

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

IQE PLC,
Petitioner

v.

CORNELL RESEARCH FOUNDATION INC.,
Patent Owner

Case: IPR2024-00609
U.S. Patent No. 7,250,360

PATENT OWNER'S PRELIMINARY RESPONSE

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2002	Docket Sheet, Case No. 2:24-mc-00008-RSP, <i>IQE KC, LLC v. Akoustis Technologies, Inc.</i> (E.D. Tex.) (retrieved June 17, 2024)
2003	Corporate Disclosure Statement (Dkt. 4), Case No. 2:24-mc-00008-RSP, <i>IQE KC, LLC v. Akoustis Technologies, Inc.</i> (E.D. Tex. Feb. 8, 2024) (formerly Case No. 1:24-mc-91053-AK)
2004	Notice of Subpoena and Subpoena to IQE KC, LLC, Case No. 2:23-cv-00180-JRG-RSP, <i>Akoustis Technologies, Inc. et.al. v. Qorvo, Inc.</i> (E.D. Tex. Oct. 17, 2023)
2005	Qorvo’s Invalidity Contentions Cover Pleading, Case No. 2:23-cv-00180-JRG-RSP, <i>Akoustis Technologies, Inc. et.al. v. Qorvo, Inc.</i> (E.D. Tex. Sept. 14, 2023)
2006	Joint Claim Construction and Prehearing Statement (Dkt. 81), Case No. 2:23-cv-00180-JRG-RSP, <i>Akoustis Technologies, Inc. et.al. v. Qorvo, Inc.</i> (E.D. Tex. Apr. 30, 2024)
2007	Petition (Paper 1), IPR2024-00758; <i>Qorvo, Inc. v. Cornell Research Foundation, Inc.</i> (PTAB Apr. 17, 2024)
2008	Akoustis’ Original Complaint (Dkt. 1). Case No. 2:23-cv-00180-JRG-RSP, <i>Akoustis Technologies, Inc. et.al. v. Qorvo, Inc.</i> (E.D. Tex. Apr. 20, 2023)
2009	James Richard Shealy, Cornell Engineering, <i>available at</i> https://www.engineering.cornell.edu/faculty-directory/james-richard-shealy (retrieved on June 13, 2024)
2010	Declaration of Joseph A. Smart, Ph.D., dated June 14, 2024
2011	Smart, Joseph “High Electron Mobility Transistor Structures in the

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2018	Locations, Qorvo, <i>available at</i> https://www.qorvo.com/about-us/locations (retrieved on June 13, 2024)
2019	Akoustis’ Response to IQE’s Motion to Quash (Dkt. 19), Case No. 2:24-mc-00008-RSP, <i>IQE KC, LLC v. Akoustis Technologies, Inc.</i> (E.D. Tex. Feb, 22, 2024) (formerly Case No. 1:24-mc-91053-AK)
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2023	Petitioner’s Contingent Motion for Joinder with IPR2024-00609 (Paper 3), IPR2024-00758; <i>Qorvo, Inc. v. Cornell Research Foundation, Inc.</i> (PTAB Apr. 17, 2024)
2024	UPSTO Memorandum Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (June 21, 2022)
2025	Docket Sheet, Case No. 1:21-cv-1417, <i>Qorvo, Inc. v. Akoustis Technologies, et. al.</i> (D. Del.) (retrieved June 17, 2024)

Patent Owner Cornell Research Foundation Inc. submits this preliminary response in accordance with 35 U.S.C. § 313 and 37 C.F.R. § 42.107, responding to the Petition for *Inter Partes* Review (Petition) of claims 1-24 of U.S. Patent No. 7,250,360 (the '360 Patent) filed by Petitioner IQE PLC.

I. INTRODUCTION

The Board should deny institution on several grounds:

Procedurally, the Board should deny institution on *Fintiv* grounds due to the advanced stage of related litigation set for trial nearly eight months before a Final Written Decision here. Patent Owner's exclusive licensee, Akoustis Technologies, Inc., sued Petitioner's customer, Qorvo, Inc., on April 20, 2023 in the Eastern District of Texas (EDTX) for infringing the '360 Patent (EDTX Litigation). Ex. 2001 (EDTX Litigation Docket Sheet). The same EDTX court is also handling Petitioner's subsidiary's motion to quash an EDTX Litigation subpoena. Ex. 2002 (Misc. Docket Sheet); Ex. 2003 (IQE Corporate Disclosure); Ex. 2004 (Subpoena). The EDTX Litigation, which will almost certainly not be stayed, is at an advanced stage— infringement and invalidity contentions have been exchanged, claim construction has begun, a *Markman* hearing is set for July 2024, and fact discovery closes on September 9, 2024. Ex. 1017. Moreover, the EDTX Litigation trial is set for January 27, 2025 (*id.*)—nearly eight months before a Final Written Decision here. The EDTX Litigation, which Petitioner is now involved in, significantly overlaps with

the Petition (including the same primary references asserted in the EDTX Litigation), and Petitioner fails to explain its extreme delay in filing this Petition—nearly four-and-a-half months after being subpoenaed and five-and-a-half months after its customer served overlapping invalidity contentions in the EDTX Litigation. Ex. 2004 (Subpoena); Ex. 2005 (Invalidity Contention Cover Pleading).

Moreover, any suggestion by Petitioner that it is uninvolved in the EDTX Litigation or distinct from Qorvo is belied by the evidence. Petitioner (through its subsidiary) has been subpoenaed in the EDTX Litigation and is coordinating with Qorvo—its customer, would-be co-Petitioner, and a defendant in the EDTX Litigation. Petitioner and Qorvo have overlapping interests in, and have coordinated efforts to fight, the EDTX Litigation.

Accordingly, institution of this Petition and the Qorvo petition goes against the very principles and premise of the America Invents Act. Instituting these petitions would multiply and complicate the proceedings, which are currently pending in two EDTX actions, rather than simplify matters. The Board should deny institution on *Fintiv* grounds.

Substantively, the Petition fails to establish the obviousness of the '360 Patent's claims. The Petition relies on two sets of obviousness-based Grounds: (a) Grounds 1-4 primarily rely on Urashima (claims 1-4 and 6-14) and add other references like Manabe (claims 18-24) for other challenged claims; (b) Grounds 5-6

primarily rely on Guo (claims 1-4, 6-9, and 11-14) and add Ashby (claims 5, 10, and 17). The Petition's problems are two-fold. First, the Petition fails to show that the Urashima-based Grounds 1-4 render obvious either independent claim (1 and 18). The independent claims include steps related to pretreatment and then the formation of nucleation and buffer layers using flows of group II/III and group V/VI reactants. But the Urashima-based Grounds 1-4 rely on Urashima's inapposite manufacturing techniques that do not perform the claimed pretreatment or form the claimed nucleation/buffer layers—Urashima teaches away from simultaneously flowing certain reactants. Second, the Guo-based Grounds 5-6 fail because: (a) the inventors conceived of and reduced to practice claims 1-4 and 6-14 years before the alleged 35 U.S.C. § 102(a) priority date for Guo; and (b) Petitioner's superficial and unfounded combination of Guo and Ashby fails to render obvious claims 5 and 17.

