16.

28. The '117 Patent discloses the arrangement of inhomogeneous regions within multiple levels of the semiconductor layer. For example, Figure 13A depicts reflective regions arranged within multiple levels of a semiconductor layer that are vertically offset from each other: “As shown in FIG. 13A, the reflective elements 170 in each level can be staggered with reflective elements in an adjacent level such that there is an offset in position between elements in the different levels.” Ex. 1001 at 16:3-6.

FIG. 13A



Ex. 1001, Fig. 13A (annotated).

B. Challenged Claim

29. Claim 1 of the '117 Patent is challenged in the Petition and are shown below.

1[pre] A semiconductor heterostructure, comprising:

1[a] an active region;

1[b] a metallic contact;

1[c] a group III nitride semiconductor layer located between the active region and the metallic contact;

1[d] the semiconductor layer including a plurality of inhomogeneous regions arranged within multiple levels of the semiconductor layer along a height direction of the semiconductor layer;

1[e] wherein some of the inhomogeneous regions in a first level of the semiconductor layer are vertically offset from inhomogeneous regions in a second level of the semiconductor layer, and

1[f] wherein the plurality of inhomogeneous regions include one or more of a set of transparent regions, a set of reflective regions and/or a set of conductive regions;

1[g] each of the inhomogeneous regions having a set of attributes differing from a group III nitride material forming the semiconductor layer.

Ex. 1001, claim 1.

V. CLAIM CONSTRUCTION

30. As part of my analysis I have considered the appropriate construction for the term “inhomogeneous regions.” It is my opinion that this term should be construed as “a region whose compositional makeup varies within the region.” This construction is consistent with the intrinsic and extrinsic evidence.

31. Claim 1 recites “a group III nitride semiconductor layer, ... the semiconductor layer including a plurality of inhomogeneous regions arranged within multiple levels of the semiconductor layer.”

32. A POSA reading this claim language would understand that the term “inhomogeneous regions” is not referring to the group III nitride semiconductor layer as a whole, but is referring to specific regions within that semiconductor that

are themselves inhomogeneous. There is nothing about the claim language that suggests to a POSA that the term “inhomogeneous” modifies “semiconductor layer”; that is not what the plain language says and adopting such a meaning would result in an entirely different claim term. Instead, the claim language provides that the semiconductor layer is provided with a plurality of inhomogeneous regions, i.e. regions that themselves are inhomogeneous.

33. The specification also supports SETi’s proposed construction. It discloses that “[t]he inhomogeneous regions can include one or more of: a set of transparent regions, a set of reflective regions, and/or a set of conductive regions.” Ex. 1001, 5:43-46.

34. The specification gives several examples of inhomogeneous regions that are conductive. The examples include layers that have “a higher concentration of carriers due to, for example, a locally reduced band gap of the semiconductor layer, a local high doping of the semiconductor layer, and/or the like,” i.e., its internal composition varies due to it having increased doping in certain areas of the conductive region. Ex. 1001, 5:61-65.

35. Similarly, the specification gives an example of an inhomogeneous region that is reflective, reflective region 40A-40C. It states that these regions can “be formed of a composite mirror having alternating sublayers of low index of refraction material 42 and relatively high index of refraction material 44.” *Id.*,

7:15-19. A POSA would understand that these alternating sublayers would be composed of different materials, such as TiO_2 and SiO_2 , for example.

36. The specification further states that a reflective region 40 can be “epitaxially grown, and include a superlattice of group III nitride semiconductor sublayers 42, 44,” where the composition of these layers is “chosen such that a refractive index of one sublayer is different from a refractive index of another sublayer by at least two percent.” *Id.*, 7:21-28. A POSA would understand the sublayers would have different compositional makeup, which would result in the sublayers having different refractive indices.

37. The specification also gives an example of an inhomogeneous region that is transparent: an $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}/\text{Al}_{x'}\text{In}_{y'}\text{Ga}_{1-x'-y'}\text{N}$ superlattice, which has alternating layers comprised of materials with different compositional makeup if x and y are different from x' and y' . Ex. 1001, 9:8-10.

38. A POSA would understand from these examples of inhomogeneous regions in the specification that each such region has a compositional makeup that varies within the region.

39. The extrinsic evidence also supports SETi’s proposed construction. The word “homogeneous” means “a system in which the chemical composition and physical state of any physically small portion are the same as those of any other portion.” Ex. 2001, Chambers Dict. of Sci. & Tech. (2007). Thus, the word

“inhomogeneous” would refer to a system in which the chemical composition/physical state of some of the physically small portions are different from other portions.

40. Although Dr. Shealy did not propose any claim constructions in his declaration, based on my review of his opinions, it appears he has applied an implicit claim construction that an “inhomogeneous region” is merely a region within the semiconductor layer that is somehow different than the surrounding group III nitride semiconductor layer.

41. This was made explicit by Dr. Shealy’s testimony at his deposition, where he testified that an “inhomogeneous region” was “anything that is imbedded in the semiconductor that is not the same semiconductor of identical crystal orientation would be an inhomogeneous layer.” Ex. 2019, at 63:9-14. He also testified that a region would be inhomogeneous if it “had a different crystal orientation, it had a different composition, if it had a defect running through it,” “anything that’s different about it that changes its semiconductor properties would be considered inhomogeneous.” *Id.* at 63:13-16, 64:14-17.

42. I disagree. As I stated above, claim 1 is not directed to an “inhomogeneous semiconductor layer,” but to a semiconductor layer “including a plurality of inhomogeneous regions.” Dr. Shealy’s heuristic for determining

whether a region is inhomogeneous is also flawed because it ignores the disclosures in the specification, such as the examples I discuss above.

43. It is my opinion that the remaining terms of the '117 Patent should be construed according to their plain and ordinary meaning to a POSA.

VI. A PERSON HAVING ORDINARY SKILL IN THE ART

44. For the purposes of my analysis herein, I have adopted the definition of a person of ordinary skill in the art (“POSA”) applied by the Board in its Institution Decision (Paper 11 at 8), which is a person with a “Bachelor’s degree in physics, electrical engineering, materials science, or a related field, and three to five years of experience in semiconductor devices, with specific experience in nitride based LEDs.”

VII. ASSERTED PRIOR ART REFERENCES

45. Below I provide a brief summary of the prior art asserted by Petitioner in this proceeding.

A. U.S. Patent Application Publication No. 2007/0085093 to Ohmae et al. (“Ohmae”) (Ex. 1004)

46. Ohmae discloses a light-emitting diode with a substrate having protruded portions. Ex. 1004 ¶ 21. The protruded portions are grown on the substrate and then a nitride-based III-V Group compound semiconductor layer is grown on top of them. *Id.*; *see also* ¶ 74.

47. In Ohmae's Figure 35 embodiment, protruded portions are grown on top of conductive substrate 11, followed by p-type layer 15, p-type layer 18, active layer 17, and then n-type layer 16. Ex. 1004 ¶ 231. The embodiment in Figure 35 is a vertical LED structure, with a p-type electrode formed on the backside of the conductive substrate 11 and n-side electrode 21 on top of the n-type layer 16. *Id.*; Fig. 35. This conductive substrate 11 is a p-type substrate as indicated by the p-type layer grown on top of it.

48. In Ohmae's Figure 39 embodiment, which is based off of the first embodiment (depicted in Figure 3), an n-type layer 15 is grown on top of protruded portions, followed by an additional set of protruded portions on top of that, a second n-type layer 15, a third set of protruded portions on top of the second n-type layer 15, and then a third n-type layer 15 on top of the third set of protruded portions. Ex. 1004 ¶¶ 157, 247, 248. Ohmae discloses that an n-type layer 16 is grown on top of the uppermost n-type layer 15, followed by an active layer 17, and then a p-type nitride-based III-V Group compound semiconductor layer 18. *Id.* Although the rest of the LED structure is not depicted in Figure 39, Ohmae states that the Figure 39 embodiment, other than what is described in paragraph 247, "is similar to the first embodiment." *Id.* ¶ 248. Thus, unlike the Figure 35 embodiment, which is a vertical LED that has a p-side-down structure with

contacts on the top and bottom of the LED, the Figure 39 embodiment is an n-side down structure with both of its contacts on the top of LED. Ex. 1004 ¶ 157; Fig. 3.

B. Japan Patent No. 2000-22283 to Ban *et al.* (“Ban,” Ex. 1005)

49. Ban discloses a semiconductor laser device. Ex. 1005 ¶ 42. Ban’s third embodiment discloses an n-type GaN layer and a SiO₂ mask layer 34 embedded in that layer. *Id.* ¶¶ 42, 43.

C. W.O. Publication No. 2013/023197 to Shur *et al.* (“Shur,” Ex. 1006)

50. Shur discloses a semiconductor structure with a p-type cladding layer having multiple sub-layers. Ex. 1006 ¶ 45. Figure 5 depicts conductive channels that are disposed in these sub-layers. *Id.* ¶ 54.

D. U.S. Patent Application Publication No. 2004/0031956 to Saxler (Ex. 1007)

51. Saxler discloses “a Group III nitride based semiconductor structure.” Ex. 1007 ¶ 16. Saxler discloses semiconductor layers composed of a wide bandgap material and additionally discloses incorporating a different bandgap semiconductor material inside the layers. *Id.* ¶ 25.

VIII. GROUND 1: OHMAE DOES NOT RENDER OBVIOUS CLAIM 1 OF THE ’117 PATENT

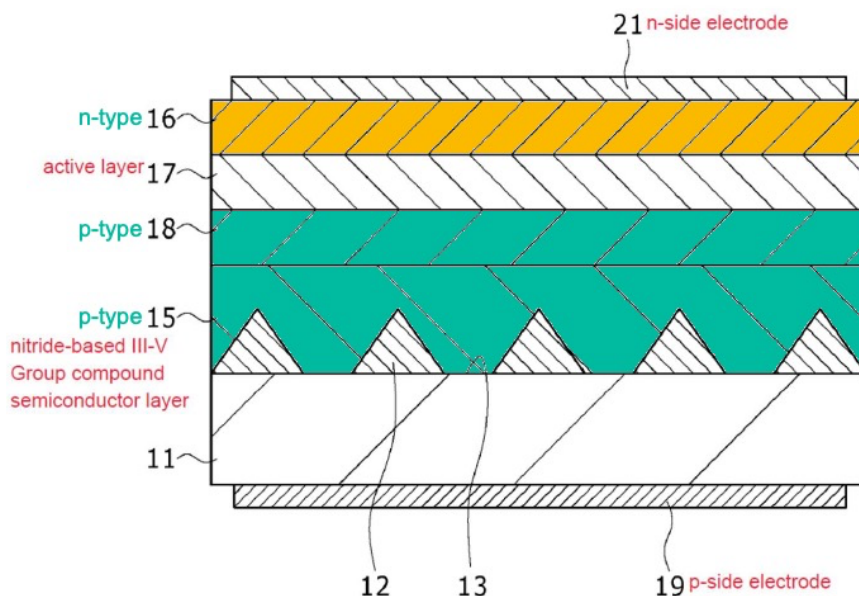
52. In my opinion, Ohmae does not disclose or render obvious all of the limitations of claim 1.

