UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TRUSTEES OF BOSTON UNIVERSITY,	)	
Plaintiff,	)	
v.	)	CIVIL NO. 12-11935-PBS CIVIL NO. 12-12326-PBS CIVIL NO. 12-12330-PBS CIVIL NO. 13-11105-PBS
EVERLIGHT ELECTRONICS CO., LTD., et al.,	)	
Defendants.	)	

MEMORANDUM AND ORDER RE: CONSTRUCTION OF DISPUTED CLAIM TERMS

May 20, 2014

Saris, U.S.D.J.

I. INTRODUCTION

Plaintiff Trustees of Boston University ("BU") brought this action under 35 U.S.C. § 271(a) against defendants[1] for the alleged infringement of U.S. Patent No. 5,686,738 ("'738 patent"), entitled "Highly Insulating Monocrystalline Gallium Nitride [("GaN")] Thin Films." GaN thin films are common components of blue light-emitting diodes ("LEDs"). LEDs are semiconductor devices that emit light

[1] "Defendants" refer to Epistar Corp.; Everlight Electronics Co., Ltd.; Everlight Americas, Inc.; Lite-On Inc.; Lite-On Service USA, Inc.; Lite-On Trading USA, Inc.; Lite-On Technology Corp.; Arrow Electronics, Inc.; and NU Horizons Electronics Corp. On February 4, 2014, a few days after the Markman hearing, plaintiff dismissed its claims against ComponentsMAX, Inc., and NRC Electronics, Inc., without prejudice. (Civil Action No. 13-11105-PBS, Docket No. 199).

Dockets.Justia.com

when charged with an electric current. LEDs containing GaN thin films can be found in light bulbs, laser printers, optical-fiber communication networks, and flat-panel displays of handheld devices and televisions. In October 2012, plaintiff filed multiple actions against manufacturers for direct infringement and against distributers for indirect infringement. The parties seek claim construction on four disputed claim terms. After holding a Markman hearing on January 30, 2014, (Docket No. 347),[2] and reviewing videotaped tutorials submitted by both parties, the Court construes these terms as follows.

II. TECHNICAL AND SCIENTIFIC BACKGROUND

A. Structure of LEDs

An LED is a device that emits light when an electrical current is applied. WILEY ELEC. & ELECS. ENG'G DICTIONARY 416 (Steven M. Kaplan ed., 2004).[3] It is constructed from a semiconductor, which is "[a] material, usually a crystal, whose conductivity lies somewhere between that of an electric conductor, such as a metal, and that of an insulator, such as rubber." Id. at 693. One example of a semiconductor is GaN. An "intrinsic" semiconductor is a pure material, such as a GaN crystal; an extrinsic semiconductor is an

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[2] All citations to the docket refer to Civil Action No. 12-11935-PBS, unless otherwise indicated.

[3] The parties agreed to the Court's use of this source for purposes of technical background. Markman Hr'g Tr. 7.

impure material, such as a GaN crystal with added magnesium (Mg) atoms. See id.; id. at 208; see also Edwin L. Piner Decl. in Supp. of Pl.'s Technical Tutorial ("Pl.'s Tutorial"), (Docket No. 296), ¶ 8.[4] These added impurities, called dopants, may be either acceptors (atoms, molecules, or ions that accept electrons) or donors (atoms, molecules, or ions that donate electrons). WILEY DICTIONARY at 6, 207, 208. Adding donors or acceptors to a material affects the concentration of "charge carriers," which are mobile electrons, holes, or ions. Id. at 107. Doping a semiconductor material increases its electrical conductivity because, the higher the concentration of charge carriers, the more easily electric current flows through the material. See id. at 107, 139, 208.

Semiconductors doped with acceptor impurities are "p-type" because acceptors contribute mobile holes to the pure semiconductor material. Id. at 547. Semiconductors doped with donor impurities are "n-type" because donors contribute mobile electrons to the pure semiconductor material. Id. at 494.

An LED chip typically consists of multiple layers, including a substrate (**100**), an n-type semiconductor layer (**104**), a p-type semiconductor layer (**106**), and electrodes (**108**, **110**). One example of an LED chip is set forth in U.S. Patent No. 6,953,703 ("'703

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[4] Intrinsic properties are the "electrical characteristics of a semiconductor material which are inherently present in the pure crystal," in "contrast[] with extrinsic properties, which are those determined by imperfections in the crystal and intentionally-introduced impurities." WILEY DICTIONARY at 290 (emphasis omitted).

patent"), fig. 12, <u>infra</u>.[5]

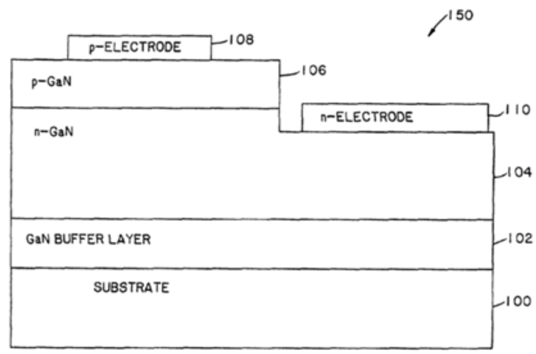

FIG.12

An LED is a semiconductor diode, which is a device made up of a p-n junction. <u>See</u> WILEY DICTIONARY at 194. The p-type and n-type layers make up the p-n junction, which is the region where the p-type semiconductor and the n-type semiconductor meet. <u>Id.</u> at 585. When electrodes are attached to the p- and n-type layers and current is applied, the energy from the current allows electrons from the n-type semiconductor and holes from the p-type semiconductor to move toward one another (opposite charges attract) and to meet at the p-n junction. Pl.'s Tutorial ¶ 6; Professor Eugene A. Fitzgerald

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[5] On June 30, 2003, BU Professor Theodore D. Moustakas, the inventor, filed Patent Application No. 10/610,332, which descended from a continuation-in-part of U.S. Patent No. 5,385,862 ("'862 patent"), which is also the direct parent of the '738 patent. This application was issued on October 11, 2005, as the '703 patent, entitled, "Method of Making a Semiconductor Device with Exposure of Sapphire Substrate to Activated Nitrogen." <u>See</u> Defs.' Prelim. Claim Constr. Br. ("Defs.' Br."), (Docket No. 213), Ex. 3 (Patent Family Tree).