Patent Owner respectfully requests that the Board deny the Petition.

II. BACKGROUND

A. The '360 Patent claims novel semiconductor manufacturing techniques.

The '360 Patent is entitled "Single step, high temperature nucleation process for a lattice mismatched substrate" and relates to a process for the nucleation and subsequent epitaxial growth on a lattice mismatched substrate. '360 Patent at Title, 1:39-41. According to the '360 Patent, "[h]eteroepitaxial growth of GaN and related

alloys on severely mismatched substrates such as sapphire, SiC and silicon requires thin nucleation layers to provide nucleation sites to initiate crystal growth,” and that “[w]hen optimized, these nucleation layers accommodate the strain between the substrate and epitaxial layers caused by lattice and thermal mismatches, while still maintaining crystallographic registration of the epitaxial films to the substrate lattice structure.” *Id.* at 1:21-28. According to the patent, “[n]umerous applications exist for a lattice mismatched substrate having an epitaxial nitride based material, such as (Al)GaN, in the areas of high power, high frequency electronics, short wavelength optoelectronics, biology, and micromachining technologies.” *Id.* at 3:43-47. But, as the ’360 Patent notes, then-existing solutions had temperature, pressure, and flow issues. *Id.* at 1:29-35, 2:3-9.

The ’360 Patent inventors set out to address these problems, including through the use of a novel pretreatment step. As the patent describes, “[a] single step process for nucleation and subsequent epitaxial growth on a lattice mismatched substrate is achieved by ***pre-treating*** the substrate surface with at least one group III reactant or at least one group II reactant prior to the introduction of a group V reactant or a group VI reactant.” *Id.* at Abstract (emphasis added). Then, “[o]nce the pre-treatment of the surface is complete, a group V reactant or a group VI reactant is introduced to the growth chamber to commence the deposition of a nucleation layer. A buffer layer is then grown on the nucleation layer providing a surface upon which

the epitaxial layer is grown preferably without changing the temperature within the chamber.” *Id.*

The '360 Patent describes in detail a preferred embodiment using Figure 1 as an aid (showing “[a] schematic representation of a single step process for nucleation and subsequent growth of a preferred GaN-based material,” *Id.* at 3:51-53). Specifically, the '360 Patent notes the following steps may be used:

1. The substrates are heated up to 1100° C in hydrogen for 10 minutes to clean the surface of the substrate.
2. After 10 minutes, the temperature is decreased to the growth temperature of 1040° C.
3. After the temperature has stabilized, the aluminum reactant and the gallium reactant [both group III], preferably TEG [triethylgallium] and TMA [trimethylaluminum], are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC [silicon carbide] is fixed at 0.06. The substrates are exposed for 100 seconds.
4. Ammonia [which contains nitrogen (group V element)] is then switched into the growth chamber, forming $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($x=0.06$ for SiC, and $x=0.15$ for sapphire) on the metal rich substrate surface. Around 20 nm of AlGa_xN is grown.
5. The gallium reactant is switched into the growth chamber if not already present (in the case of an AlN [aluminum nitride] nucleation layer).

6. The aluminum reactant is then ramped down to 0.0 in 30 seconds, then switched out of the growth chamber.
7. This results in GaN [gallium nitride] deposition, providing a buffer layer on which other GaN-based epitaxial layers can subsequently be deposited without any change in growth chamber temperature.

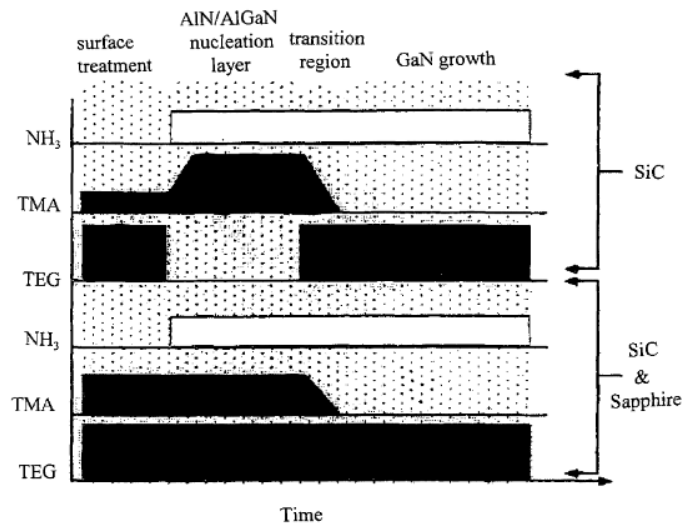


FIG. 1

Id. at 3:61-4:16, Fig. 1 (showing at least one group III material (TMA or TEG) remaining on during the introduction of a group V material (NH₃)).

B. No specific claim constructions are required at this stage.

For the purpose of this Preliminary Response only, Patent Owner agrees that no express claim constructions are required and that all claim terms should be given their plain and ordinary meaning. Patent Owner has applied these plain and ordinary meaning constructions throughout this Preliminary Response, including using the words of all claims to understand what the claims mean.

Notably, Petitioner and its customer and aspiring co-Petitioner (Qorvo) take contrary claim construction positions here and in the EDTX Litigation. Petitioner tries reserving the right to raise indefiniteness in the district court. Pet. 9 n.3. In the district court, Qorvo argues that “elevated growth temperature” is indefinite. Ex. 2006 (Joint CC Statement). Yet both Petitioner and Qorvo are somehow able to understand the plain and ordinary meaning of the “elevated growth temperature” term in this proceeding Pet. 9; Ex. 2007 (Qorvo Petition) at 8-9.

C. The parties disagree about the skill level of a person of skill in the art, but the difference does not matter at this stage.

A person of ordinary skill in the art (POSITA) would have a bachelor’s degree in electrical engineering, materials science, chemical engineering, or an equivalent field, and such a person would have at least 3 years of academic or industry experience in nucleation and epitaxial growth processes, or other comparable industry experience. This level of skill is approximate and more experience would compensate for less formal education, and vice versa. Petitioner alleges that a POSITA “would have a bachelor’s degree in electrical engineering, computer engineering, chemical engineering, or an equivalent field, or an advanced degree in those fields, as well as least 3-5 years of academic or industry experience in nucleation and epitaxial growth processes, or comparable industry experience.” Pet.

9. For the purpose of this Preliminary Response only, the result here does not depend on which of the two articulations that the Board chooses.