A. Ohmae discloses multiple different embodiment that cannot be combined in the manner proposed by Lite-On

53. I understand that Lite-On and Dr. Shealy rely on both Figure 35 and Figure 39 in their arguments with respect to Ohmae. For example, Dr. Shealy relies solely on Figure 35 as allegedly disclosing claim limitations 1[a], 1[b], and 1[c]. Ex. 1002 ¶¶ 71-74. However, with respect to limitation 1[d], Dr. Shealy relies on Figure 39, which depicts a different embodiment than Figure 35. *Id.* ¶¶ 75-78. Dr. Shealy relies on Figure 39's depiction of protruded portions disposed in successive layer 15s to demonstrate disclosure of the limitation "the semiconductor layer including a plurality of inhomogeneous regions arranged within multiple levels of the semiconductor layer" because the Figure 35 embodiment only depicts protruded portions in one layer. *Id.* ¶ 77. He then concludes that "[b]ased on the teachings of Figure 39 of Ohmae, in my opinion, the nitride-based III-V Group compound semiconductor layer 15 in Figure 35 of Ohmae can include multiple levels (i.e., multiple sub-layers 15) as shown in Figure 39 of Ohmae" *Id.* ¶ 78. I disagree.

54. Figure 35 and Figure 39 depict separate embodiments (the twelfth and sixteenth embodiments, respectively). Ex. 1004 ¶¶ 231, 247. As discussed above, the LED in Figure 35 has a vertical LED structure, with contacts on the top and bottom of the LED, and with the bottom contact deposited beneath the conductive

substrate. *Id.* ¶ 231. A p-type nitride-based III-V Group compound semiconductor layer 15 is then grown on the conductive substrate, followed a p-type nitride-based III-V Group compound semiconductor layer 18, an active layer 17, an n-type nitride-based III-V Group compound semiconductor layer 16, and an n-side electrode on top. *Id.*; *see also* Fig. 35. Notably, the p-type layers are grown first in this embodiment, instead of the n-type layers, the latter being far more common in the art at the time of the filing of the '117 Patent (and at the time of Ohmae's 2007 publication date). Growing the n-type layers first is preferred because the crystal quality of an n-type layer is generally superior to the crystal quality of a p-type layer, which allows for better active region quality when growing on top of an n-type layer. In addition, n-type III-nitride materials are significantly more conductive than p-type III-nitride materials, so having the n-type layer grown first enables better current spreading within the LED. Growing the p-type layers first can also cause magnesium (Mg) memory effects, in which the p-type dopant (Mg) diffuses into the active region and/or n-side of the LED, compensating the n-type dopants and degrading the electrical characteristics of the diode. The layer types in Figure 35 are labeled and colored in the annotated version of the figure below (with the red text originally annotated by Lite-On):

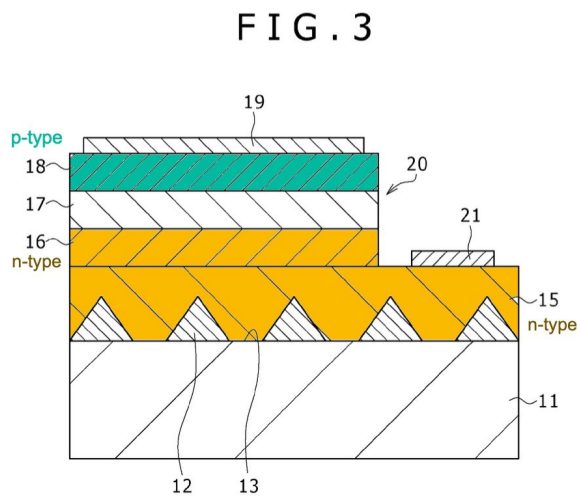


55. In contrast, the Figure 39 embodiment is not a vertical LED structure, but an LED with both contacts on the top side. Although Figure 39 only depicts the substrate and three layer 15s, Ohmae's description provides that the Figure 39 embodiment is the same as the first embodiment other than the specific differences described. Ex. 1004 ¶ 248.

56. Ohmae discloses that three nitride-based III-V Group compound semiconductor layer 15s are grown in succession. *Id.* ¶ 247. A nitride-based III-V Group compound semiconductor layer 16 is then grown on top of the uppermost nitride-based III-V Group compound semiconductor layer 15, followed by an active layer 17, and a p-type nitride-based III-V Group compound semiconductor layer 18. *Id.* Thus, because the p-type layer 18 is grown on top of the active layer 17, a POSA would understand that the three layer 15s and the layer 16 are n-type

layers, based on Ohmae's disclosure with respect to the first embodiment, and because the n-type layers are needed to form a p-n junction that allows the LED to operate.

57. This is confirmed by Ohmae's description and depiction of the first embodiment. Ohmae discloses that in the first embodiment, an **n-type** layer 15 is grown on top of a substrate, followed by an n-type layer 16, an active layer 17, and a p-type layer 18. Ex. 1004 ¶ 157; Fig. 3. The p-side electrode is formed on top of p-type layer 18 and the n-side electrode is formed on top of n-type layer 15. *Id.* ¶¶ 159, 162. The n-type layers and p-type layer are shown in the annotated version of Figure 3 below:



58. Thus, in view of Ohmae's description of the first embodiment, a POSA would understand that the sixteenth embodiment is configured in a similar

way, except with three n-type layers 15 instead of the one n-type layer 15 depicted in Figure 3.

59. Dr. Shealy agrees, as he testified that the three layer 15s in Figure 39 are n-type layers. Ex. 2019, 58:16-25.

60. Thus, contrary to Dr. Shealy's testimony "the nitride-based III-V Group compound semiconductor layer 15 in Figure 35 of Ohmae can include multiple levels (i.e., multiple sub-layers 15) as shown in Figure 39 of Ohmae" based on the teachings of Figure 39, these are different embodiments that have fundamentally distinct structures.

61. First, as I stated above, the Figure 35 embodiment has two p-type layers deposited first, whereas the Figure 39 embodiment has four n-type layers deposited in succession. The p-type layer(s) provide the holes and n-type layer(s) provide the electrons that recombine in the active layer. In addition, the conductivities of n-type and p-type III-nitride materials differ by around two orders of magnitude, so interchanging the layers would alter the electrical characteristics of the LED. As described above, inverting the growth order of the layers can negatively affect the LED performance for a variety of reasons. Finally, merely substituting the three n-type layers 15 from the Figure 39 embodiment in place of the p-type layer 15 in the Figure 35 embodiment would result in a device that

would have two p-n junctions, leading to a device with at least one reverse-biased p-n junction and rectifying current-voltage characteristics.

62. Second, as discussed above, the Figure 35 embodiment is a vertical LED structure, whereas the Figure 39 embodiment has its two contacts disposed on the top of the LED.

63. Third, the conductive substrate 11 in Figure 35 is a p-type substrate, given that in the unmodified embodiment, a p-type layer is deposited on top of that substrate. Thus, to substitute the three n-type layers 15 would require also replacing the p-type substrate 11 with an n-type substrate.

64. For all of these reasons, there is no reason to apply the “teachings of Figure 39” to the Figure 35 embodiment, as proposed by Dr. Shealy. Notably, Dr. Shealy provides no explanation or reasoning as to why a POSA would make the multitude of changes that would be necessary for his proposed modification of Figure 35, except the claim language.

65. For this reason, Ohmae does not disclose or render obvious limitation 1[d].

B. Ohmae does not disclose or render obvious “the semiconductor layer including a plurality of inhomogeneous regions arranged within multiple levels of the semiconductor layer along a height direction of the semiconductor layer”

66. Dr. Shealy opines that “protruded portions made of dielectric materials or conductors would constitute inhomogeneous regions within the semiconductor layer composed of nitride-based III-V Group compound semiconductor.” Ex. 1002 ¶ 76. Thus, according to Dr. Shealy, because the protruded portions are not made of the nitride-based III-V Group compound semiconductor material that Figure 35’s layer 15 is made of, they are “inhomogeneous regions.” Ex. 2019, 63:14-17, 64:14-17. I disagree.

67. As discussed above, limitation 1[d] provides for a semiconductor layer that includes a plurality of inhomogeneous regions arranged within the layer; the claim limitation is not directed to an inhomogeneous semiconductor layer. *See supra* Section VI. That the protruded portions are made of material that is different than the nitride-based III-V Group compound semiconductor layer does not make the protruded portions “inhomogeneous regions.” Indeed, Dr. Shealy does not explain how these materials are “regions whose compositional makeup varies within the regions.” Ex. 1002 ¶ 76.

68. Dr. Shealy also opines that “the nitride-based semiconductor material grown on top of the protruded portions are also inhomogeneous regions.” *Id.* But he does not explain why this particular material within the semiconductor layer 15 additionally constitutes an “inhomogeneous region,” either under the incorrect implicit claim construction or under SETi’s proposed construction.

69. For these reasons, Ohmae additionally does not disclose or render obvious limitation 1[d] of claim 1.

IX. GROUND 2: BAN DOES NOT RENDER OBVIOUS CLAIM 1 OF THE '117 PATENT

70. In my opinion, Ban does not disclose or render obvious all of the limitations of claim 1.

71. Ban does not disclose or render obvious limitation 1[d] of Claim 1 because it does not disclose or render obvious a “plurality of inhomogeneous regions.”

72. Ban discloses that “a SiO₂ mask layer 34 (having a thickness of 100 nm) is formed by plasma CVD or the like and a striped opening with a pitch of 4μm and a width of 1.5μm is formed in the [1-100] direction of the GaN by the photolithography and dry etching processes.” Ex. 1005 ¶ 45. Ban discloses that the SiO₂ mask layer 34 is “embedded in a stripe shape” in the n-type GaN layer 33. *Id.* ¶ 43.