Decl. in Supp. of Defs.' Tech. Tutorial ("Defs.' Tutorial"), (Docket No. 295-1), ¶ 10. When an electron recombines with a hole, the energy is released in the form of a photon, and light is emitted. Pl.'s Tutorial ¶¶ 7, 14; Defs.' Tutorial ¶ 10. The energy of the photon determines the color of light produced. Defs.' Tutorial ¶ 10; see also Pl.'s Tutorial ¶¶ 17-18.

B. Fabrication of LEDs

A pure compound, when crystallized, adopts a particular structure called a lattice. WILEY DICTIONARY at 156. The structure of the crystal lattice is determined by the size and arrangement of the atoms. WILEY DICTIONARY at 156; see also, e.g., Defs.' Tutorial ¶ 20 ("Sapphire has a hexagonal structure."). For example, sapphire (Al_2O_3) has a particular crystal lattice structure made up of aluminum (Al) and oxygen (O) atoms, while GaN has a structure made up of gallium (Ga) and nitrogen (N) atoms. Sapphire and GaN have different lattice structures because of the different sizes and spacing of the atoms in their crystals. See Defs.' Tutorial ¶ 17 (GaN and sapphire "have different lattice constants [the physical dimensions of a unit cell in the crystal structure], as well as a difference in spacing between the atoms . . . . The lattice constant of sapphire is nearly 50% larger than the lattice constant of gallium nitride.").

The process of epitaxy is used to fabricate, or manufacture, semiconductors. WILEY DICTIONARY at 260; Defs.' Tutorial ¶ 30. Epitaxy is the "controlled and oriented growth of a thin single-crystal layer upon the surface of another single crystal, with the deposited layer having the same crystalline orientation as its substrate." WILEY DICTIONARY at 260-61. In molecular-beam epitaxy, the process used in the '738 patent, the lattice structures of the substrate (e.g., sapphire) and of the desired semiconductor material (e.g., GaN) are extremely important. See Defs.' Submission of Definitions from Dictionaries and Publ'ns ("Defs.' Definitions"), (Docket No. 343), Ex. E (MOLECULAR BEAM EPITAXY 99 (Alfred Cho ed., 1994)) ("The thin film grown [by MBE] has a crystallographic structure related to that of the substrate."). "Epitaxial growth of [GaN] by MBE involves a series of events: (1) adsorption[6] of the constituent atoms and molecules; (2) surface migration and dissociation of the adsorbed molecules; (3) [and] incorporation of the atoms to the substrate resulting in nucleation and growth." Id. Nucleation occurs when the desired material (e.g., Ga and N atoms) forms on the surface of the substrate (e.g., sapphire); the desired material initially gathers at "nucleation sites" and eventually grows into a layer as more material is deposited. Markman Hr'g Tr. 12 (defendants' expert described epitaxial growth as the process in which gases in a chamber start depositing on the surface of the substrate, "not uniformly" but at

[6] Adsorption is the "adherence of a substance to the surface of another." WILEY DICTIONARY at 15.

"nucleation sites, which is where there's . . . a gathering of material at a site" which then "grow[s] . . . into a layer."); see also Pl.'s Prelim. Claim Constr. Br. ("Pl.'s Br."), (Docket No. 212), at 4 n.16 (defining "nucleation" similarly). The substrate "acts like a seed" - for example, the Ga and N atoms deposited on the sapphire substrate "tend to replicate that [substrate's] crystal structure as [the Ga and N atoms] come up [grow]." Markman Hr'g Tr. 13 (defendants' expert's description of the epitaxial growth process); see also Defs.' Definitions, Ex. D (McGRAW-HILL ELECS. DICTIONARY 193 (John Markus & Neil Sclater eds., 5th ed. 1994)) (An "epitaxial layer" is a "semiconductor layer with the same crystalline orientation as the substrate on which it is grown" because, at a particular temperature, "the atoms are mobile and able to take up the orientation of the substrate lattice.").

However, the lattice of sapphire does not match that of an ideal GaN crystal. Defs.' Tutorial ¶ 17. Therefore, when a GaN layer is deposited directly on the surface of a sapphire substrate, the lattice mismatch at the interface will introduce stress into the growing GaN semiconductor material. Id. ¶ 18; Pl.'s Tutorial ¶ 19. This can cause defects such as atomic dislocations and cracking. Defs.' Tutorial ¶ 18; WILEY DICTIONARY at 156; see also, e.g., '738 patent 4:50-51 (GaN buffer layer grown directly on sapphire substrate in preferred embodiment is "highly defective").

C. Development of Blue LEDs

The first LEDs were developed in the early 1960s but have changed significantly in the past fifty years, particularly in the last two decades. Pl.’s Tutorial ¶ 16; Defs.’ Tutorial ¶¶ 4-5. Initially, LEDs were restricted to the colors red, orange, and yellow. Pl.’s Tutorial ¶¶ 16-17; Defs.’ Tutorial ¶ 12. Certain nitrides such as GaN were identified more than forty years ago as potential LED materials that could produce light in the short-wavelength spectrum (blue and violet). Pl.’s Tutorial ¶ 18; Defs.’ Tutorial ¶ 12.