D. Petitioner asserts six alleged prior art references, but only four need to be considered at this stage.

The Petition relies on six alleged prior art references:

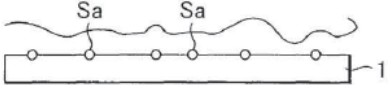
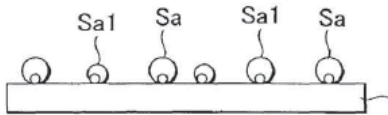
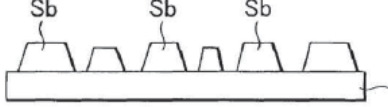
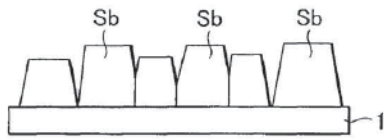
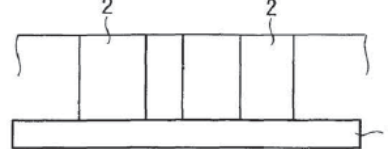
- (1) U.S. Patent Application Pub. No. 2002/0155712 (Urashima, Ex. 1004);
- (2) JP Patent No. JPH0563305 (Nagata, Ex. 1005);
- (3) *Metal organic vapour-phase epitaxy (MOVPE) growth of InP and InGaAs using tertiarybutylarsine (TBA) and tertiarybutylphosphine (TBP) in N₂ ambient*, Keiper et al. (Journal of Crystal Growth 1999) (Keiper, Ex. 1006);
- (4) U.S. Patent No. 5,122,845 (Manabe, Ex. 1007);
- (5) U.S. Patent Application Pub. No. 2004/0119063 (Guo, Ex. 1008); and
- (6) U.S. Patent Application Pub. No. 2002/0090816 (Ashby, Ex. 1009).

For the purposes of this Preliminary Response, Patent Owner focuses on Urashima, Manabe, Guo, and Ashby.

- 1. Urashima (Ex. 1004) relates to fabricating specific types of group-III nitride semiconductors where group-V materials such as nitrogen are not flowed simultaneously with metals such as those from group III.**

Urashima is a patent application entitled “Method of fabricating group-III nitride semiconductor crystal, method of fabricating gallium nitride-based

compound semiconductor, gallium nitride-based compound semiconductor, gallium nitride-based compound semiconductor light-emitting device, and light source using the semiconductor light-emitting device.” Ex. 1004 at 1 (Title). Urashima uses a specific process, including as depicted in Figures 1(a) – 1(e) below and described in paragraphs [0107] and [0108] of Urashima.

Figure	Urashima Description
FIG.1(a) 	“As shown in FIG 1(a), in step A (the first step), a metal element, preferably metal nuclei (droplets) Sa of a group III metal element are adhered to a substrate 1.” Ex. 1004 at [0107].
FIG.1(b) 	“Next, in step B (the second step), the metal nuclei Sa are annealed (FIG. 1(b)). Even if, in the first step, the particles were not in the required state of complete isolation, they are after the annealing.” <i>Id.</i> at [0107].
FIG.1(c) 	“Next, in step C (the third step), the annealed metal nuclei Sa1 are nitrided to form growth nuclei Sb (FIG. 1(c)).” <i>Id.</i> at [0107].
FIG.1(d) 	“In step D (the fourth step), a gallium nitride-based compound semiconductor layer is grown on the substrate 1 having the growth nuclei Sb (FIG. 1(d))” <i>Id.</i> at [0108].
FIG.1(e) 	“The growth proceeds horizontally, mostly accompanying the dislocation, ensuring an adequate layer depth (for example 2 μm), thereby providing a flat,

	horizontal layer of gallium nitride-based compound semiconductor 2 (FIG. 1(e)).” <i>Id.</i> at [0108].
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Unlike the '360 Patent, Urashima is clear that its group-V nitrogen *should not* be introduced along with any metals (such as group-III gallium):

If the step of nitriding the metal nuclei takes place in an atmosphere containing metal material, the crystallinity of the gallium nitride-based compound semiconductor grown in the following step will be degraded. Therefore, the nitriding step should be performed in an atmosphere that does not contain metal material.

Id. at [0123].

2. Manabe (Ex. 1007) relates to specific ways of manufacturing gallium nitride on sapphire substrates for LEDs.

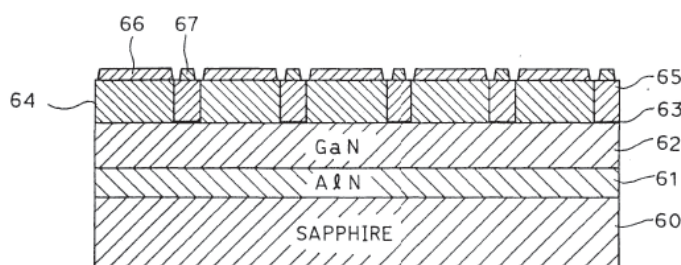
Manabe is a patent entitled “Substrate for growing gallium nitride compound-semiconductor device and light emitting diode.” Ex. 1007 at 1 (Title). According to Manabe, its “invention relates to a substrate for producing a gallium nitride compound-semiconductor device and the structure of a light emitting diode.” *Id.* at 1:8-10. Manabe focuses on problems related to growing gallium nitride on sapphire substrates and describes two goals:

The first object of the present invention is to grow a high-quality single crystalline gallium nitride compound-semiconductor having fewer lattice defects on a sapphire substrate.

The second object of the present invention is to provide a light emitting diode in which blue light is a high-efficiency emitting light, by growing a high-quality single crystalline gallium nitride compound-semiconductor on the sapphire substrate.

Id. at 1:39-47. Figure 16 of Manabe shows “a cross-sectional view demonstrating the structure of a wafer on w[h]ich light emitting diodes are constructed.” *Id.* at 2:66-68.

FIG. 16

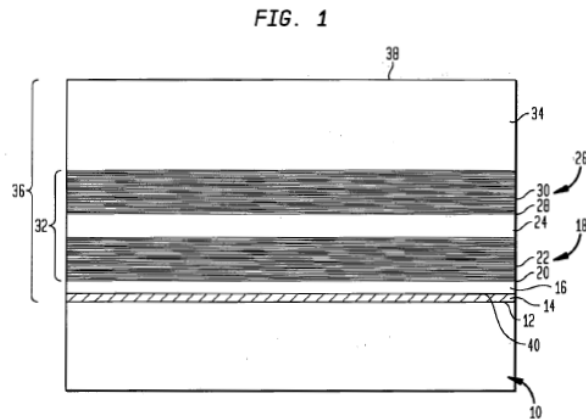


Id. at Fig. 16.