73. Dr. Shealy opines, without explanation, that “[i]n my opinion, the SiO₂ mask layer constitutes an inhomogeneous region.” Ex. 1002 ¶ 92. Dr. Shealy testified that because the SiO₂ mask layer 34 has a different composition and different crystalline structure than the GaN layer 33, it is inhomogeneous. Ex. 2019, 64:18-65:4. I disagree.

74. The SiO₂ mask layer cannot be an “inhomogeneous region” because it is a homogeneous material, a fact that Dr. Shealy admitted at his deposition. Ex. 2019, 72:18-73:3.

75. Thus, by Dr. Shealy’s own admission, the SiO₂ mask layer 34 cannot constitute “a plurality of inhomogeneous regions” because the mask layer is a homogeneous material. Similarly, the mask layer does not constitute a “plurality of inhomogeneous regions” under SETi’s proposed construction of the term, because its composition does not vary within the layer.

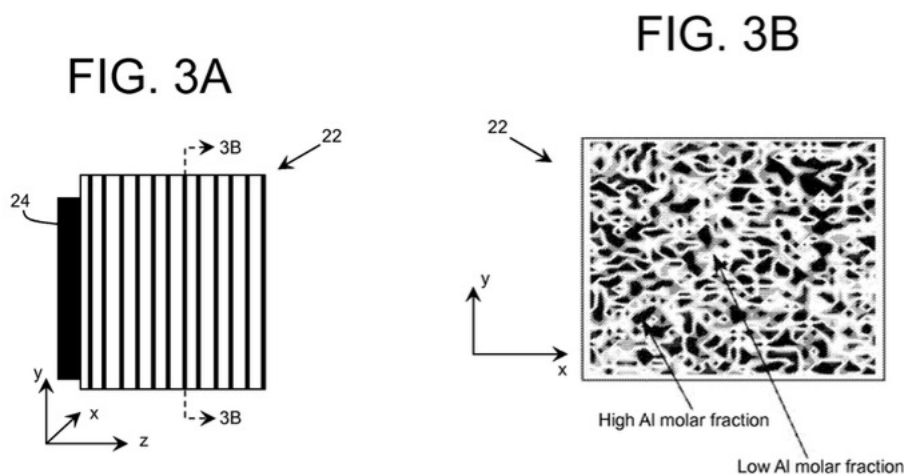
76. For this reason, Ban does not disclose or render obvious limitation 1[d] of claim 1.

X. GROUND 3: SHUR DOES NOT RENDER OBVIOUS CLAIM 1 OF THE ’117 PATENT

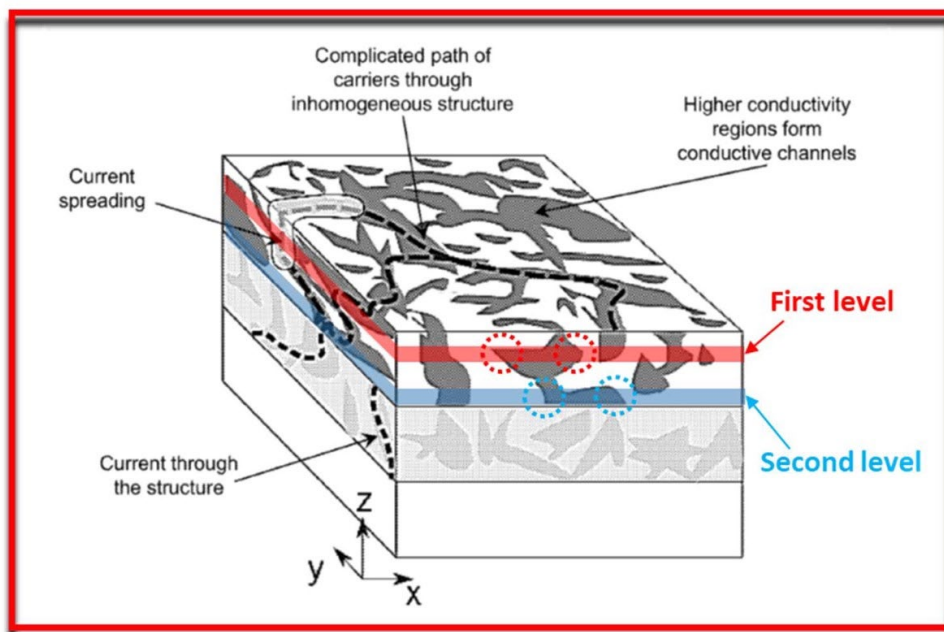
77. In my opinion, Shur does not disclose or render obvious all of the limitations of claim 1.

78. Shur discloses in Figure 3A a p-type cladding layer made up of “a Al_xGa_{1-x}N/Al_yGa_{1-y}N superlattice.” Ex. 1006, ¶ 45. Shur further discloses that Figure 3A “illustrates variation in aluminum composition within the layer 22 along the height of the layer (e.g., indicated by direction z) in a direction normal to a surface of the layer 22 adjacent to the p-type metal 24.” *Id.* Shur then discloses that Figure 3B illustrates “variation in the aluminum composition of the p-type

cladding layer 22 in the **lateral directions** (e.g., indicated by directions x and y) of the layer 22.” *Id.*, ¶ 46 (emphasis added). Shur states that “areas with a high aluminum composition are indicated by the dark regions, while areas with a low aluminum composition are indicated by the lighter/bright regions.” *Id.*, ¶ 45.



79. Shur’s Figure 5 depicts “a schematic representation of an illustrative carrier path in a complicated energy landscape caused by the inhomogeneities according to an embodiment.” *Id.* ¶ 54. Lite-On and/or Dr. Shealy annotated Figure 5 below by adding arbitrary “First level” and “Second level” delineations, shown in red and blue below:



80. Dr. Shealy opines that the annotated Figure 5 shows “red-circled inhomogeneous regions in a first level of the semiconductor layer that are vertically offset from blue-circled inhomogeneous regions in a second level of the semiconductor layer.” Ex. 1002 ¶ 117. He then states “[i]n my opinion, each of the red circle or blue circle constitutes an inhomogeneous region within the semiconductor layer; thus, Shur discloses this limitation.” *Id.* I disagree.

81. First, the “regions” identified by Dr. Shealy are not separate regions. Instead, Dr. Shealy has identified a **single** region in Figure 5. The dark areas in Figure 5 are areas of relatively low aluminum composition and thus they form

conductive channels.¹ Ex. 1006 ¶ 54. These dark areas, as depicted in Figure 5, are separated by gaps, as can plainly be seen in the figure. In his annotations, Dr. Shealy circles four parts (two red circles and two blue circles) of a single connected and continuous dark region.

82. However, the four “regions” identified by Dr. Shealy have no gap in between them and are in fact one region. Dr. Shealy additionally admitted at his deposition that the dark region where he and Lite-On’s attorneys applied red and blue circles was “one continuous region.” Ex. 2019, 76:4-10.

83. Because limitation 1[e] requires separate “inhomogeneous regions in a first level of the semiconductor layer” and “inhomogeneous regions in a second level of the semiconductor layer” and because Dr. Shealy only identified a single region (that was arbitrarily cut up into four alleged “regions”), Dr. Shealy cannot show that Shur discloses or renders obvious separate “inhomogeneous regions in a first level of the semiconductor layer” and “inhomogeneous regions in a second level of the semiconductor layer.”

84. A single continuous region also cannot be “vertically offset” as required by the claim because a single region cannot be offset from itself. This is

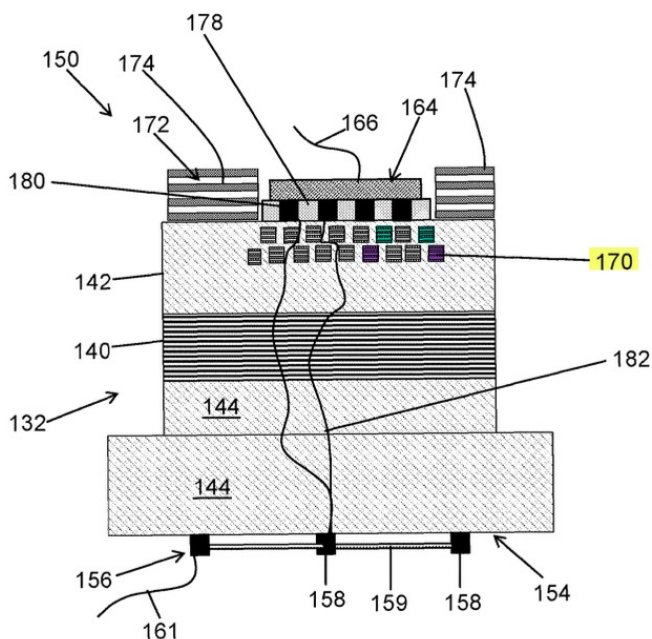
¹ This shading is reversed from Figure 3B, in which “areas with a high aluminum composition are indicated by the dark regions, while areas with a low aluminum composition are indicated by the lighter/bright regions.” Ex. 1006 ¶ 45.

contrast to the '117 Patent, which discloses staggered inhomogeneous regions 170

“such that there is an offset in position between elements in the different levels.”

Ex. 1001, 16:3-6. This is depicted in Figure 13A, reproduced below, with annotations added:

FIG. 13A



85. Unlike the inhomogeneous regions 170 in Figure 13A, Dr. Shealy's single continuous region in Shur, Figure 5 is not offset in position from itself.

86. For these reasons, Lite-On has failed to demonstrate that Shur discloses or renders obvious limitation 1[e] of claim 1.

XI. GROUND 4: SAXLER DOES NOT RENDER OBVIOUS CLAIM 1 OF THE '117 PATENT

87. In my opinion, Saxler does not disclose or render obvious all of the limitations of claim 1.

A. Saxler discloses multiple different embodiment that cannot be combined in the manner proposed by Lite-On

88. Dr. Shealy relies exclusively on the Figure 4 embodiment as disclosing claim limitations 1[a], 1[b], and 1[c]. Ex. 1002 ¶¶ 125-129. However, for limitations 1[d], 1[e], 1[f], and 1[g] however, he relies on the Figures 1, 3, and 4 embodiments, but offers no justification for this combination of different embodiments. *Id.* ¶¶ 130-144.