However, inventors encountered a number of problems when attempting to fabricate monocrystalline GaN LEDs. Pl.’s Tutorial ¶ 19; Defs.’ Tutorial ¶ 17. The four basic structures for solid-state materials are (1) monocrystalline, a single crystalline structure with long-range order, consistent spacing between atoms, and few defects; (2) polycrystalline, a crystal structure with short-range order where individual crystals are separated at angles with unstructured interfaces; (3) amorphous, a non-crystalline structure with inconsistent spacing between atoms and no long-range order; and (4) a mixture of polycrystalline and amorphous, where individual crystals are separated by amorphous regions of material. Defs.’ Tutorial ¶ 26; WILEY DICTIONARY at 22, 589, 713.[7] Of particular

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[7] The term “single crystalline” refers to monocrystalline structures. Defs.’ Tutorial ¶¶ 26-27; Pl.’s Br., Edwin L. Piner Decl. ¶ 23; <u>see also</u> Pl.’s Reply Claim Constr. Br., (Docket No. 258), at 7.

relevance here, it was difficult to synthesize monocrystalline GaN films given the lack of substrates with a suitable lattice match. Pl.'s Tutorial ¶ 19; Defs.' Tutorial ¶ 17. Because compounds with different lattice structures than GaN had to be used as substrates, GaN films grown directly on these lattice-mismatched substrates had high levels of defects. Defs.' Tutorial ¶ 18; see also Defs.' Prelim. Claim Constr. Br. ("Defs.' Br."), (Docket No. 213), Ex. 17 (Hiroshi Amano, Masahiro Kito, Kazumasa Hiramatsu, & Isamu Akasaki, P-Type Conduction in Mg-Doped GaN Treated with Low-Energy Electron Beam Irradiation (LEEBI), 28(12) Jap. J. Applied Physics L2112-14, L2112 (1989)), ("Amano paper"), ("Because of the large lattice mismatch and the large difference in the thermal expansion coefficient between GaN and sapphire, it used to be fairly difficult to grow high-quality epitaxial GaN film with a flat surface free from cracks.").

By 1989, Japanese scientists were able to use epitaxy to grow monocrystalline GaN films by first growing an aluminum nitride (AlN) buffer layer on a sapphire (Al_2O_3) substrate, and then depositing GaN on the AlN buffer layer. Amano paper at L2112, L2113 fig. 3, infra. However, these GaN films were highly resistive,[8] so p-type doping did not have the desired effect of increasing the flow of current. Id. at L2112 ("The as-grown GaN:Mg is highly

[8] Resistance is "opposition a material offers to the flow of current." WILEY DICTIONARY at 656.

resistive.”). Only an additional procedural step, such as LEEBI treatment or heating the material, restores the p-type character of the film. Id.; see also Pl.’s Tutorial ¶ 24; Defs.’ Tutorial ¶ 12.

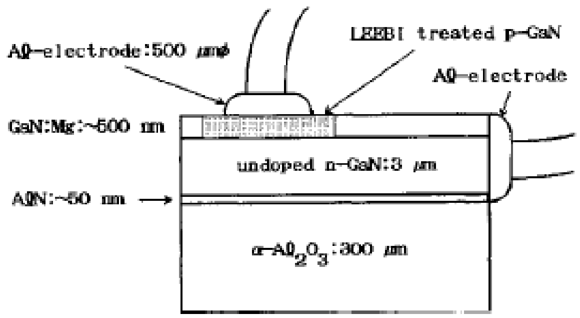

Fig. 3. The structure of the p-n junction LED.

In June 1990, BU Professor Theodore D. Moustakas found that, with an intervening GaN buffer layer, he could fabricate highly insulating, near-intrinsic GaN monocrystalline films through epitaxy without an additional step. Pl.’s Tutorial ¶ 25; Defs.’ Tutorial ¶ 76. He filed a patent application on January 13, 1995; and, after several rounds of amendments, the ’738 patent was issued on November 11, 1997.

III. DISCUSSION

A. Guidelines for Claim Construction

A patent’s claims “define the invention to which the patentee is entitled the right to exclude.” Phillips v. AWH Corp., 415 F.3d 1303, 1312 (Fed. Cir. 2005). “Construction of a patent, including terms of art within its claim, is exclusively within the province of the court." Markman v. Westview Instruments, Inc., 517 U.S. 370, 372 (1996); see also Lighting Ballast Control LLC v. Philips Elecs. N. Am. Corp., 744 F.3d 1272, 1285 (Fed. Cir. 2014) (rehr'g en banc). Courts must abide "by the standard construction rule that a term can be defined only in a way that comports with the instrument as a whole." Markman, 570 U.S. at 389.

1. Intrinsic Evidence

First, "the words of a claim are generally given their ordinary and customary meaning." Phillips, 415 F.3d at 1312 (internal quotation marks omitted). "[T]he ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention," which "provides an objective baseline from which to begin claim interpretation." Id. at 1313. "Importantly, the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification." Id. Therefore, the court consults "the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art." Id. at 1314; see also Takeda Pharm. Co. Ltd. v. Zydus Pharms. USA, Inc., 743 F.3d 1359, 1363 (Fed. Cir. 2014).

The patent specification "is always highly relevant to the claim construction analysis," is "[u]sually . . . dispositive," and "is the single best guide to the meaning of a disputed term." Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996). "[T]he specification may reveal a special definition given to a claim term by the patentee that differs from the meaning it would otherwise possess," in which case "the inventor's lexicography governs." Phillips, 415 F.3d at 1316. "In other cases, the specification may reveal an intentional disclaimer, or disavowal, of claim scope by the inventor," whose "intention, as expressed in the specification, is regarded as dispositive." Id. However, the court must be wary not to read limitations from the specification into the claims when the specification "describes very specific embodiments of the invention" but is not meant to "confin[e] the claims to those embodiments." Id. at 1323.

A patent's prosecution history encompasses "the complete record of the proceedings before the [United States Patent and Trademark Office] and includes the prior art cited during the examination of the patent." Id. at 1317. Although the record "often lacks the clarity of the specification and thus is less useful for claim construction purposes," it may reveal the patentee's intended meaning of a claim term or certain limits on claim scope if the patentee disclaimed particular embodiments to avoid prior art. Id.; see also Schindler Elevator Corp. v. Otis Elevator Co., 593 F.3d

1275, 1285 (Fed. Cir. 2010) ("An argument made to an examiner constitutes a disclaimer only if it is clear and unmistakable," not if it is merely an "ambiguous disavowal.") (internal quotation marks and citations omitted); Nystrom v. TREX Co., Inc., 424 F.3d 1136, 1145 (Fed. Cir. 2005) (finding that the inventor's consistent use of a term in the prosecution history - with nothing contrary in the intrinsic record - defined the limits of a claim term).