3. Guo (Ex. 1008) relates to specific ways of manufacturing gallium nitride on silicon substrates.

Guo is a patent application entitled “Gallium nitride-based devices and manufacturing process.” Ex. 1008 at 1 (Title). According to Guo, “it has been difficult to grow high-quality gallium nitride-based semiconductors on silicon substrates,” and devices “have suffered from performance problems caused by the silicon substrate itself.” *Id.* at [0010]. Thus, Guo says that it “provides a method of making a semiconductor structure including the steps of depositing a small amount

of aluminum directly on a silicon substrate to provide an aluminum protected substrate, and then depositing a nucleation layer of a nitride semiconductor on the aluminum protected substrate.” *Id.* at [0011]. Moreover, “the method according to this aspect of the invention preferably further includes the step of epitaxially growing a buffer structure including one or more superlattices of nitride semiconductor on the nucleation layer, and then epitaxially growing an operative structure including one or more gallium nitride-based semiconductors on the buffer structure.” *Id.* Below is Figure 1 from Guo, which is “a fragmentary, diagrammatic sectional view on an enlarged scale of a semiconductor structure according to one embodiment of the present invention.” *Id.* at [0023].



Id. at Fig. 1.

4. Ashby (Ex. 1009) relates to a cantilever epitaxy process that uses specially-patterned substrates to reduce dislocation densities.

Ashby is a patent application entitled “Cantilever epitaxial process.” Ex. 1009 at 1 (Title). Ashby’s “invention relates to a process for growth of materials on a substrate, and more particularly, to a process for epitaxial growth where the lateral and vertical growth rates of the material is controlled by processing conditions.” *Id.* at [0002]. Specifically, “[t]he process of [Ashby’s] present invention, referred hereafter as cantilever epitaxy (CE), is a single-growth process that uses specially patterned substrates to capitalize on the dependence of dislocation density on the lateral dimension of the growth surface to produce dislocation densities that are as low or lower than those produced by ELO or PE over the entire patterned region of the substrate.” *Id.* at [0014].

III. HISTORY OF THE ’360 PATENT AND THE EDTX LITIGATION

A. The inventors conceived of the invention and reduced it to practice while working at Cornell in the late 1990s.

The ’360 Patent inventors began working together at Cornell in the 1990s. James Shealy earned his PhD in Electrical and Computer Engineering from Cornell in 1987 and joined the Cornell faculty that year. Ex. 2009 (Shealy Engineering). Joseph Smart, who received his bachelor’s degree in Electrical Engineering in 1987 and spent several years in the semiconductor industry, enrolled at Cornell in fall 1995 to earn advanced degrees. Ex. 2011 (Smart Thesis) at iii. Dr. Shealy served as

Dr. Smart's thesis advisor. *Id.* at vi. Dr. Smart presented his thesis in 2006 (Ex. 2011), which has been available since 2006, and received his PhD from Cornell (Ex. 2010 ¶2). *See* Ex. 2014 (<https://catalog.hathitrust.org/Record/009236785>); Ex. 2015 (<https://catalog.library.cornell.edu/catalog/6035819>).

While at Cornell, Drs. Shealy and Smart worked on issues, *inter alia*, techniques for growing gallium nitride (GaN) and other materials on lattice mismatched substrates such as silicon carbide (SiC), sapphire, and silicon (Si). Ex. 2011 (Smart Thesis) at 2, 103, 114. One already-accepted technique for such growth was a “[t]wo [t]emperature [n]ucleation” or “two-step” process: “a thin low temperature GaN [3] or AlN [3,4] nucleation layer followed by a thick high-temperature GaN buffer.” *Id.* at 103, 115. But there were issues with that approach, including “structural and native defects” that formed. *Id.* at 103.

Recognizing these issues with the prior approach, the inventors developed “[a] single, high temperature process” “using $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films as nucleation layers on both sapphire and SiC which results in highly resistive GaN buffer layers.” *Id.* at 104. “This process simplifies the growth by eliminating large temperature ramps, while producing device-quality GaN-based films with low background carrier concentrations.” *Id.* This novel process was “achieved by introduction of the group III reactants [such as trimethyl aluminum (TMA) and triethyl gallium (TEG)] only (*OM-Preflow*) into the growth chamber at growth temperature of 1040° C” before

introducing group V reactants (such as a nitrogen [N] source like ammonia [NH₃]).
Id. at 119, 121 (emphasis added).

Appendix B of Dr. Smart’s thesis details “[o]ver 300 epitaxial runs” done leading up to and following the first successful “OM preflow” (or pretreatment)—between June 19, 1997 and May 10, 2000. *Id.* at 105, Appendix B. The entry for December 31, 1997—Run III304—shows the inventors achieved their “FIRST SUCCESSFUL NUCLEATION LAYER” using a “4 minute OM preflow prior to growth,” as Dr. Smart described earlier in this thesis. *Id.* at 223 (Appendix B).

RUN #	Date	Description	Results
III297	12/9/97	Two Temperature Nucleation	Changed ammonia MFC from 5K to 15 K to increase V/III ratios
III298	12/10/97	Two Temperature Nucleation	Parked susceptor, no rotation, increase growth times by 3X
III299	12/13/97	Two Temperature Nucleation	Parked susceptor, no rotation, increase growth times by 3X
III300	12/16/97	Two Temperature Nucleation	Parked susceptor, no rotation, increase HT GaN growth time
III301	12/18/97	Two Temperature Nucleation	Low temperature nitridation, new TEG, new ammonia tanks
III302	12/25/97	Two Temperature Nucleation	Repeat of III258, changed filters in lower end cap
III303	12/29/97	Two Temperature Nucleation	Increased nucleation time from 10 to 20 minutes
III304	12/31/97	High Temperature Nucleation on SiC	4 minute OM preflow prior to growth
FIRST SUCCESSFUL NUCLEATION LAYER			
III305	1/4/98	AlGaIn Calibration, New Nucleation	HT nucleation scheme, 4 minute TMA & TEG preflow
III306	1/6/98	AlGaIn Calibration, no OM preflow	NO preflow, to see if nucleation works without it
III307	1/6/98	Ammonia Preflow Experiment	Ammonia into cell 2 seconds before OM's

Id. (highlighting added).