89. Instead, Dr. Shealy states that “a POSITA would understand that Saxler’s teaching” in the Figure 1 embodiment can be applied to the Figure 4 embodiment. Ex. 1002 ¶ 134. He bases his opinion on Saxler’s statement that “embodiments of the present invention are not limited to such a structure” and “may be suitable for use in light emitting devices and/or lasers such as those described in” more than a dozen other patents. *Id.* ¶ 134. (“Saxler expressly discloses that embodiments of its invention (e.g., its teaching of the regions 22 embedded in the layer 20) can be applied to other light emitting diode structures and incorporated by reference several disclosures.”). I disagree.

90. There is no “teaching” in Saxler that the regions 22 in Figure 1 can be combined or applied to the structure depicted in Figure 4. Nor is there any motivation identified by Dr. Shealy for doing so. Rather, the paragraph of Saxler that Dr. Shealy relies on is about applying the Saxler embodiments to light emitting devices and/or lasers in **other** prior art patents. Ex. 1007 ¶ 30.

91. Similarly, Dr. Shealy relies on the Figure 3 embodiment to disclose limitation 1[e] but offers no explanation for combining the Figure 3 and Figure 4 embodiments. Ex. 1002 ¶ 135. Indeed, for this limitation, Dr. Shealy does not even mention the Figure 4 embodiment. *Id.* A POSA would not be motivated to modify Figure 4 in view of the Figure 3 embodiment because it adds significant complexity to the growth process, including three additional pattern and re-growth steps.

92. For these reasons, Saxler fails to disclose or render obvious limitations 1[d] and 1[e].

B. Lite-On has not established that Saxler discloses or renders obvious limitation 1[a], “an active region”

93. Dr. Shealy relies on optional layer 36 in Saxler’s Figure 4 embodiment, which includes an “may be provided between the first layer 32 and a third layer 38 and may have a lower bandgap than that of the first layer 32 and the third layer 38 to provide a well region for the device.” Ex. 1007 ¶ 26.

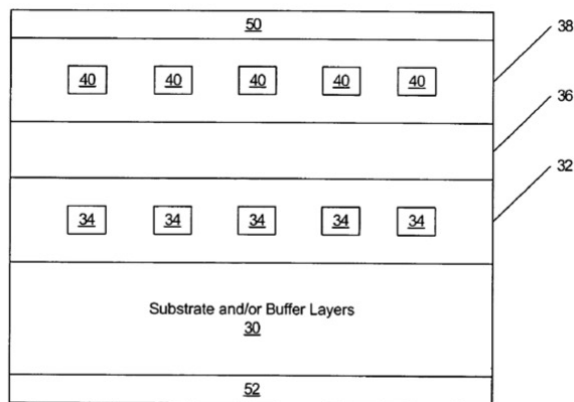


Figure 4

94. Saxler also discloses that “the first layer 32, second layer 36 and/or third layer 38 may be multiple layers, for example, in a multi-quantum well embodiment of the present invention.” *Id.* ¶ 28.

95. The active region refers to a layer or layers where holes and electrons are injected and electron-hole recombination occurs to emit light (photons). As the '117 Patent discloses and as Dr. Shealy similarly acknowledges in his declaration, “during operation of the LED, a voltage bias applied across doped layers leads to injection of electrons and holes into an active layer where electron-hole recombination leads to light generation.” Ex. 1001, 1:39-42; Ex. 1002 ¶¶ 37, 44. But Dr. Shealy does not identify any disclosure in Saxler regarding any recombination of electrons and holes or any light emission by second layer 36; indeed, layer 36 is described by Saxler as being “optional,” further cutting against this layer being the claimed “active region.”

96. For this reason, Lite-On has failed to demonstrate that Saxler discloses or renders obvious limitation 1[a] of claim 1.

C. Lite-On has not established that Saxler discloses or renders obvious limitation 1[b], “a metallic contact”

97. Saxler does not disclose or render obvious limitation 1[b] of Claim 1 because it does not disclose a metallic contact. Saxler merely discloses, in Figure 4, that “[c]ontacts 50 and 52 may also be provided.” Ex. 1007 ¶ 26.

98. Dr. Shealy opines that contact 50 is made of metal, but fails to point to any disclosure of a metallic contact in Saxler. Ex. 1002 ¶ 126. Instead, Dr. Shealy concludes: “[a] POSITA would understand that contact 50 (and alternatively, contact 52) is a metallic contact of the semiconductor device; specifically, a POSITA would understand that contact 50 is an ohmic contact made of metal.” *Id.* ¶ 126. Dr. Shealy offers no explanation or basis for why a POSITA would understand that contact 50 is “an ohmic contact made of metal.”

99. However, a POSA would understand that the contact in Saxler could, for example, be made of Indium Tin Oxide (ITO), a common p-type contact material. Ex. 2003 at 167-68. Although ITO is frequently used for its high transparency to visible light, ITO is *not* metallic. Ex. 2003 at 168. Instead, it is a transparent conducting oxide, with significantly lower conductivity and higher contact resistance than a metallic contact.

100. For this reason, Lite-On has failed to demonstrate that Saxler discloses or renders obvious limitation 1[b] of claim 1.

D. Saxler does not disclose or render obvious limitation 1[d], “the semiconductor layer including a plurality of inhomogeneous regions arranged within multiple levels of the semiconductor layer along a height direction of the semiconductor layer”

101. Saxler discloses, in the Figure 1 embodiment, “a first layer 20 of wide bandgap semiconductor material having a first bandgap has included therein regions 22 of wide bandgap semiconductor material having a second bandgap.” Ex. 1007 ¶ 18. Figure 1 depicts a “top view of a layer of wide bandgap semiconductor material” and Figure 2 depicts a cross section of the layer of Figure 1. Figure 2 additionally depicts regions 22 arranged in a single level of layer 20.

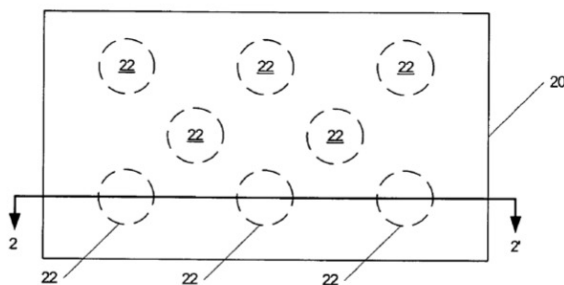


Figure 1

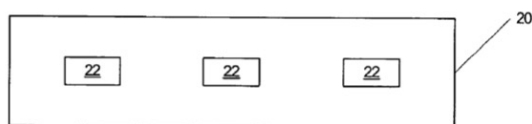


Figure 2

102. Dr. Shealy opines that “the regions 22 constitute inhomogeneous regions because these regions can include wider bandgap material, transparent regions, and contribute to higher electrical conductivity of the semiconductor layer 20 in which the regions 22 are embedded.” Ex. 1002 ¶ 131. I disagree. There is no disclosure or teaching in Saxler that the regions 22 are transparent and Dr. Shealy does not point to such a disclosure. Instead, he relies on the teachings of the ’117 Patent with respect to the properties of the alleged plurality of inhomogeneous regions. *Id.*

103. And, once again, Dr. Shealy’s opinion is based on his implicit and erroneous claim interpretation that the term requires an “inhomogeneous semiconductor layer,” and not that the regions 22 are themselves “inhomogeneous regions.”

104. Dr. Shealy also fails to demonstrate that these regions are regions whose compositional makeup varies within the region, as required by SETi’s proposed construction.

105. Dr. Shealy then relies on Figure 3 as disclosing the arrangement of regions in multiple levels, Ex. 1002 ¶ 132, but there is no disclosure in Saxler regarding the composition of the regions 22 in the Figure 3 embodiment, such that Lite-On can demonstrate that these regions constitute “inhomogeneous regions.”

Ex. 1007 ¶ 21. At best, Dr. Shealy relies on the generic disclosure that the regions “can include a wider bandgap material. Ex. 1002 ¶ 131.

106. With respect to the allegations that Saxler meets limitation 1[d]’s requirement of “inhomogeneous regions” in multiple levels, Dr. Shealy does not cite to or rely on the specification’s description of Figure 3, and instead creates his own summation of what Figure 3 depicts:

“Annotated FIG. 3 of Saxler . . . shows the semiconductor layer 20 including a plurality of inhomogeneous regions (the regions 22; shown in yellow) arranged within multiple levels of the semiconductor layer (layer 20) along a height direction (vertical direction) of the semiconductor layer.”

Ex. 1002 ¶ 132.

107. Additionally, Figure 4 does not disclose this limitation, as the regions 40 and 34 are in **separate** semiconductor layers, and are not arranged within one semiconductor layer as required by the claim.

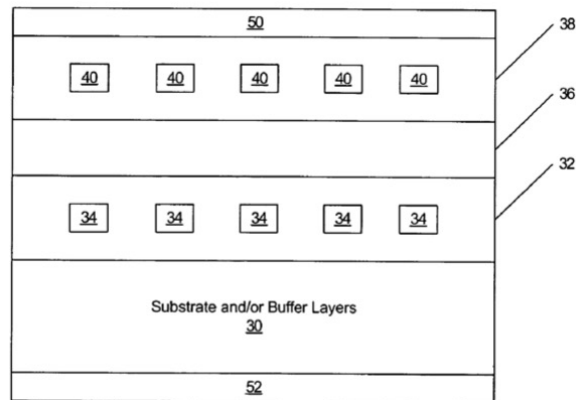


Figure 4

108. As discussed above, Dr. Shealy does not discuss any reason that a POSA would modify the Figure 4 embodiment in view of the Figure 3 embodiment, and in fact, a POSA would not be so motivated to make that modification.

109. For these reasons, Saxler does not disclose or render obvious limitation 1[d] of claim 1.

E. Saxler does not disclose or render obvious limitation 1[e], “wherein some of the inhomogeneous regions in a first level of the semiconductor layer are vertically offset from inhomogeneous regions in a second level of the semiconductor layer”

110. Saxler does not disclose or render obvious limitation 1[e] of Claim 1. As discussed above, a POSA would not be motivated to modify the Figure 4 embodiment, which does not depict the alleged inhomogeneous regions in two separate levels as vertically offset from each other, in view of the Figure 3 embodiment.

111. For this reason, Saxler does not disclose or render obvious limitation 1[e] of claim 1.

XII. CONCLUSION

112. For the reasons set forth above, it is my opinion that claim 1 is not unpatentable over the prior art of record.

113. In signing this declaration, I recognize 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 also recognize that I may be subject to cross-examination in the 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.