A related patent may also bear on claim construction "if, for example, it addresses a limitation in common with the patent in suit." Advanced Cardiovascular Sys., Inc. v. Medtronic, Inc., 265 F.3d 1294, 1305 (Fed. Cir. 2001); see also Omega Eng'g, Inc. v. Raytek Corp., 334 F.3d 1314, 1333 (Fed. Cir. 2003) ("[P]rosecution disclaimer may arise from disavowals made during the prosecution of ancestor patent applications."); Jonsson v. Stanley Works, 903 F.2d 812, 818 (Fed. Cir. 1990) (finding prosecution history and claim construction of a related patent "is relevant to an understanding of [a shared term] as that term is used in the [disputed] patent").

2. Extrinsic Evidence

Extrinsic evidence, such as expert testimony and dictionary definitions, is "in general . . . less reliable than the patent and its prosecution history in determining how to read claim terms" and therefore must be considered "in the context of the intrinsic evidence." Phillips, 415 F.3d at 1318-19. Where the specification supports multiple interpretations of a term, extrinsic evidence may clarify which interpretation is more consistent with the understanding of a person of skill in the art. See, e.g., Conoco, Inc. v. Energy & Envtl. Int'l, L.C., 460 F.3d 1349, 1362 (Fed. Cir. 2006); Tap Pharms. Prods., Inc. v. Owl Pharms., LLC, 419 F.3d 1346, 1354 (Fed. Cir. 2005). However, courts should disregard expert opinions that are merely conclusory and unsupported by intrinsic evidence or other sources. SkinMedica, Inc. v. Histogen Inc., 727 F.3d 1187, 1195 (Fed. Cir. 2013).

B. Claim Construction

The four disputed terms are (1) "grown on," (2) "a non-single crystalline buffer layer," (3) "the first material consisting essentially of gallium nitride," and (4) "layer." As a representative claim that contains each of the disputed terms (noted by emphasis), Claim 1 provides:

> 1. A semiconductor device comprising:
>
> a substrate, said substrate consisting of a material selected from the group consisting of(100) Silicon, (111) silicon, (0001) sapphire, (11-20) sapphire, (1-102) sapphire, (111) gallium aresenide [sic],[9] (100) gallium aresenide [sic], magnesium oxide, zinc oxide and silicon carbide;
>
> **a non-single crystalline buffer layer** having a thickness of about 30 Å to about 500 Å, comprising a first material **grown on** said substrate, **the first material consisting essentially of gallium nitride**; and
>
> a first growth **layer grown on** the buffer **layer**, the first growth **layer** comprising gallium nitride and a first dopant material.

[9] The patent refers to gallium arsenide ("GaAs").

For each of the disputed claim terms, the Court presents plaintiff's and defendants' proposed constructions and the Court's final construction in chart form. Where one of the parties construes a term as two separate terms, these separate constructions are indicated in the chart.

1. "Grown on" (Claims 1, 2, 9, 15, 18, 19, 20)

Plaintiff's Proposed Construction	**Defendants' Proposed Construction**	**Court's Construction**
formed indirectly or directly above	formed in direct contact with	formed indirectly or directly above

The parties' main dispute centers on whether the patent requires direct contact between the substrate and the buffer layer, between the buffer layer and the first growth layer, and between the first growth layer and the second growth layer.[10] Plaintiff asserts that "grown on" specifies only a spatial and temporal relationship between layers but does not require crystal or atomic interaction. Defendants argue that the specification and prosecution history make clear that "grown on" means directly on top of, because atomic interaction is required for the successful fabrication of near-intrinsic GaN films. Central to the dispute is whether the claims permit additional intervening layers.

[10] See, e.g., '738 patent, Claim 2, which provides, in its entirety: "The semiconductor device of claim **1** further comprising: a second growth layer grown on the first growth layer, the second growth layer comprising gallium nitride and a second dopant material." (emphasis in original).

The plain language of the claims supports plaintiff's interpretation. Claim 1 describes a "semiconductor device comprising: a substrate . . . a non-single crystalline buffer layer . . . and a first growth layer." '738 patent 5:18-19, 25, 29. The transition "comprising" in patent language "creates a presumption that the claim does not exclude additional, unrecited elements." ArcelorMittal France v. AK Steel Corp., 700 F.3d 1314, 1320 (Fed. Cir. 2012). Conventional drafting language supports plaintiff's argument that the claims do not limit the number of layers in the semiconductor device; additional unrecited layers may exist.

The next, and tougher, question is whether the term "grown on" precludes the addition of layers between the layers expressly recited in the patent. "Grown on" is used only twice in the specification and appears both times in the description of the preferred embodiment, where no additional layers are mentioned. The term initially appears when describing the first growth layer, which "grows on top of the GaN buffer [layer] and does not see the underlying substrate." '738 patent 4:47-48 (emphasis added). The buffer layer, located between the substrate and the first growth layer, provides "the appropriate lattice match for the desired crystal structure of GaN," id., Abstract; and the near-intrinsic GaN growth layer "'recognizes' the GaN buffer layer . . . on which it can grow without defects," id. 4:48-50.

Defendants argue that "recognize" and "see" require an atomic interaction (i.e., direct contact). Yet, they have provided no evidence that a person of ordinary skill in the art would understand the words "see" and "recognize" to require direct contact or atomic interaction. Defendants' own expert stated at the hearing that the word "recognize" has no "scientific meaning" but is "a very casual term that's not typically used." Markman Hr'g Tr. 64. The Court will not read a limitation from the preferred embodiment into the claims from the use of an ambiguous word like "recognizes." See Phillips, 415 F.3d at 1323.

Later on in the specification, the term "grown on" appears the second time during a discussion of the results of the preferred embodiment: "the X-ray diffraction (XRD) pattern of a GaN film grown on the α-plane of sapphire (11-20) in a one-step process (FIG. 2a) and a two-step process (FIG. 2b)." '738 patent 4:41-43 (emphasis added). The XRD pattern shows the difference between a GaN film grown directly on top of the substrate, and that grown on top of a GaN buffer layer. Id. 4:44-48 ("The two peaks . . . of FIG. 2a are attributed to a defective GaN crystal," while "FIG. 2b has a single peak indicating a film of better quality . . . because a majority of the film grows on the top of the GaN buffer and does not see the underlying substrate.") (emphasis added); see also id. 4:37-38 ("Any further growth takes place on the crystallized GaN buffer layer.").