Dr. Smart’s thesis’ description of the invention and its conception and reduction to practice on New Year’s Eve 1997 is corroborated by other evidence. For instance, Drs. Shealy and Smart’s invention disclosure is marked as being received by Cornell on September 18, 2000—just after the last entry in Dr. Smart’s thesis’ Appendix B (May 10, 2000). Ex. 2012 (IDS) at 1. The invention disclosure

states that the invention related to a “[s]ingle step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates” and that the invention was achieved by “a surface treatment prior to epitaxial growth” that “eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” *Id.* at 1. Additional information is found on the invention disclosure, including that the form: (a) is labeled “Docket No. 2759”; (b) notes that conception and reduction to practice date was December 31, 1997; and (d) notes that conception and reduction to practice is reflected in “system III run logs”—runs/experiments noted in Appendix B of Dr. Smart’s thesis. *Id.*

Cornell University Invention Disclosure		
Submit Completed Form To:	SEP 18 2000 CORNELL RESEARCH FOUNDATION, INC. 20 Thornwood Drive, Suite 105 Ithaca, New York 14850 (or campus mail) 607-257-1081 FAX 607-257-1015 www.research.cornell.edu/crf	CRF ONLY: Docket No. 2759 Technology No. 1417-17 Classification Code: Date Received:
Title of Invention Single step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates		
Brief Description of Invention A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.		
PLEASE INCLUDE COPIES OF RELEVANT REFERENCES WITH THIS INVENTION DISCLOSURE		
Sponsorship US Government ☒ Commercial/Private _____ Cornell Univ. _____ Personal _____ Biotech _____ Other _____ Name of Sponsor _____ Sponsor's Contract No. _____ Cornell Univ. Account No. _____ Office of Naval Research _____ John Zolper _____ N00014-96-1-1223 DARPA _____ BOB LEHENEY _____ DARPA 63-055-0121		
Q: Was this invention developed using resources in the Theory Center or the Biotech Building? _____ (Y/N)		
Collaborating Institution / Company/Organization Organization _____ Principal Investigator Name _____ Address _____		
Record of Invention Date of Conception 12/31/97 Documented: Yes ☒ No ☐ Form system III run logs Location 20 Thornwood Drive, Ithaca Invention Reduced to Practice: Yes ☒ No ☐ Date of First Reduction to Practice 12/31/97 Prototype Available: Yes ☐ No ☐		
Publication(s) Submittal: Date _____ Journal _____ Publication Date _____ [] Estimated [] Actual Oral Disclosure: Date _____ Occasion _____ Handouts: [] Yes [] No Poster presentation: Date made _____ Published abstract: [] Yes [] No Citation _____		

Id. at 1 (highlighting added). The form also includes an assignment of rights from the inventors to Cornell, both dated October 2000. *Id.* at 2; Ex. 2010 (Smart Decl.) ¶ 9 (confirming signature and date on IDS).

Additional corroboration of Dr. Smart’s thesis is found in a binder containing several “system III run logs” referenced in the thesis—plus images generated from materials made by the corresponding “runs.” Ex. 2013 (Run Log Binder); Ex. 2010 (Smart Decl.) ¶¶ 4-8 (explaining that Dr. Smart prepared the binder using original run log pages and scans). One of the entries in the binder includes a “2/24/98” “Run #iii333” log with “JAS” as “operator”—Joseph A. Smart—which corresponds with the “2/24/98” “RUN # III333” entry in Dr. Smart’s thesis’ Appendix B:

Run Log Entries (Ex. 2013 at 19-20)

OMVPE III Run # 1133 date: 2/24/98 operator: JPS

description: PATTERNED SUBSTRATES ELO Project.

Problems with N₂H₄ line between ALGaN buffer
and GaN layer.

program used for this run: -MANUAL-

V/III ratio	growth segment	time	actual susceptor temp	TC temp	RF amps
= 900 ~ 3000 x 1800	H ₂ bake	10 min			43.4
	GaN Preflow	4 min			4.4
	ALGaN Buffer (~6-7% Al)	30 min			4.4
	GaN Layer	420 min			4.3
	ALGaN cap layer (200-250 Å)	2 min			4.3

rotation speed: -0.1 cell press: .75 vent press: ± .1

zone I manifold temp: 52.5 OM3 heat tape: 59.0

NH₃ cylinder: (left/right) start weight/press: 339.6 / 95 psi heat tape voltage: 60 V

finish weight/press: 163

	OM1	OM2	OM3	OM4	OM5	OM6
temp			30.1		16.4	
grams used			✓			
mfc offset			0.0		0.8	
Pres. closed			163		159	

wafers:

wt pinn sic wt patterned w_s pinn sic/wt C

Samples RCA → RCA →

"2" pocket Bare wafer Si: P MPF (111)

Si-solvents + HF dip (1 min.)

Solvents Solvents

2" pocket W.B. Patterned Si - with C Solvents + HF dip (1 min.)

Wt Si: pinn sic w_s patterned sapphire w_s pinn sic w_s patterned sapphire

	Temp	RF	Comments	TMAF	TEG (M3)	NH3 zone1	NH3 block	Cell Throttle	BE lead Can (TC)
			RF on					4.9	12.9 3.3
		30A	Balance on 20A					5.3	19.4 26
	100	45A	changed NAs line.					5.3	20.8 36
12:28	402 920	45A	with vent gasoline in						
12:30	431 1038	45A	Start back down			2.9		4.8	52.1 28
12:32	755 1055	43A				3.1		4.8	55.1 15
12:33	757 1019	43A	Change out pressure	15.3 15.7	200				
12:35	715 1023	45A	TEG ON	15.4 15.7		15.0	-	4.8	56.7 29
12:40	735 1021	44A	can't breathe Hemol	15.1 15.2		15.3	-	4.3	59.2 30
12:45	776 1030	44A		25.3 25.4	80.4	15.3	-	5.4	59.4 30
12:50	800 1037	44A	NHA at 100 NHA at 100	25.0 25.1	80.4	15.4	0.0	5.5	60.7 30
12:52	801 1036	44A		25.2 25.3	80.4	15.2	0.6	5.6	60.9 30
13:00	800 1036	44A		25.1 25.1	80.4	15.2	5.7	5.7	60.1 30
13:20	800 1037	44A	Ramp out all lines at 370 then throttle W/ 1000	27.1 27.2	80.4	15.1	0.6	5.9	60.3 30
13:33	798 1036	44A	Throttle down	27.1 27.1	80.4	30.0	17.0	6.3	60.5 31
			HAD BIG Problem with NHA!!!						
			Got flow up to 60% in ZONE I						
			105 T DR ACROSS GETTING MEET						
			They dropped to 50%!! sent						
			the machine into oscillations!!!						
			could have lost all flow in the block!						
13:17	805 1041	44		11.6 11.6	300	17.0	6.4	6.1	61.1 31
13:37	802 1043	44		X 11.2	300	17.0	6.4	6.1	60.9 31
13:41	803 1042	44		X 11.2	300	17.0	6.4	6.1	60.9 31
13:50	803 1041	43A		11.6 11.6	300	17.0	6.4	6.1	61.1 31

Thesis Appendix B (Ex. 2011 at 225)