114. I hereby 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.

February 9, 2023

By: 
Daniel Feezell, Ph.D.

Appendix A

DANIEL F. FEEZELL, PH.D.

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EDUCATION

Ph.D. Electrical Engineering, University of California Santa Barbara, 2005

Thesis Title: *Long-Wavelength Vertical-Cavity Surface-Emitting Lasers with Selectively Etched Thin Apertures*

Advisor: Professor Larry A. Coldren

M.S. Electrical Engineering, University of California Santa Barbara, 2001

B.S. Electrical Engineering, University of California Irvine, 2000

PROFESSIONAL EXPERIENCE

General Chair, Optical Science and Engineering (OSE) Program, University of New Mexico, Albuquerque, NM, 2022 – present

Associate Professor (with tenure) - Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM, 2017 – present

Assistant Professor - Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM, 2012 – 2017

Project Scientist (advisor: Professor Shuji Nakamura) - Materials Department and Solid-State Lighting and Energy Center, University of California Santa Barbara, Santa Barbara, CA, 2010 – 2012

Director of Fabrication and Senior Device Scientist (first employee) - Soraa, Inc., Goleta, CA, 2007 – 2010

Postdoctoral Researcher (advisor: Professor Shuji Nakamura) - Materials Department, University of California Santa Barbara, Santa Barbara, CA, 2005 – 2007

Graduate Student Research Assistant (advisor: Professor Larry A. Coldren) - Electrical and Computer Engineering Department, University of California Santa Barbara, Santa Barbara, CA, 2000 – 2005

Undergraduate Research Assistant (advisor: Professor Henry Lee) - Electrical Engineering and Computer Science Department, University of California Irvine, Irvine, CA, 1999 – 2000

AWARDS AND HONORS

UNM Regents' Lecturer, 2020-2022

Selected for *Physica Status Solidi Showcase 2020* for “A Decade of Nonpolar and Semipolar III-Nitrides: A Review of Successes and Challenges”, 2020

Top 20 Most Cited Papers in *Applied Physics Letters* in 2018 for “Impact of crystal orientation on the modulation bandwidth of InGaN/GaN light-emitting diodes”

Sole Selected UNM Nominee for Blavatnik Award in Physical Sciences & Engineering Category, 2017

Editor's Pick, Optics Express, 2017 (doi.org/10.1364/OE.25.019343)

School of Engineering Junior Faculty Research Award, University of New Mexico, 2016

STC Innovation Award, University of New Mexico, 2016, 2019, 2020, 2021

NSF Faculty Early Career Development (CAREER) Program Award for “CAREER: Short-Wavelength Vertical-Cavity Surface-Emitting Laser Arrays Using Nonpolar and Semipolar GaN,” National Science Foundation, 2015

DARPA Director’s Fellowship for “High-Speed Nonpolar InGaN/GaN Light-Emitting Diodes Using Plasmonic Core-Shell Nanowires,” Defense Advanced Research Projects Agency, 2015

Young Professional Speaker Award at the 2015 Electronic Materials and Applications Conference

DARPA Young Faculty Award for “High-Speed Nonpolar InGaN/GaN Light-Emitting Diodes Using Plasmonic Core-Shell Nanowires,” Defense Advanced Research Projects Agency, 2013

Editor’s Pick, Applied Physics Letters, 2013

30th Annual JSAP Outstanding Paper Award, Japan Society of Applied Physics, 2008

Excellence in Technical Communication Award, Laser Focus World Magazine, 2007

Outstanding Research Achievement, Solid-State Lighting and Display Center, University of California Santa Barbara, 2007

National Research Council (NRC) Postdoctoral Associate Fellowship (declined), NIST, 2007

Three-Year Graduate Student Support Package, University of California Santa Barbara, 2000

ECE Departmental Fellowship, University of California Santa Barbara, 2000

FUNDING HISTORY

Total funding awarded at UNM since joining in 08/2012 is \$9.63M. The listed total funding and individual award values represent only Prof. Feezell’s portion at UNM in the case of multi-institution and/or multi-PI grants (except in the case of equipment grants):

(co-PI) Department of Energy (DOE) National Nuclear Security Agency (NNSA) Minority Serving Institution Partnership Program (MSIPP), Sub-Contract from UT El Paso (UTEP), “Consortium for Education and Research in Electronics for Extreme Environments (E3C),” \$1,125,000, 10/1/22 – 9/30/27, Grant No: 226160676C

(PI) MSI STEM Research and Development Consortium (MSRDC) through DOE, “Scaling Effects in InGaN/GaN Micro-LEDs: Non-Radiative Surface Recombination and Efficiency,” \$99,681.00, 12/6/21 – 12/5/22, Grant No: D01_W911SR-14-2-0001-(OR#57)

(PI) Army Research Laboratory (ARL), “Energy Efficient Electronics and Photonics: III-Nitride VECSELs, UV LEDs, and Integrated Photonics Components for Defense Applications,” \$240,000, 09/15/20 – 12/14/22, Grant No: W911NF2020234

(PI) Applied Materials, “Epitaxial Growth and Characterization of Gallium Nitride Nanostructure-Based Micro-LEDs,” \$245,984, 05/08/20 – 12/31/22, Grant No: 2RQD1

(PI) Applied Materials, “Fabrication of Gallium Nitride Nanostructure-based micro-LEDs,” \$73,800, 05/08/20 – 12/31/22, Grant No: 2RQC9

(co-PI) Sandia National Laboratories, “Designing and fabrication of isolation layer with Porous GaN (for LDRD 218435),” \$54,000, 11/05/2020 – 9/30/2022, Grant No: SPO: 2208054

(co-PI) Sandia National Laboratories, “Student Training and Consumables Procurement for Growth of Low-Dislocation-Density GaN-Based Nanowire Electronics,” \$84,905, 06/23/2021 – 9/30/2022, Grant No: SPO: 2277542

(co-PI) Department of Energy (DOE), “Efficient Green and Yellow LEDs for Solid State Lighting Applications,” \$560,000, 4/1/20 – 3/31/24, Grant No: 20-0374

(PI) Facebook Reality Labs, “Dynamic characterization of μ LEDs,” \$159,264, 10/1/2019 - 3/31/22, Grant No: 2RPM5.

(PI) BluGlass, Ltd, “GaN-Based RPCVD-Grown Laser Diodes,” \$203,000, 12/10/18 – 1/31/22.

(PI) Air Force Research Labs (AFRL), "Advanced Components for Electronics in Space," \$140,000, 2/7/17–01/22/22, Grant No: 2RJN5

(co-PI) Sandia National Laboratories, “Fabrication of Isolation Layer with Porous GaN,” \$25,000, 01/08/2020 – 09/30/2020, Grant No: SPO: 2122883

(PI) Army Research Laboratory (ARL) “High-Efficiency III-Nitride Ultraviolet Light-Emitting Diodes for Defense Applications,” \$231,747, 09/15/18–09/14/20, Grant No: W911NF1820281

(co-PI) National Science Foundation, “MRI: Acquisition of a Magnetic Property Measurement System (MPMS) To Support Research and Education in the State of New Mexico,” \$276,436, 08/01/18–07/31/21, Grant No: 1828744

(co-PI) Defense Threats Reduction Agency (DTRA), “Radiation Effects in N-Face and Nonpolar m-Plane III-Nitrides and Heterostructures,” \$495,000, 08/16/17–08/15/20, Grant No: HDTRA1-17-1-0056 (sub-award: 5704-UNM-DTRA-0056)

(PI) National Science Foundation Electronic, Photonic, and Magnetic Devices Program (**CAREER Award**), “CAREER: Short-Wavelength Vertical-Cavity Surface-Emitting Laser Arrays Using Nonpolar and Semipolar GaN,” \$500,000, 03/01/2015 – 02/29/20, Grant No: 1454691

(co-PI, with Sandia National Labs) Advanced Research Projects Agency Energy (ARPA-E), “High Voltage Re-grown GaN P-N Diodes Enabled by Defect and Doping Control,” \$687,200, 11/15/17–5/14/20, Grant No: DE-AR0000869

(PI) Department of Defense (Army Research Office), “High-Resolution X-Ray Diffractometer for Advanced Epitaxial Thin-Film and Nanoscale Materials Characterization,” \$438,653, 09/5/17–09/4/18, Grant No: W911NF-17-1-0476

(PI) Advanced Research Projects Agency (ARPA-E) via iBeam Materials, Inc., “Epitaxial GaN on Flexible Metal Tapes for Low-Cost LED Devices,” \$130,000, 01/13/17–11/30/18, Grant No: DE-AR0000447 (sub-award: 170846)

(co-PI) National Science Foundation Engineering Research Center in Smart Lighting (sub-contract from Rensselaer Polytechnic Institute), “Patterned m-Plane Nanowall LEDs,” \$999,705 (Fezell portion), \$4,010,723 (total budget), 09/2012 – 08/2018, Grant No: EEC-0812056 (sub-award: A12020)

(PI) Office of Naval Research, “High-Speed Blue and Green Light-Emitting Diodes Using Polarization-Free GaN,” \$593,974, 08/01/2015 – 07/31/2018, Grant No: W911NF-15-1-0428

(PI) Department of Energy (Basic Energy Sciences, Energy Efficiency and Renewable Energy), “Investigation of Superluminescent Diodes for Smart Lighting Systems,” \$400,000, 08/01/2016 – 07/31/2018, Grant No: DE-SC0016618

(co-PI) National Science Foundation, “MRI: Acquisition of Multi-Material Dry Etcher for Nanophotonics,” \$553,348, 09/1/15-08/31/17, Grant No: 1532098.