The preferred embodiment describes a "typical process" of "deposit[ing] the initial buffer layer of GaN" on the substrate. Id. 4:11-15. However, neither the claims nor the specification require the deposition of the buffer layer directly on the substrate to produce these XRD results. Although the buffer layer in the preferred embodiment is described as "highly defective," id. 4:50-51, due to the lattice mismatch between the substrate and GaN, the specification does not preclude an underlying, intervening layer which could still allow for the growth of a defective GaN buffer layer. In fact, in the related '703 patent, a GaN buffer layer is grown directly on an intervening, atomically smooth AlN layer, which directly contacts the underlying sapphire substrate. '703 patent 9:57-62. This AlN layer still allows for the growth of a defective GaN layer followed by fabrication of a near-intrinsic GaN growth layer. Id. 10:1-4 (GaN buffer "nucleation layer will be amorphous or defective crystalline.").

Furthermore, the preferred embodiment, while never explicitly naming an intervening layer, may in fact allow for a thin layer of aluminum nitride (AlN) between the substrate and buffer layer. "In a typical process, the substrate [e.g., sapphire] [is] sputter-etched by the nitrogen plasma at 600°C." '738 patent, 4:11-12. Because deposition of the buffer layer occurs after sputter-etching by nitrogen plasma, id., 4:13-15, an AlN layer may actually form in the preferred embodiment. The sputter-etching process exposes a substrate to plasma to remove impurities from the surface of a substrate. See Defs.' Rebuttal Claim Constr. Br., (Docket No. 268), Ex. 25 (Theodore Moustakas Dep., Apr. 3, 2002) at 59:21-60:5. The '703 patent states that this process can cause the formation of another layer (such as AlN) between the substrate and the buffer layer. See '703 patent 9:59-62 (describing process of nitridation and formation of AlN by exposing sapphire substrate to nitrogen plasma).[11] Although the formation of an AlN layer through sputter-etching was unanticipated by the inventor at the time of the '738 patent, see Moustakas Dep., Apr. 3, 2002, at 59:21-60:11, and is mentioned nowhere in the '738 patent, a court should hesitate to adopt a construction that reads out the preferred embodiment from the scope of the patent. MBO Labs., Inc. v. Becton, Dickinson & Co., 474 F.3d 1323, 1333 (Fed. Cir. 2007) (noting that a "claim interpretation that excludes a preferred embodiment from the scope of the claim is rarely, if ever, correct").

Relying on the prosecution history to support direct contact, defendants point out that, to obviate the Examiner's objections, the inventor emphasized that "a non-single crystal buffer layer is

[11] But see Professor Eugene A. Fitzgerald Decl. in Supp. of Defs.' Rebuttal Claim Constr. Br., (Docket No. 263), ¶ 7 (explaining that while sputter-etching "can result in a monolayer or more of aluminum nitride to form on top of the substrate," this "layer may not form, however, and whether one does would be heavily dependent on processing conditions."); Markman Hr'g Tr. 60-61 (plaintiff's expert also admits that AlN layer may not form through sputter-etching).

'grown on said substrate.'" Defs.' Br., Ex. 5 (Petitioner's Responsive Amendment to Sep. 20, 1996 Office Action), ("Pet.'s Resp. Am."), at 10. The Examiner's objection was based on the fact that "the term 'buffer'" did not "structurally distinguish over the references of record, in particular, Amano." Id. at 9. However, plaintiff correctly notes that the inventor's statement describes the buffer layer's crystallinity ("non-single crystal buffer layer") in addition to its location ("grown on said substrate"). Id. at 10. In fact, during prosecution the inventor distinguished his patent from prior art - specifically, Amano - based on the crystallinity of the GaN buffer layer. Id. at 11 (distinguishing inventor's GaN buffer layer from Amano's GaN layer by the non-single crystalline character of the former). Considered in light of the "totality of the prosecution history," the inventor's argument can be fairly viewed as distinguishing the crystallinity of his buffer layer from those in the prior art. Computer Docking Station Corp. v. Dell, Inc., 519 F.3d 1366, 1379 (Fed. Cir. 2008) (entire record of prosecution history informs disavowal record). Even if the buffer layer in the '738 patent can also be distinguished from prior art by location (direct contact with the substrate), the inventor's statement is not a clear and express disavowal of indirect contact. See Omega Eng'g, 334 F.3d at 1325-26.

Extrinsic evidence provides further support for plaintiff's proposed claim construction. As plaintiff's expert states, "[T]here is ample evidence that a growth layer 'recognizes' other buffer layer materials, whether directly on [sic] indirectly contacting such materials," such as when using graded buffer layers. Edwin L. Piner Decl. in Supp. of Pl.'s Reply Claim Constr. Br. ("Pl.'s Reply Expert Decl."), (Docket No. 258-6), ¶¶ 4-5. Furthermore, a recent patent, in which defendants' expert is named as an inventor, describes a layer "grown on" a substrate that does not in fact contact the substrate due to an intervening layer. See, e.g., Pl.'s Reply Claim Constr. Br. ("Pl.'s Reply Br."), (Docket No. 258), Ex. 16 (U.S. Patent No. 8,586,452 filed Sep. 7, 2011) at 6:41-49 ("In some embodiments, a uniform semiconductor layer (not shown) . . . is disposed between graded buffer layer **14** and substrate **12**. This uniform semiconductor layer may be grown to improve the quality of layers subsequently grown on substrate **12**, such as graded buffer layer **14**, by providing a clean, contaminant-free surface for epitaxial growth.") (emphasis added).

Finally, plaintiff's interpretation is consistent with another court's claim construction in BridgeLux, Inc. v. Cree, Inc., an earlier case in which one of plaintiff's licensees brought suit against a manufacturer of LED chips. No. C-06-6495, 2008 WL 3843072 (N.D. Cal. Aug. 15, 2008). The court construed the term "on"[12] as

[12] The BridgeLux court construed the single word "on" because the parties had previously agreed that the term "epitaxially grown" should be construed as the "[g]rowth of one crystal on the surface of another crystal in which the growth of the deposited crystal is oriented by the lattice structure of a substrate." Pl.'s Br., Ex.