RUN #	Date	Description	Results
III320	2/3/98	AlGa _N on Patterned Si Substrates	All at High Temperature
III326	2/10/98	AlGa _N Calibration on SiC and Sapphire	30 minutes AlGa _N at 1040 C
III327	2/11/99	AlGa _N Calibration on Sapphire	Trying to get HT nucleation to work on sapphire
III328	2/13/98	AlGa _N Calibration on SiC	30 % AlGa _N
III329	2/14/98	HEMT Structure	AlGa _N nuke/GaN buffer/ AlGa _N Barrier
III330	2/19/98	HEMT Structure	AlGa _N nuke/GaN buffer/ AlGa _N Barrier – filter change
III331	2/21/98	HEMT Structure	AlGa _N nuke/GaN buffer/ AlGa _N Barrier – thicker barrier
III332	2/23/98	HEMT Structure	AlGa _N nuke/GaN buffer/ AlGa _N Barrier SiC substrates
III333	2/24/98	FIRST ELO RUN, Patterned Substrates	420 minute GaN buffer, full HEMT structure
III334	3/1/98	ELO on Patterned Substrates	Whiskers growing up from surface
III335	3/5/98	AlGa _N Calibration	15 % AlGa _N , rebuilt ammonia gettering melt
III336	3/6/98	HEMT Structure on Sapphire	17.5 % AlGa _N nuke/GaN buffer/ AlGa _N Barrier

B. Cornell filed a patent application that the USPTO granted on July 31, 2007 as the '360 Patent.

On March 2, 2005, Cornell filed U.S. Patent Application No. 11/069,040 for an invention labeled “Attorney Docket No. CRF D-2759”—the same number as in the invention disclosure. Ex. 1002 at 1; *see also* Ex. 1001, Ex. 2012 (IDS) at 1.

The examiner allowed the application’s claims without amendment after a single office action. In that office action, the examiner rejected some claims as being anticipated based on U.S. Patent No. 6,218,280 (claims 1-9 and 13-16), but allowed others if written in independent form (claims 10-12 and 17) and others altogether (claims 18-24). Ex. 1002 at 37-40. Applicant responded to the office action on December 8, 2006, pointing out that claim 1’s “pre-treating step includes subjecting the surface of the substrate to at least one group III reactant or at least one group II

reactant prior to introducing a group V reactant or a group VI reactant. Therefore, the group III reactant and the group II reactant do not include a group V reactant or a Group VI reactant.” *Id.* at 47 (emphasis original). Applicant further pointed out that “the present invention is directed to growing the epitaxial layer on a silicon, sapphire or SiC substrate (see claim 2).” *Id.* On the other hand, according to applicant, U.S. Patent No. 6,218,280 “specifically teaches simultaneously subjecting the substrate to a group III reactant (TMG reacted with HCl) and a group V reactant (NH₃)” and “does not disclose the preferred substrates (silicon, sapphire and SiC) that are listed in claim 2.” *Id.* (emphasis original). The examiner thereafter allowed the claims on March 5, 2007, and the ’360 Patent issued on July 31, 2007. *Id.* at 60-62, 71.

C. Petitioner’s subsidiary acquired a wafer fabrication facility from Qorvo’s predecessor and is now a party to an EDTX action co-pending with the EDTX Litigation after Petitioner’s subsidiary moved to quash an EDTX Litigation subpoena.

Petitioner is no stranger to Qorvo or Akoustis—the EDTX Litigation parties. Petitioner’s relationship with Qorvo dates back to at least 2012. On June 5, 2012, that Petitioner acquired a “molecular beam epitaxy (MBE) wafer growth facility” from RF Micro Devices, Inc. (RFMD). Ex. 2016 (2012 Press Release). RFMD became Qorvo after a 2015 merger with TriQuint Semiconductor, Inc. Ex. 2017

(2015 Press Release). The relationship between Petitioner and Qorvo continues to this day—inside and outside the courtroom.

In April 2023, Akoustis brought suit against Qorvo in EDTX, where Qorvo has a GaN manufacturing facility, for infringing the '360 Patent. Ex. 2008 (Complaint); Ex. 2018 (Qorvo Locations). After EDTX Litigation discovery opened, Akoustis sought discovery on the manufacture of the epitaxial wafers used in Qorvo's products. Ex. 2021 (Motion to Quash Opp.) at 3. In response, Qorvo informed Akoustis that Qorvo does not make the epitaxial wafers used in many of its products (despite Qorvo's website representing otherwise) and instead pointed Akoustis to third parties that Qorvo buys wafers from as possessing relevant information. *Id.* Akoustis subpoenaed Petitioner's subsidiary. *Id.*; Ex. 2004 (IQE Subpoena). After Petitioner's subsidiary moved to quash Akoustis' subpoena, the motion to quash action was transferred to the EDTX where it remains pending in front of Magistrate Judge Payne who also is presiding over the EDTX Litigation. Ex. 2022 (MTQ Order); Ex. 2002 (Misc. Docket Sheet).

Patent Owner, too, is involved in the EDTX Litigation. Since the summer of 2023, Qorvo has challenged Akoustis' standing to bring suit for infringement of the '360 Patent. Ex. 2020 (MTD). As part of its challenge, Qorvo sought Patent Owner's addition to the EDTX Litigation. *Id.* at 12. Thus, in March 2024, Patent Owner

agreed to join the EDTX Litigation as co-plaintiff, though Qorvo now opposes Patent Owner's joinder. Ex. 2021 (MFL). The motion to join remains pending.

IV. ARGUMENT

- A. The Petition should be denied under *Fintiv* as the issues presented by the Petition and Qorvo's (Petitioner's customer and would-be co-Petitioner) petition will be resolved in the underlying EDTX Litigation months before any Final Written Decision.**

Petitioner seeks *inter partes* review of the '360 Patent despite the existence of a co-pending, highly-overlapping, and procedurally-advanced EDTX Litigation. The EDTX Litigation was on file nearly a year before Petitioner filed its Petition, and trial in the EDTX Litigation is set for nearly eight months before a Final Written Decision would be due here. The EDTX Litigation involves all of Petitioner's prior art for the claims asserted in the EDTX (Urashima, Guo, and Ashby)—prior art that Qorvo (Petitioner's customer and would-be co-Petitioner) asserted nearly five-and-a-half months before Petitioner filed its Petition.

Nor can Petitioner distance itself from the EDTX Litigation. Qorvo alleges that Petitioner supplies Qorvo with accused instrumentalities. Akoustis subpoenaed Petitioner in the EDTX Litigation more than four months before Petitioner filed its Petition. And Petitioner seeks to quash that subpoena in a motion pending in front of the same court as the EDTX Litigation.

As Director Vidal has said, “Congress designed the America Invents Act (AIA) post-grant proceedings ‘to establish a more efficient and streamlined patent system that will improve patent quality and limit unnecessary and counterproductive litigation costs.’” Ex. 2024 (Interim Procedure) at 1 (citing H.R. Rep. No. 112- 98, pt. 1, at 40 (2011), 2011 U.S.C.C.A.N. 67, 69; *see* S. Rep. No. 110- 259, at 20 (2008)). Instituting here is contrary to this goal because “[p]arallel district court and AIA proceedings involving the same parties and invalidity challenges ***can increase, rather than limit***, litigation costs.” *Id.* at 1 (emphasis added).