(PI) Defense Advanced Research Projects Agency (**DARPA**) **Young Faculty Award + Director's Fellowship Extension**, "High-Speed Nonpolar InGaN/GaN Light-Emitting Diodes Using Plasmonic Core-Shell Nanowires," \$936,747, 08/2013 – 07/2017, Grant No: D13AP00055

(PI) Army Research Laboratory (ARL) "Nonpolar Vertical-Cavity Surface-Emitting Lasers for Ytterbium Atomic Clocks," \$259,000 (UNM portion), \$500,000 (total budget including sub-contract to UCSB), 01/2015 – 07/2016, Grant No: W911NF-15-1-0027

(PI) Sandia National Laboratories, "III-Nitride Lasers for Solid-State Lighting," \$121,901, 09/2013 – 10/2015, Grant No: 1391774

TEACHING AND STUDENT SUPERVISION

Courses Taught:

ECE 371, *Materials and Devices*, Required Undergraduate Course, University of New Mexico, Fall Semester 2013, 2014, 2017, and 2019

ECE 471, *Materials and Devices II*, Elective Undergraduate Course, University of New Mexico, Spring Semester 2020

ECE 475, *Introduction to Electro-Optics and Opto-Electronics*, Elective Undergraduate Course, University of New Mexico, Spring Semester 2013, 2015, and 2018, Fall Semester 2022

ECE 495/595, *ST: Light-Emitting Diodes and Solid-State Lighting*, University of New Mexico, Fall Semester 2018

ECE 570, *Optoelectronic Semiconductor Materials and Devices*, Required Graduate Course, University of New Mexico, Fall Semester 2015 and 2016, Spring Semester 2022

ECE 577, *Fundamentals of Semiconductor LEDs and Lasers*, Elective Graduate Course, University of New Mexico, Spring Semester 2012, 2016, and 2019

ECE 595, *ST: Characterization Techniques for Semiconductor Materials and Devices*, University of New Mexico, Fall Semester 2021

MAT 215C, *Semiconductor Device Processing*, Elective Graduate Course, University of California Santa Barbara, Spring Quarter 2011 (with Prof. Nakamura)

ECE 162B, *Fundamentals of Solid-State Physics*, Required Undergraduate Course, University of California Santa Barbara, Winter Quarter 2010 (with Prof. DenBaars)

Graduate Student Advising:

Current Ph.D.:

Mr. Xuefeng Li, Ph. D. Student (post-qualifier, post-proposal), January 2019-present

Mr. Abdelrahman Tarief Mohamed Fawzy Elshafiey Alakrat, Ph. D. Student (post-qualifier, pre-proposal), August 2017-present

Mr. Hatem Babaa, Ph. D. student (post-qualifier, pre-proposal), August 2019-present

Ms. Elizabeth DeJong, Ph.D student (post-qualifier, pre-proposal), August 2019-present

Mr. Caleb Glaser, University of New Mexico, Ph. D Student (pre-qualifier, pre-proposal), August 2018-present

Mr. Zachary Meinelt (on leave), Ph. D. student (pre-qualifier, pre-proposal), August 2019-present

Graduated Ph.D (8 as primary research advisor, 1 as chairperson):

Dr. Farnood Mirkhosravi, University of New Mexico, Ph.D. Graduate, May 2022, “Gamma and Neutron Irradiation Impacts on Ga-polar and N-polar GaN based diodes.” Currently Postdoctoral Fellow at UNM.

Dr. Andrew Aragon, University of New Mexico, Ph.D. Graduate, April 2021, “Etched-and-Regrown Diodes on M-Plane GaN for Next Generation Power Electronic Devices,” **Graduated with Distinction.** Currently at Intel.

Dr. Nick Boynton, University of New Mexico and Sandia National Laboratories, Ph.D. Student (post-qualifier, post-proposal), May 2020. Currently a Senior Member of Technical Staff at Sandia National Laboratories.

Dr. Saadat Mishkat-UI-Masabih, University of New Mexico, Ph.D. Graduate, August 2019, “Nonpolar GaN-Based VCSELs With Lattice-Matched Nanoporous Distributed Bragg Reflector Mirrors,” **Graduated with Distinction.** Currently a Technology Development Module Engineer at Intel.

Dr. Md Mottaleb Hossain, University of New Mexico, Ph.D. Graduate, May 2019, “Algorithmic Multi-Color CMOS Avalanche Photodiodes For Smart-Lighting Applications.” Daniel Feezell (Chairperson), Majeed Hayat (Research Advisor).

Dr. Arman Rashidi, University of New Mexico, Ph.D. Graduate, December 2018, “Carrier Dynamics in High-Speed III-Nitride Light-Emitting Diodes for Visible-Light Communication,” **Won best dissertation award from Optical Sciences and Engineering program at UNM. Graduated with Distinction.** Currently a postdoctoral researcher at UCSB.

Dr. Mohsen Nami, University of New Mexico, Ph.D. Graduate, October 2017, “Nanowire-Based Light-Emitting Diodes: A New Path Towards High-Speed Visible Light Communication.” **Won best dissertation award from Optical Sciences and Engineering program at UNM. Graduated with Distinction.** Currently a postdoctoral researcher at Yale University.

Dr. Nick Martinez, University of New Mexico and Sandia National Laboratories, Ph.D. Graduate, July 2017, “Waveguide-coupled Avalanche Photodiodes for a CMOS Compatible Transceiver Package.” Currently a Senior Member of Technical Staff at Sandia National Laboratories.

Dr. Jeremy Wright, University of New Mexico and Sandia National Laboratories, Ph.D. Graduate, September 2014, “III-Nitride Nanowire Lasers.” Currently a Senior Member of Technical Staff at Sandia National Laboratories.

*Served on the Ph.D. committee for an additional >15 graduated students

Current M.S.:

Julianna Khenaisser, M.S. student, August 2022 – present

Graduated M.S. (22 as primary advisor):

Ms. Elizabeth DeJong, University of New Mexico, OSE M.S. Graduate, May 2022.

Mr. Hatem Babaa, University of New Mexico, OSE M.S. Graduate, May 2022.

Mr. Zachary Meinelt, University of New Mexico, OSE M.S. Graduate, May 2022.

Ms. Windy Slater, University of New Mexico, ECE M.S. Graduate, May 2022.

Mr. Gevoni Briseno, University of New Mexico, ECE M.S. Graduate, May 2022.

Mr. Andrew Miano, University of New Mexico, ECE M.S. Graduate, August 2021.

Mr. Jack Kramer, University of New Mexico, ECE M.S. Graduate, August 2021.
Mr. Xuefeng Li, University of New Mexico, OSE M.S. Graduate, May 2019.
Mr. Alexander Pumerantz, University of New Mexico, ECE M.S. Graduate, May 2019.
Mr. Huck Green, University of New Mexico, ECE M.S. Graduate, May 2019.
Mr. Gabriel Rodriguez, University of New Mexico, ECE M.S. Graduate, May 2018.
Mr. Nick Boynton, University of New Mexico, ECE M.S. Graduate, December 2017.
Mr. Vincent Woods, University of New Mexico, ECE M.S. Graduate, May 2017.
Mr. Kenneth DaVico, University of New Mexico, M.S. Graduate, December 2017.
Mr. Isaac Stricklin, University of New Mexico, ECE M.S. Graduate, December 2017.
Mr. Arman Rashidi, University of New Mexico, OSE M.S. Graduate, December 2017.
Mr. Jimmy Stricklin, University of New Mexico, ECE M.S. Graduate, May 2017.
Mr. Nick Martinez, University of New Mexico, ECE M.S. Graduate, April 2017.
Mr. Bryan Ruane, University of New Mexico, ECE M.S. Graduate, December 2016.
Mr. Saadat Mishkat-Ul-Masabih, University of New Mexico, ECE M.S. Graduate, December 2016.
Mr. Rhett Eller, University of New Mexico, OSE M.S. Graduate, July 2014.
Mr. Mohsen Nami, University of New Mexico, OSE M.S. Graduate, December 2012.

*Served on the M.S. committee for an additional >10 graduated students

Postdoctoral Researcher Advising:

Current:

Dr. Farnood Mirkhosravi, University of New Mexico, University of New Mexico, Postdoctoral Fellow, July 2022-present. Project: “Epitaxial Growth and Characterization of Gallium Nitride Nanostructure-Based Micro-LEDs” with AMAT.

Former:

Dr. Mahmoud Behzadirad, University of New Mexico, Postdoctoral Fellow, January 2019-May 2022. Project: “GaN based RPCVD Grown Laser Diodes” with Blu Glass.

Dr. Arman Rashidi, University of New Mexico, Postdoctoral Fellow, December 2018-June 2020. Project: “RF Characterization of III-nitride optoelectronic Devices.”

Dr. Ashwin Rishinaramangalam, University of New Mexico, Postdoctoral Fellow, August 2012-December 2019. Project: “Coaxial Nanostructure LEDs” with Smart Lighting Engineering Research Center (ERC). Currently at Intel.

Dr. Morteza Monavarian, University of New Mexico, Postdoctoral Fellow, June 2016-June 2019. Project: “High-Speed Blue and Green Light-Emitting Diodes Using Polarization-Free GaN” with DoD. Currently at UCSB.

Dr. Serdal Okur, University of New Mexico, Postdoctoral Fellow, February 2015-June 2016. Project: “Nonpolar Vertical-Cavity Surface-Emitting Lasers for Ytterbium Atomic Clocks” with DARPA. Currently at Structured Materials and Industries, Inc.

Dr. Benjamin Bryant, University of New Mexico and Sandia National Laboratories, September 2013-2015. Project: “High-Speed Nonpolar InGaN/GaN Light-Emitting Diodes Using Plasmonic Core-Shell Nanowires” with DARPA Young Faculty Award. Currently at Avogy.

Undergraduate Student Advising:

Current:

None

Former:

Mr. Neema Naeemi, University of New Mexico, ECE Undergraduate, May 2017-May 2018. Funded by DOD HBCU/MI.

Mrs. Gabriela Rumella, California Polytechnic University San Luis Obispo, June 2018 – August 2018. Funded by Nanoscience and Microsystems Research Experience for Undergraduates (REU) Program.

Mr. William Hale, College of New Mexico Undergraduate, May 2017-August 2017. Funded by Nanoscience and Microsystems Research Experience for Undergraduates (REU) Program.

Ms. Olivia Johnson, University of New Mexico, ECE Undergraduate, August 2015-May 2017. Funded by DOD HBCU/MI. Currently at Palo Verde Nuclear Generating Station.

Mr. Jorge Romero, University of New Mexico, ECE Undergraduate, October 2014-May 2015. Funded by Smart Lighting Engineering Research Center. Currently a graduate student at University of Utah.

Ms. Jacquie Shortridge, University of Arizona Physics Undergraduate, June 2014-August 2014. Funded by Nanoscience and Microsystems Research Experience for Undergraduates (REU) Program.

Ms. Rekha Schnepf, Mellon University Undergraduate, June 2013-August 2013. Funded by Nanophotonics REU Program. Currently at Colorado School of Mines. Received NSF Graduate Fellowship.