"positioned indirectly or directly above" because it "is a common English term, and the parties point[ed] to no evidence showing that it is a technical term within the LED design field." Id. at *10. While not binding,[13] the previous claim construction of the '738 patent should be consulted. Cf. Finisar Corp. v. DirecTV Group, Inc., 523 F.3d 1323, 1329 (Fed. Cir. 2008) ("consult[ing] the claim analysis of different district courts on the identical terms in the context of the same patent" in "the interest of uniformity and correctness").

Based on the intrinsic and extrinsic record, the Court construes "grown on" as "formed indirectly or directly above."

2. "A Non-Single Crystalline Buffer Layer" (Claims 1, 9, 15, 18, 19, 20)

Plaintiff's Proposed Construction	Defendants' Proposed Construction	Court's Construction

18 ("Agreed Terms USP '236, '738 and '819 Patents").

[13] While the BridgeLux court reached claim construction, the case was dismissed before any final judgment on infringement.

"a non-single crystalline buffer layer" - a layer of material that is not monocrystalline, located between the first substrate and the first growth layer	SEPARATE TERMS: "a non-single crystalline layer" - a layer that is polycrystalline, amorphous or a mixture of polycrystalline and amorphous[14] "a buffer layer" - a layer that covers the substrate and directly contacts the substrate on one side and a growth layer on the opposite side	"a non-single crystalline buffer layer" - a layer of material that is not monocrystalline, namely, polycrystalline, amorphous or a mixture of polycrystalline and amorphous, located between the first substrate and the first growth layer

The dispute over the meaning of the term "non-single crystalline buffer layer" is more easily resolved because the inventor expressly defined "non-single crystalline" as "polycrystalline, amorphous or a mixture of polycrystalline and amorphous" during prosecution of related U.S. Patent No. 7,235,819 ("'819 patent"). See Defs.' Br., Ex. 8 (Dr. Theodore D. Moustakas Decl., Mar. 22, 2006) at 4. He expressly applied this description to the invention of the '819 patent's ancestor, U.S. Patent No. 5,385,862 ("'862 patent"),[15] which is the direct parent of the '738

[14] Defendants initially proposed "a layer that is polycrystalline, amorphous, or a mixture of polycrystalline and amorphous throughout its thickness," Am. Joint Claim Constr. & Prehr'g Statement, (Docket No. 325), at 3 (emphasis added), but later agreed to abandon this limitation and address it in the context of the term "layer," Markman Hr'g Tr. 94, 98-99.

[15] On August 30, 1993, Moustakas filed Patent Application No. 08/113,964 with the United States Patent and Trademark Office. See Patent Family Tree. This application was issued on January 31,

patent. Id. ("U.S. Patent No. 5,385,862 describes a buffer layer that is non-single crystalline, namely, polycrystalline, amorphous or a mixture of polycrystalline and amorphous"); Defs.' Br., Ex. 3 (patent family tree showing '738 patent is a direct continuation from '862 patent); see also Defs.' Br., Ex. 9 (Pet.'s Supp. Am., Apr. 20, 2006) at 7 (also during prosecution of the '819 patent, Moustakas reiterated this definition of "non-single crystalline" and referenced earlier parent applications, including the '738 patent, for support). If the inventor "acted as his own lexicographer and clearly set forth a definition of the disputed claim term in either the specification or prosecution history, then that definition governs." Advanced Fiber Techs. Trust v. J&L Fiber Servs., Inc., 674 F.3d 1365, 1374 (Fed. Cir. 2012) (internal quotation marks omitted). Because the inventor limited the scope of the term for a parent application from which the patent-at-issue is a continuation, the limitation applies with equal force to the '738 patent. See Omega Eng'g, 334 F.3d at 1333.

At the hearing, plaintiff pointed out that there may exist materials that do not qualify as polycrystalline, amorphous, a mixture of polycrystalline and amorphous, or monocrystalline. See

1995, as the '862 patent and entitled, "Method for the Preparation and Doping of Highly Insulating Monocrystalline Gallium Nitride Thin Films." See id. The '819 patent arises from a continuation-in-part derived from the '862 patent. See id.

Markman Hr'g Tr. 81-83, 85. This issue has not been well-developed and the Court declines to address it based on this record.

3. "The First Material Consisting Essentially of Gallium Nitride" (Claims 1, 9, 15, 18, 19, 20)

Plaintiff's Proposed Construction	**Defendants' Proposed Construction**	**Court's Construction**
the first material contains GaN and may only include other materials that do not materially affect the buffer layer's ability to enable the subsequent growth of high-quality GaN growth layers	the first material contains GaN and may only include other materials that do not materially affect the crystallographic, electrical or optical characteristics of the buffer layer	the first material contains GaN and may only include other materials that do not materially affect the buffer layer's ability to grow near-intrinsic monocrystalline GaN films that can be controllably doped n-type or p-type

This dispute turns on the meaning of the claim language "consisting essentially of," which in patent-drafting is a term of art that "necessarily includes the listed ingredients and is open to unlisted ingredients that do not materially affect the basic and novel properties of the invention." PPG Indus. v. Guardian Indus. Corp., 156 F.3d 1351, 1354 (Fed. Cir. 1998). The caselaw is somewhat unclear as to how to determine the "basic and novel properties" of an invention. The Court begins with the intrinsic record. See AK Steel Corp. v. Sollac, 344 F.3d 1234, 1239-40 (Fed. Cir. 2003) (defining basic and novel properties from the specification which stated the goal of the invention, as distinguished from prior art); Atlas Powder Co. v. E. I. Du Pont de Nemours & Co., 750 F.2d 1569, 1574-75 (Fed. Cir. 1984) (defining properties in light of the "essence of the claimed composition," as distinguished from prior art).[16] While a claim with the transition "consisting essentially of" is open to additional ingredients, the additives cannot negate other claim limitations. Talbert Fuel Sys. Patents Co. v. Unocal Corp., 275 F.3d 1371, 1375 (Fed. Cir.) (holding that the phrase "consisting essentially of" regarding the composition of the hydrocarbon mixture does not negate the additional temperature range limitation for the entire gasoline), vacated and remanded on other grounds, 537 U.S. 802 (2002). If a

[16] The Guidelines for the Examination of Patent Applications state:

> For the purposes of searching for and applying prior art under 35 U.S.C. [§§] 102 and 103, absent a clear indication in the specification or claims of what the basic and novel characteristics actually are, "consisting essentially of" will be construed as equivalent to "comprising." If an applicant contends that additional steps or materials in the prior art are excluded by the recitation of "consisting essentially of," applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention.