Here, instituting the Petition (and Petitioner’s customer’s co-pending petition (Ex. 2007)) will have the same outcome as the ***single*** EDTX Litigation (upholding the validity of or invalidating the patents), but will dramatically increase the litigation costs of the parties. The EDTX Litigation is considering the same references for the claims asserted there and will also consider more invalidity grounds—and will do so many months ahead of this proceeding. It is a fallacy to consider Petitioner’s and its customer’s petitions as streamlining the dispute between the parties. The Board should use its discretion to deny institution.

Under 35 U.S.C § 314(a), the Board has discretion to deny a petition based on the status of a related litigation. The Board considers six factors to determine whether efficiency, fairness, and the merits support denial:

Factor 1: whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;

Factor 2: proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;

Factor 3: investment in the parallel proceeding by the court and the parties;

Factor 4: overlap between issues raised in the petition and the parallel proceeding;

Factor 5: whether the petitioner and the defendant in the parallel proceeding are the same parties;

Factor 6: other circumstances that impact the Board's exercise of discretion, including the merits.

Apple v. Fintiv, IPR2020-00019, Paper 11 at 5-6 (PTAB March 20, 2020) (precedential).

As discussed below, each of the *Fintiv* factors supports denying institution. The current advanced state of the EDTX Litigation, as well as the lack of a granted stay, favors denial of the Petition. By the time the Board would issue an institution decision (expected September 2024), infringement and invalidity contentions will have been exchanged, claim construction briefing will be complete, a *Markman* hearing will have been held (July 24, 2024), and fact discovery will be closed (September 9, 2024). Ex. 1017. The district court trial is scheduled for January 2025, nearly eight months *before* the Final Written Decision would be due. *Id.*

Petitioner's proposed stipulation does not meaningfully streamline the issues. Petitioner merely offers to not assert only those grounds that are instituted by the

Board. This would mean that Petitioner and its customer could still assert invalidity grounds based on §§ 102 and 103 in district court that would not and could not be addressed by the Board. And those invalidity grounds in district court would be tried before a jury many months before any Final Written Decision would issue. Institution would merely increase the likelihood of inconsistent results across proceedings. There is no argument that can be offered that supports instituting these Petitions—that would issue narrow invalidity rulings under 35 U.S.C. § 103 months after EDTX Litigation trial—rather than letting the parties resolve all these issues in a single, quicker district court case that is already scheduled to be complete in less than a year. Accordingly, the Board should deny institution to maintain the goals of efficiency and efficacy. *See General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 at 16-17 (PTAB Sept. 6, 2017).

Factor 1: the EDTX Litigation has not been stayed nor is it likely to be stayed. Petitioner states that this factor is neutral or favors institution. However, Petitioner has failed to consider the totality of the evidence. This Board has previously held that “[i]n the absence of specific evidence, we will not attempt to predict how the district court in the related district court litigation will proceed because the court may determine whether or not to stay any individual case.” *Sand Revolution II, LLC v. Continental Intermodal Group – Trucking LLC*, IPR2019-01393, Paper 24 at 7 (PTAB June 16, 2020) (informative).

Here, all evidence points to a stay not being entered in the EDTX Litigation pre- or post-institution. Indeed, Petitioner’s customer—despite filing a petition that is nearly identical to Petitioner’s and seeking to join Petitioner (*compare* Petition with Ex. 2007 (Qorvo Petition))—has not raised the issue of a stay.

Moreover, even if instituted, the timing and advanced stage of litigation indicates that Judge Gilstrap, who along with Magistrate Judge Payne is presiding over the EDTX Litigation, is highly likely to deny a motion to stay. *See, e.g., MyPort, Inc. v. Samsung Elecs. Co., Ltd.*, Case No. 2:22-CV-00114-JRG, Dkt. 73 at 4-5 (E.D. Tex. June 13, 2023) (denying a motion to stay when trial was scheduled and “the PTAB [final written] decision is not due until over two months after jury trial is set to begin.”); *Solas OLED Ltd. v. Samsung Display Co., Ltd.*, Case No. 2:19-CV-00152-JRG, Dkt. 133 at 3-4 (E.D. Tex. July 17, 2020) (denying a motion to stay despite the Board’s institution on the patents-in-suit largely because “discovery is complete[] and trial is only a few months away” when PTAB final written decisions would have been issued months after the scheduled trial); *Oyster Optics, LLC, v. Infierna Corp.*, Case No. 2:19-CV-00257-JRG, Dkt. 87 at 4-5 (E.D. Tex. July 17, 2020) (denying a motion to stay although the asserted claims were instituted because claim construction briefing was finished and “[f]act discovery is closing in about a month and trial is only six months away.”). By the time the Board would issue an institution decision (expected September 2024), infringement and invalidity

contentions will have been exchanged, claim construction briefing will be complete, a *Markman* hearing will have been held (July 2024), and fact discovery will be closed (September 9, 2024). Ex. 1017. The EDTX Litigation trial is scheduled for January 2025, nearly eight months *before* the Final Written Decision would be due. *Id.* This timing demonstrates that Judge Gilstrap is highly likely to deny a motion to stay.

Thus, this factor supports denial of institution.

Factor 2: the EDTX Litigation is set for trial nearly eight months before a Final Written Decision is expected here. The Board holds that this factor supports denial of institution when the trial date is months before the projected statutory deadline of the Final Written Decision. *Fintiv*, IPR2020-00019, Paper 11 at 9 (“If the court’s trial date is earlier than the projected statutory deadline, the Board generally has weighed this fact in favor of exercising authority to deny institution.”). The Board regularly finds a period of time less than eight months between the expected date of the Final Written Decision and trial supports denial. *See, e.g., id.* (five to six months based on the time-to-trial evidence); *Satco Products, Inc. v. The Regents of the University of California*, IPR2021-00794, Paper 14 at 19 (PTAB Nov. 10, 2021) (five months); *Maxlite, Inc. v. Jiaxing Super Lighting Electric Appliance Co., Ltd.*, IPR2020-00208, Paper 32 at 5 (PTAB Oct. 12, 2021) (four months); *Stanley Black & Decker, Inc., et al. v. Zircon Corp.*, IPR2020-01572, Paper 10 at 12 (PTAB April 19, 2021) (three months); *Next Caller, Inc. v. TrustID, Inc.*, IPR2019-

00961, Paper 10 at 14-15 (PTAB Oct. 16, 2019) (three months); *E-One, Inc. v. Oshkosh Corp.*, IPR2019-00161, Paper 16 at 6 (PTAB May 15, 2019) (one month). Here, trial is set for January 2025—nearly eight months before a Final Written Decision would be due (September 2025). Ex. 1017 at 1.