Mr. Michael Wabaunsee, Southwestern Indian Polytechnic Institute (SIPI) Undergraduate, October 2012-May 2013. Funded by Nanophotonics REU Program.

High School Student Advising:

Former:

Ms. Sonia Macias, Atrisco Heritage Academy High School Student, June 2017-August 2017. Funded by Smart Lighting Engineering Research Center.

Ms. Aryn Gallegos, Albuquerque Academy High School Student, June 2015-August 2015. Funded by Smart Lighting Engineering Research Center.

Ms. Isabel Gallegos, Albuquerque Academy High School Student, June 2016-August 2016. Funded by Smart Lighting Engineering Research Center.

CONSULTING EXPERIENCE

Independent Technical Consultant (Expert), Radulescu LLP, 12/2022 - present

Independent Technical Consultant, BluGlass Ltd, 03/2020 – present

Independent Technical Consultant (Expert), Perkins Coie, LLP, 04/2020 – 05/2021

SATCO PRODUCTS, INC. Petitioner, v. SEOUL VIOSYS CO., LTD. Patent Owner, Case IPR2020-00655, Patent 9,627,435 B2

SATCO PRODUCTS, INC. Petitioner, v. SEOUL VIOSYS CO., LTD. Patent Owner, Case IPR2020-00608, Patent 9,343,631

Independent Technical Consultant, Exalos, 10/2020 – 06/2021

Independent Technical Consultant, Kairos Ventures, 04/2019 – 07/2019

Independent Technical Consultant (Expert), Latham and Watkins, LLP, 05/2017 – 06/2018

Independent Technical Consultant, CITIC Capital, 12/2016 – 03/2017

Independent Technical Consultant, Masimo Semiconductor, 09/2016 – 9/2017

Independent Technical Consultant (Expert), Williams & Connolly, LLP, 05/2013 – 12/2014

Independent Technical Consultant (Expert), Skadden, Arps, Slate, Meagher, and Flom, LLP, 09/2011 – 09/2012

Independent Technical Consultant for GaN-Based Lasers, Insite Partners: 08/2010 – 11/2010

SERVICE ACTIVITIES

Service to UNM:

UNM: Reviewing of internal proposals for OVPR, 2015 - present

UNM: Large Equipment Advisory Group, 2017 - present

ECE Department: Graduate Curriculum Committee, 2013 – present

CHTM: Nanofabrication Facility Committee, 2018 – present

CHTM: Director's Advisory Committee, 2018 – present

ECE Workload Policy Committee, 2017 and 2021

ECE Department: Optoelectronics Area Chair, 2015 – 2020

UNM: Research Misconduct Committee, 2019 – 2020

CHTM Faculty Search Committee (committee chair), 2018 – 2019 – two faculty hired (ECE and Physics)

ECE Promotion and Tenure Committee, 2018-2019

ECE Department Faculty Search Committee, 2017

CHTM: Director Search Committee, 2017

School of Engineering: Dean Search Committee, 2016

ECE Department: ABET Assessment Committee, 2015

ECE Department: Undergraduate Curriculum Committee, 2013 – 2015

CHTM: Nanofabrication Facility Steering Committee, 2014 – 2015

CHTM: Faculty Search Committee, 2013 – 2014

CHTM: Cleanroom Manager Search Committee, 2014

Leadership:

General Chair, Optical Science and Engineering (OSE), 2022 - present

Chair, CHTM Cleanroom Committee, 2021 - present

Area Chair, Optoelectronics, ECE Department, 2015 – 2020

Chair, CHTM Faculty Search Committee, 2018 – 2019 – two faculty hired (ECE and Physics)

Proceedings Chair and Editor, International Workshop on Nitride Semiconductors (IWN), October 2016

Faculty Advisor, CHTM Nanofabrication Facility, 2015 – 2018

Sources Thrust Leader, NSF Engineering Research Center on Smart Lighting, 2012 – 2019

Professional Service:

DOE Diversity, Equity, Inclusion, and Respect (DEIR) Working Group, 2022 - present

Program Committee, 2022 International Workshop on Nitride Semiconductors (IWN), Optical Devices

Program Committee, 2022 Compound Semiconductor Week (CSW), Semiconductor Lasers and LEDs

Program Committee, 2021 International Conference on Nitride Semiconductors (ICNS)

Session Chair, 2020 SPIE Photonics West

Program Committee, 2020 Lester Eastman Conference

Program Committee, 2020 International Workshop on Nitride Semiconductors (IWN), Optical Devices

Program Committee, 2019 19th International Conference on Crystal Growth and Epitaxy (ICCGE-19) and the 19th US Biennial Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-19)

Program Sub-Committee (Displays and Lighting), 2019 IEEE Photonics Conference

Program Committee, 2019 International Conference on Nitride Semiconductors (ICNS)

Program Committee, 2019 ISPlasma 2019/IC-PLANTS

Technical Committee (Semiconductor Lasers), 2018 Compound Semiconductor Week

Program Committee, 2018 International Workshop on Nitride Semiconductors (IWN)

Program Committee, 2018 SPIE Optics and Photonics Conference (Wide Bandgap Devices)

Program Committee, 2017 International Symposium on Semiconductor Light-Emitting Devices (ISSLED)

Program Committee, 2017 International Conference on Nitride Semiconductors (ICNS)

Session Chair and Organizer for 18th US Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-18)

Invited Organizer for *Group III-Nitrides and Compound Semiconductor Growth on Silicon* topics at 2015, 2016, 2017, 2018 Electronic Materials Conference

Technical Committee Member for Lester Eastman Conference, August 2016

Invited Organizer for *Compound Semiconductor Growth on Silicon* topic at 2014 Electronic Materials Conference

Session Chair for *III-Nitride Novel Device Concepts and Nanowires: Structures and Defects* sessions, 2014 Electronic Materials Conference

Subcommittee Member for *Science and Innovation 15: LEDs, Photovoltaics and Energy-Efficient ("Green") Photonics*, 2014 Conference on Lasers and Electro-Optics

Reviewing and Panels:

DOE Diversity, Equity, Inclusion, and Respect Roundtable, 12/7/21

KAUST PhD Dissertation External Reviewer, 2021

KAUST CRG 2019 proposal reviewer, 7/17/19

DOE Solid State Lighting BTO National Lab Call proposal reviewer, 5/31/19

UNM ADVANCE panel member for “How to talk to your program officer,” 10/19/18

Army Research Office proposal reviewer, 9/26/18

National Science Foundation proposal review panel for Photonics and Lasers in Electronic, Photonic, and Magnetic Devices Program, 1/7/16 – 1/8/16

Department of Energy Solid-State Lighting Roundtable Discussion, 9/9/15

Army Research Labs program reviewer for Sensors and Electron Devices Directorate, 7/22/15

National Science Foundation proposal review panel for LEDs, OLEDs, Lighting, Displays in SBIR/STTR Program, 8/26/14

National Science Foundation proposal review panel for LEDs, OLEDs, and Light Sources in SBIR/STTR Program, 2/26/14

National Science Foundation proposal review panel for Emitters and Detectors in Electronic, Photonic, and Magnetic Devices Program, 1/27/14 – 1/28/14

Technical Journal Reviewer: Applied Physics Letters, Nature, Nano Letters, Optics Express, Journal of Applied Physics, Journal of Crystal Growth, Physica Status Solidi, Photonics Technology Letters, Laser and Photonics Reviews, Electron Device Letters, Photonics Review, Electrochemical and Solid-State Letters, Rapid Research Letters, Applied Physics Express, Japanese Journal of Applied Physics.

Outreach:

Collaborator, Southwestern Indian Polytechnic Institute (SIPI) through NSF CAREER Award, 03/2015-present

Mentor, Research Experience for Undergraduates (REU), University of New Mexico, 09/2012 – 08/2018

Mentor, Research Experience for Teachers (RET), University of New Mexico, 06/2013 – 08/2017

Presenter, “Electricity and Light!,” Pajarito Elementary School (1st – 5th grade gifted class), 05/15/17

Presenter, “Electricity and Light!,” Manzano Day School Elementary (1st grade class), 03/09/17

Presenter, “High Efficiency Solid-State Lighting, Light-Emitting Diodes, and Smart Lighting,” Southwestern Indian Polytechnic Institute (SIPI), 12/05/13 and 04/03/14.

Presenter, “Light-Emitting Diodes and Smart Lighting,” Dolores Gonzales Elementary School (5th grade class), 10/26/12

Instructor for high-school and community college students, National Nanotechnology Infrastructure Network (NNIN), University of California Santa Barbara, 09/2004-06/2005

Professional Standing:

Faculty Associate: Center for High Technology Materials, University of New Mexico

Member: IEEE (Senior Member), IEEE Photonics Society, SPIE, OSA, MRS, Tau Beta Pi

Prior Member: American Physical Society, American Ceramic Society, Eta Kappa Nu

PUBLICATIONS

As of Sept. 2, 2022: **h-index** = **46**, **i10-index** = **97**, and number of **citations** = **7,894** (source: Google Scholar). Since joining UNM in August 2012, I have published 56 peer-reviewed journal articles, 110 peer-reviewed conference presentations/proceedings (including 18 invited presentations), 1 book chapter, 6 popular/technical press publications, 24 workshop/non-refereed presentations, and 10 UNM patents.