Guidelines for the Examination of Patent Applications Under the 35 U.S.C. 112(a) or Pre-AIA 35 U.S.C. 112, ¶ 1, "Written Description" Requirement, 66 Fed. Reg. 1099 (Jan. 5, 2001) (emphasis added) (internal citations omitted); MPEP § 2163. Although the Guidelines are not binding on the courts, Enzo Biochem., Inc. v. Gen-Probe Inc., 285 F.3d 1013, 1019 (Fed. Cir.), reversed and remanded on other grounds, 323 F.3d 956 (Fed. Cir. 2002), they do support the discernment of an invention's basic and novel properties from "clear indication[s]" in the claims and specification.

factual dispute remains as to what materially affects the basic and novel properties of the invention, this dispute must be resolved by the factfinder as a question of infringement rather than by the Court as a question of claim construction - though the line is sometimes blurred. PPG Indus., 156 F.3d at 1355; see also AK Steel, 344 F.3d at 1240 (holding that "consisting essentially of aluminum" required nearly pure aluminum because even small amounts of other materials "would materially alter the basic and novel properties of the invention"). This is a turgid, difficult nook of patent law.

The threshold question is to determine the basic and novel properties of the invention. Plaintiff contends that the basic and novel property of the invention is the ability of the buffer layer to allow for the subsequent growth of high-quality GaN layers. Defendants argue that the basic and novel properties of the invention are the crystallographic, electrical and optical characteristics of the buffer layer.

The goal of the invention is straightforward. After describing previous attempts (and failures) to fabricate near-intrinsic GaN films, the patent states that the "invention presents a method to prepare near-intrinsic monocrystalline GaN films and to selectively dope these films n- or p-type." '738 patent 2:4-6; see also id. 2:9-10 (patent reiterates in the "Summary of the Invention" that "[t]he method according to this invention [is] for preparing highly insulating near-intrinsic monocrystalline GaN films."); id. 3:1-7 (describing near-intrinsic GaN films). Based on the understanding of a person of skill in the art, plaintiff's expert concludes: "In my opinion, the basic and novel properties of the invention pertaining to the buffer layer reside in the growth of a near-intrinsic monocrystalline GaN growth layer that can be controllably doped n- or p-type." Pl.'s Reply Expert Decl. ¶ 10. Defendants agreed, "According to the '738 patent, the purpose of a GaN buffer layer is to permit growth of higher quality gallium growth layers (which can then be doped p-type or n-type)." Defs.' Br. at 14; see also Professor Eugene A. Fitzgerald Decl. in Supp. of Defs.' Claim Constr. Br. ("Defs.' Expert Decl."), (Docket No. 215), ¶ 27.

The crystallographic, electrical and optical characteristics of the buffer layer, however, are not basic and novel properties of the invention. Although the buffer layer must provide an "appropriate lattice match" for the subsequent growth of an intrinsic GaN layer, this requirement does not clearly limit the crystallographic properties of the buffer layer. '738 patent, Abstract. In fact, the buffer layer's crystal structure changes throughout the process and is not uniform in the final product. See id. 4:31-32, 34-36 ("nucleation" of the buffer layer occurs by heating, and the "amorphous film [buffer layer] crystallizes"). The claims also show that the buffer layer's crystal structure is not specifically defined; in fact, the term "non-single crystalline" allows its structure to be polycrystalline, amorphous, or a mixture of polycrystalline and amorphous. See Pl.'s Reply Expert Decl. ¶ 9 ("[I]t is to be expected that there will be variations in the 'electrical and optical characteristics' of the buffer layer due to, for example, the wide range of crystallographic characteristics disclosed by the '738 patent, and acknowledged by the [d]efendants."). Furthermore, neither the claims nor specification discuss the buffer layer's electrical or optical properties. The specification only refers to the electrical and optical properties of the GaN product in prior art; with respect to the '738 patent, this compares to the GaN growth layer, not the buffer layer. '738 patent 1:34-35 (discussing other inventors' earlier attempts to grow intrinsic GaN that resulted in "n-type [GaN] films" in which "[n]itrogen vacancies affect[ed] the electrical and optical properties of the [GaN] film"); see also Pl.'s Reply Expert Decl. ¶ 8.

Plaintiff's proposed claim construction encompasses nearly any additions to the first material that would still allow for the growth of high-quality, or "near-intrinsic monocrystalline," GaN films. '738 patent 2:4-5. I agree. However, based on the language in the specification and the declaration of plaintiff's own expert, the ability to control the doping of these GaN films should be included. See also id. 1:26-35 (distinguishing invention from prior art by the latter's fabrication of GaN with unintentional n-type characteristics).

For these reasons, ingredients may be added to the GaN "first material" only if they do not materially affect the buffer layer's ability to grow near-intrinsic monocrystalline GaN films that can be controllably doped n-type or p-type. To the extent defendants argue that the addition of specific ingredients materially affects this property, that dispute involves a question of infringement, not claim construction.

4. "Layer" (Claims 1, 2, 9, 15, 18, 19, 20)

Plaintiff's Proposed Construction	**Defendants' Proposed Construction**	**Court's Construction**
a defined thickness that is part of a material	a film of material having the same chemical composition (including dopants, if any) and crystal structure	a thickness of material with particular physical and/or chemical characteristics

Plaintiff argues that the term layer means a defined thickness that is part of a material, whereas defendant argues that it should be defined as a film having the same chemical composition and crystal structure. I do not adopt either proposed construction.