ACCEPTED, SUBMITTED, IN-PREPARATION JOURNAL / CONFERENCE PUBLICATIONS

- [1] F. Mirkhosravi, A. Rashidi, J. Gallagher, Z. Abedi, K. Ahn, A. Lintereur, E.K. Mace, M.A. Scarpulla, **D. Feezell**, “Effects of fast and thermal neutron irradiation on Ga-polar and N-polar GaN diodes,” accepted in *Journal of Applied Physics*, July 2022.
- [2] N Pant, X. Li, E. DeJong, **D. Feezell**, R. Armitage, and E. Kioupakis, “Origin of the injection-dependent emission blueshift and linewidth broadening in III-nitride light-emitting diodes,” accepted in *AIP Advances*.
- [3] **D. Feezell**, X. Li, A. Rashidi, M. Nami, M. Monavarian, A. Rishinaramangalam, E. DeJong, and R. Armitage, “Carrier Dynamics of Polar, Semipolar, and Nonpolar InGaN/GaN LEDs Measured by Small-Signal Electroluminescence,” accepted to *SPIE Photonics West*, to be presented Feb. 2023 (Invited).
- [4] N Pant, X. Li, E. DeJong, **D. Feezell**, R. Armitage, and E. Kioupakis, “How numerical simulations can advance wide bandgap materials and devices: a case study on the optical spectrum of visible light-emitting diodes,” submitted to *APS Physics March Meeting*.
- [5] X. Li, E. DeJong, N. Pant, E. Kioupakis, R. Armitage, and **D. Feezell**, “Effect of Emission Wavelength on Carrier Dynamics in InGaN/GaN LEDs,” in preparation for *Applied Physics Letters*.
- [6] M. Behzadizad, R. Someshwar, M. Khoury, and **D. Feezell**, “High-Quality c-Plane GaN Film with Controlled Polarity on PVD AlN Buffer on Si (111),” in preparation.
- [7] A. Rashidi, M. Monavarian, and **D. Feezell**, “Methods for Characterization of Carrier Dynamics in III-Nitride Light-Emitting Diodes,” in preparation for *Laser and Photonics Reviews*.
- [8] M. Monavarian, M. Behzadizad, T. Busani, and **D. Feezell**, “A review of advances and challenges of III-nitride nanostructures: From synthesis/fabrication methods to applications,” in preparation.
- [9] N. A. Sanford, P. T. Blanchard, A. Roshko, A. K. Rishinaramangalam, **D. Feezell**, and A. V. Davydov, “Laser-assisted atom probe tomography study of c-plane and m-plane InGaN test structures: likely contributions from spontaneous polarization effects,” in preparation.

INVITED REFEREED JOURNAL PUBLICATIONS:

- [1] M. Monavarian, A. Rashidi, and **D. Feezell**, “A Decade of Nonpolar and Semipolar III-Nitrides: A Review of Successes and Challenges,” *Phys. Stat. Sol. (a)*, vol. 216, pp. 1800628, Jan. 2019. doi: 10.1002/pssa.201800628 **Selected for Physica Status Solidi Showcase 2020**
- [2] **D. Feezell** and S. Nakamura, “Invention of the Blue Light-Emitting Diode, the Enabler of Solid-State Lighting,” *Comptes Rendus De L’Academie Des Sciences – Serie IV Physique-Astrophysique, The*

Revolution of LED Lighting special issue, vol. 19, pp. 113-133, May 2018. doi: 10.1016/j.crhy.2017.12.001

- [3] **D. Feezell**, J. Speck, S. DenBaars, and S. Nakamura, "Semipolar ($2\bar{0}\bar{1}$) InGa_N/Ga_N Light-Emitting Diodes for High Efficiency Solid-State Lighting," *J. Display Technol.*, vol. 9, pp. 190-198, Feb. 2013.
- [4] S. DenBaars, **D. Feezell**, K. Kelchner, S. Pimputkar, C. Pan, C. Yen, S. Tanaka, Y. Zhao, N. Pfaff, R. Farrell, M. Iza, S. Keller, U. Mishra, J. Speck, and S. Nakamura, "Development of Gallium-Nitride-Based Light-Emitting Diodes (LEDs) and Laser Diodes for Energy-Efficient Lighting and Displays," *Acta Materialia*, vol. 61, pp. 945-951, Feb. 2013.
- [5] M. Hardy, **D. Feezell**, S. DenBaars, and S. Nakamura, "Group III-Nitride Lasers: A Materials Perspective," *Materials Today*, vol. 14, pp. 408-415, Sep. 2011.
- [6] **D. Feezell**, M. Schmidt, S. DenBaars, and S. Nakamura, "Development of Nonpolar and Semipolar InGa_N/Ga_N Visible Light-Emitting Diodes," *MRS Bulletin: Nonpolar and Semipolar Group III Nitride-Based Materials*, vol. 34, pp. 318-323, May 2009.

REFEREED JOURNAL PUBLICATIONS:

- [1] M. Monavarian, B. Abaie, S. Mishkat-Ul-Masabih, F. Mirkhosravi, A. Mafi, and **D. Feezell**, "Disorder-induced broadband distributed Bragg reflectors in dielectric and nanoporous GaN systems," *Physica Status Solidi (PSS) Rapid Research Letters (RRL)*, pp. 2100598(1-5), Feb. 2022. doi:10.1002/pssr.202100598
- [2] K. Ahn, Y. K. Ooi, F. Mirkhosravi, J. Gallagher, A. Lintereur, **D. Feezell**, E. K. Mace, and M. A. Scarpulla, "Differences in electrical responses and recovery of GaN p+n diodes on sapphire and freestanding GaN subjected to high dose ⁶⁰Co gamma-ray irradiation," *Journal of Applied Physics*, vol. 129, pp. 245703(1-10), June 2021. doi.org/10.1063/5.0050365
- [3] M. Behzadizad, S. Mecholdt, J. Randall, J. Ballard, J. Owen, A. Rishinaramangalam, A. Reum, T. Gotszalk, **D. Feezell**, I. Rangelow, T. Busami, "Advanced Scanning Probe Nanolithography Using GaN Nanowires," *Nano Letters*, vol. 21(13), pp. 5493-5499, June 2021. doi.org/10.1021/acs.nanolett.1c00127
- [4] F. Mirkhosravi, A. Rashidi, J. Gallagher, M. Monavarian, A. Aragon, K. Ahn, Y. K. Ooi, A. Lintereur, E.K. Mace, M.A. Scarpulla, and **D. Feezell**, "Impact of gamma-ray irradiation on electrical characteristics of N-polar and Ga-polar GaN p-n diodes," *AIP Advances*, vol. 11, pp. 025009(1-8), Feb. 2021. doi: 10.1063/5.0021382
- [5] L. Miaja-Avila, B. Caplins, A. Chiaramonti, P. Blanchard, M. Brubaker, A. Davydov, D. Diercks, B. Gorman, A. Rishinaramangalam, **D. Feezell**, K. Bertness, and N. Sanford, "Extreme Ultraviolet Radiation Pulsed Atom Probe Tomography of III-Nitride Semiconductor Materials," *J. Phys. Chem. C*, vol. 125 (4), pp. 2626-2635, Jan. 2021. doi.org/10.1021/acs.jpcc.0c08753
- [6] A. Aragon, M. Monavarian, G. Pickrell, M. Crawford, A. Allerman, **D. Feezell**, and A. Armstrong, "Defect suppression in wet-treated etched-and-regrown nonpolar m-plane GaN vertical Schottky diodes: A deep-level optical spectroscopy analysis," *Journal of Applied Physics*, vol. 128, pp. 185703, Nov. 2020. doi: 10.1063/5.0018829

- [7] M. Behzadizad, A. Rishinaramangalam, **D. Feezell**, T. Busani, C. Reuter, A. Reum, M. Holz, T. Gotszalk, S. Mecholdt, M. Hofmann, A. Ahmad, T. Ivanov, and I. Rangelow, "Field Emission Scanning Probe Lithography with GaN nanowires on active cantilevers," *Journal of Vacuum Science and Technology B*, vol. 38, pp. 032806, May. 2020. doi: 10.1116/1.5137901
- [8] P. Ranga, A. Bhattacharyya, A. Rishinaramangalam, Y. K. Ooi, M. Scarpulla, **D. Feezell**, and S. Krishnamoorthy, "Delta-doped β -Ga₂O₃ thin films and β -(Al_{0.26}Ga_{0.74})₂O₃/ β -Ga₂O₃ heterostructures grown by metalorganic vapor-phase epitaxy," *Applied Physics Express*, vol. 13, pp. 045501, Mar. 2020. doi: 10.35848/1882-0786/ab7712
- [9] A. Rashidi, A. Rishinaramangalam, M. Monavarian, S. Mishkat Ul Masabih, A. Aragon, C. Lee, S. DenBaars, and **D. Feezell**, "Nonpolar GaN-Based Superluminescent Diode with 2.5 GHz Modulation Bandwidth," *Photon. Technol. Lett.*, vol. 32, pp. 383, Feb. 2020. doi: 10.1109/LPT.2020.2976060
- [10] A. Tarief Elshafiey, K.M. Davico, A. K. Rishinaramangalam, A. Rashidi, A. Aragon, **D. Feezell**, C. Sheehan, and V. Matias, "GaN/InGaN Blue Light-Emitting Diodes on Polycrystalline Molybdenum Metal Foils by Ion Beam-Assisted Deposition," *Physica Status Solidi (a)*, vol. 1900800, pp. 1-6, Feb. 2020. doi.org/10.1002/pssa.201900800
- [11] A. Rashidi, M. Monavarian, A. Aragon, and **D. Feezell**, "Thermal and efficiency droop in InGaN/GaN light-emitting diodes: decoupling multiphysics effects using temperature-dependent RF measurements," *Scientific Reports*, vol. 9, pp.19921, Dec. 2019. doi: 10.1038/s41598-019-56390-2
- [12] A. Aragon, M. Monavarian, I. Stricklin, G. Pickrell, M. Crawford, A. Allerman, A. Armstrong, and **D. Feezell**, "Interfacial impurities and their electronic signatures in high-voltage regrown nonpolar m-plane GaN vertical p-n diodes," *Physica Status Solidi (a)*, vol. 19000757, pp. 1-7, Dec. 2019. doi: 10.1002/pssa.201900757
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- [2] **D. Feezell**, “Perspectives from the University of New Mexico (an R1 HIS/MI/MSI),” Department of Energy (DOE) Diversity, Equity, Inclusion, and Respect (DEIR) Roundtable Discussion, Online Zoom Meeting, Dec. 7, 2021.
- [3] **D. Feezell**, “Small-Signal RF Measurements for LED Carrier Dynamics,” DOE Solid-State Lighting R&D Roundtable Discussion, virtual event, Aug. 2021.
- [4] **D. Feezell**, “Nonpolar and Semipolar III-Nitride Optoelectronics at UNM,” Facebook Seminar, virtual event, Mar. 2021.
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- [7] **D. Feezell**, “Nonpolar and Semipolar III-Nitride Optoelectronics,” Center for Integrated Nanotechnologies (CINT) Seminar, June. 2019.
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- [19] **D. Feezell**, “Nonpolar Vertical-Cavity Surface-Emitting Lasers for Ytterbium Atomic Clocks,” guest speaker at DARPA LUSTER Program Review, Feb. 2016.
- [20] **D. Feezell**, “Superluminescent Diodes: an Alternative to Lasers for Advanced Lighting Systems?,” Department of Energy Solid-State Lighting Roundtable Meeting, Nov. 2015.
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