The Court starts with the intrinsic evidence to determine the plain and ordinary meaning of the term "layer." The claims describe the different "layers" in terms of thickness, composition or crystal structure. In some of the claims, the patent specifies the buffer layer's exact or relative thickness. E.g., '738 patent 5:25-26 ("having a thickness of about 30 Å to about 500 Å"); id. 6:64-65 (same); id. 7:11-12 (same); id. 7:34-35, 38-40 ("buffer layer having a first thickness" while the "growth layer . . . ha[s] a second thickness which is at least ten times greater than the first thickness"). The thickness of other layers, including that of all growth layers and some buffer layers, is not specified in the claims. E.g., id., Claims 8, 9, 11, 13, 19, 20, 21.

Both the buffer and growth layers are distinguished based on chemical composition and/or crystal structure. The claims require that the buffer layer is "non-single crystalline." See, e.g., id. 5:25. Meanwhile, the specification - in fact, the title of the patent - makes clear that the growth layers are monocrystalline. Id. 1:12-13 ("monocrystalline gallium nitride thin films"); see also Pet.'s Supp. Am. at 11 ("The present application and related [parent patent of '738] . . . also describe a monocrystalline film being grown subsequent to the buffer layer at higher temperatures on the underlying non-single-crystalline buffer layer."). The growth layers are also distinguished from one another in the claims by composition. See '738 patent 5:29-36 ("the first growth layer comprising gallium nitride and a first dopant material" versus "the second growth layer comprising gallium nitride and a second dopant material").

The specification does not contain a definition of "layer," so the Court must determine the meaning of the term to a person of ordinary skill in the art. The WILEY ELEC. & ELECS. ENG'G DICTIONARY defines a "layer" as "[a] defined thickness which is part of a material or which surrounds it . . . . [f]or example, . . . a layer in a semiconductor." WILEY DICTIONARY at 413. Two other technical dictionaries have different definitions which are not consistent with the claims or specification. One technical dictionary defines a "layer" "[i]n a semiconductor device [as] a region having unique electrical properties." Defs.' Definitions, Ex. F (THE ILLUSTRATED DICTIONARY OF ELECS. 378 (Stan Gibilisco ed., 6th ed. 1994)). Another defines an "epitaxial layer" as a "semiconductor layer with the same crystalline orientation as the substrate on which it is grown." MCGRAW-HILL ELECS. DICTIONARY 193. These latter two dictionaries do not accurately capture the patent's description of the buffer layer as "highly defective," '738 patent 4:50-51; for the buffer layer does not have "the same crystalline orientation as the substrate" or "unique electrical properties" (due to its nonuniform crystallinity), see Markman Hr'g Tr. 90-91 (both plaintiff's and defendants' experts testified in depositions that the non-single crystalline - and thus, non-uniform - character of the buffer layer makes its physical properties impossible to specifically classify).

In BridgeLux, the court construed "layer" based on both its "ordinary English meaning" and the WILEY DICTIONARY definition as "a defined thickness which is part of a material." 2008 WL 3843072, at *7. Noting that a "'layer' might have one or more of those properties," i.e., a "specific doping concentration," a "specific composition of chemical elements," or "boundaries defined by a change in chemical composition or the doping concentration (or both)," the court found that no evidence supported the conclusion that a layer "must have all of those properties." Id., at *7-8 (emphases in original) (internal quotation marks omitted). I agree with this analysis: the claims and specification distinguish the buffer and growth layers in multiple ways (i.e., position, thickness, composition, crystallinity) but do not uniformly and consistently distinguish them by any particular characteristic.

Furthermore, the extrinsic evidence comports with this reasoning. Defendants' expert declared that a layer is "a film of material having the same chemical composition (including dopants, if any) and crystal structure," characteristics an expert would use "to distinguish discrete and distinct portions of epitaxial film." Defs.' Expert Decl. ¶ 39. According to plaintiff's expert:

> One of ordinary skill in the art would understand the term "layer" to mean a material region with particular physical and/or chemical characteristics of a certain thickness. Physical characteristics would include crystal structure, including encompassing the various structures such as amorphous and polycrystalline coexisting . . . . Chemical characteristics would include composition. Distinctions are often made between GaN layers, AlN layers, and AlGaN layers, among many others. The "layer" is identified by a certain thickness, but not as a limiting factor in the definition of the term[,] thus allowing variations in thickness, including non-continuous materials, to still be termed a "layer."

Pl.'s Br., Edwin L. Piner Decl. ("Pl.'s Expert Decl.") ¶ 29 (internal citations omitted).

The Court concludes that the customary and ordinary meaning of "layer" is a thickness of material with particular physical and/or chemical characteristics. This is consistent with its everyday meaning, the WILEY DICTIONARY definition, and the claim terms themselves. The Court adopts plaintiff's expert's language, "particular physical and/or chemical characteristics," in lieu of defendants' proposal of "same" chemical composition and crystal structure. Pl.'s Expert Decl. ¶ 29. Defining a layer by its physical and/or chemical characteristics does not require that its composition be uniform throughout. "Nowhere does the patent refer to 'chemical uniformity' as a characteristic of a layer." AFG Indus., Inc. v. Cardinal IG Co., Inc., 239 F.3d 1239, 1250 (Fed. Cir. 2001) (finding that the chemical composition of a "layer" need only be "substantially uniform").

IV. ORDER

The disputed terms are construed as:

(1) "Grown on" - formed indirectly or directly above;

(2) "A non-single crystalline buffer layer" - a layer of material that is not monocrystalline, namely, polycrystalline, amorphous or a mixture of polycrystalline and amorphous, located between the first substrate and the first growth layer;

(3) "The first material consisting essentially of gallium nitride" - the first material contains GaN and may only include other materials that do not materially affect the buffer layer's

ability to grow near-intrinsic monocrystalline GaN films that can be controllably doped n–type or p-type; and

(4) "Layer" - a thickness of material with particular physical and/or chemical characteristics.

SO ORDERED.

/s/ PATTI B. SARIS
PATTI B. SARIS
Chief United States District Judge