Thus, despite Petitioner baselessly suggesting that the EDTX Litigation “is in its early stages” (Pet. 73), this factor strongly supports denial of institution. *See Duplo U.S.A. Corp. v. MGI Digital Tech. S.A.*, IPR2023-00936, Paper 8 at 17 (PTAB Dec. 5, 2023) (“Because the district court would address issues relating to the validity of the ’806 patent well before we would issue a final written decision, we find that the second *Fintiv* factor weighs heavily in favor of discretionary denial of institution.”).

Factor 3: there has been and continues to be significant investment by the parties in the EDTX Litigation and Petitioner’s related motion to quash proceeding pending in EDTX. The Board has used its discretion to deny institution when, as here, there is significant investment in the parallel district court proceeding. The parties in the EDTX Litigation have:

1. exchanged infringement and invalidity contentions;
2. exchanged initial disclosures;
3. served subpoenas;
4. produced tens of thousands of pages of documents; and

5. begun the claim construction process.

Ex. 1017. And by the time of an institution decision here, even more will be complete in the EDTX Litigation: a *Markman* hearing is set for July 2024 and fact discovery closes on September 9, 2024. Ex. 1017.

Additionally, Petitioner did not expeditiously file its Petition. Petitioner waited ten months after the district court complaint was filed, more than five months after Petitioner's customer and would-be co-Petitioner served invalidity contentions, and more than four months after Petitioner was served with an EDTX Litigation subpoena before filing its Petition. *Id.*; Ex. 2004 (Subpoena); Ex. 2001 (EDTX Litigation Docket Sheet). Petitioner waited to file its Petition until just after briefing on its motion to quash was completed. Ex. 2002 (Misc. Docket Sheet). Petitioner fails to explain its delay.

Accordingly, the parties have expended a significant amount of time and resources related to the EDTX Litigation and Petitioner's motion to quash that is pending in EDTX, and this factor strongly supports denial of institution. *See Duplo U.S.A.* IPR2023-00936, Paper 8 at 18 (holding "that the third *Fintiv* factor weighs heavily in favor of discretionary denial" where "there has been substantial investment by the parties and the district court in the parallel proceeding, including the completion of preliminary disclosures and claim construction, and the near-completion of discovery").

Factor 4: there is significant overlap between issues raised in the Petition and in the EDTX Litigation. The overlap between this Petition and the co-pending EDTX Litigation supports denial of institution. “[I]f the petition includes the same or substantially the same claims, grounds, arguments, and evidence as presented in the parallel proceeding, th[at] fact has favored denial.” *Fintiv*, IPR2020-00019, Paper 11 at 12. As to the EDTX Litigation asserted claims (1-4, 6-7, 9-14), Petitioner asserts just a subset of the prior art that its customer asserted in invalidity contentions five and a half months before this Petition. *Compare* Pet. 5 (listing Grounds, including assertion of only Urashima, Ashby, and Guo against claims 1-4, 6-7, 9-14) *with* Ex. 2005 (September 14, 2023 Invalidity Contentions) at 19-20 (listing Urashima and Guo as charted references among many other charts), 9 (listing Ashby as prior art among many other references). In fact, Petitioner relies on the same primary references (Urashima and Guo) that its customer asserted in EDTX Litigation September 14, 2023 invalidity contentions (Ex. 2005)—five and a half months before Petitioner filed the present Petition (February 28, 2024). This overlap undermines Petitioner’s suggesting that it selected a “small subset” of a vast trove of prior art (Petitioner at 2)—if that were true, Petitioner would be asserting non-overlapping primary references. Thus, the Petition includes substantial overlap with the claims and evidence asserted in the parallel EDTX Litigation, and this factor strongly supports denial of institution.

Moreover, Petitioner and its customer—who seeks to join Petitioner here—take contrary claim construction positions as to the “elevated growth temperature” term. *See* Section II.B, *supra*. This have-their-cake-and-eat-it-too approach, despite the significant overlap between the Petition and the EDTX Litigation, creates the possibility of conflicting results.

In addition, Petitioner’s narrow stipulation will not mitigate the overlap between the EDTX Litigation (or any other district court litigation) and the Petition. Petitioner could have included a broader stipulation that might better address the duplicative efforts, and adhere to the purpose of *inter partes* review as an alternative to district court litigation. *Compare Sand Revolution II*, Paper 24 at 12 n.5 (“Petitioner stipulates only that it will not pursue, in district court, the ‘same grounds’ presented in the Petition . . . Petitioner could have stipulated that it would not pursue any ground raised or that *could have been reasonably raised in an IPR*.”) (emphasis added) *with Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 19 (PTAB Dec. 1, 2020) (precedential) (“Importantly, Petitioner broadly stipulates to not pursue ‘any ground raised or that could have been reasonably raised.’”). Here, Petitioner’s stipulation “that, if the Board Institutes this Petition, Petitioner will not raise at trial ... any invalidity challenges based on the prior art asserted here” (Pet. 74) falls short of a *Sotera* stipulation. In fact, Petitioner’s stipulation is superficial as it does not even meet the estoppel that would arise after

an *inter partes* review is instituted and a Final Written Decision is issued. *See* 35 U.S.C. § 315 (e)(2) (“The petitioner in an *inter partes* review of a claim in a patent under this chapter that results in a final written decision under section . . . may not assert either in a civil action . . . that the claim is invalid on any ground that the petitioner raised or reasonably could have raised during that *inter partes* review.”).

The combination of the substantial overlap between proceedings, Petitioner’s and its customer’s contradictory claim construction positions, and Petitioner’s lacking stipulation supports denial of institution.

Factor 5: Petitioner and its customer in the parallel proceeding are coordinating parties, and the same parties are involved in the EDTX Litigation or a related EDTX action brought by Petitioner’s subsidiary. Factor 5 weighs in favor of denial because both parties to this proceeding, Petitioner’s customer and would-be co-Petitioner (Qorvo), and Patent Owner’s exclusive licensee (Akoustis), are all involved in the EDTX Litigation. Akoustis, Qorvo, and likely Patent Owner (if and when it is joined in the case as Qorvo has requested) are parties to the EDTX Litigation. Petitioner’s subsidiary was subpoenaed in the EDTX Litigation after Qorvo alleged that Petitioner supplies Qorvo with accused instrumentalities, and Petitioner’s subsidiary is challenging that subpoena in the same EDTX court as the EDTX Litigation. Ex. 2004 (Subpoena); Ex. 2003 (IQE Corporate Disclosure); Ex. 2021 (MTQ Response); Ex. 2002 (Misc. Docket Sheet).

Petitioner suggests that this factor strongly favors institution, but Petitioner's argument is based on the false notion that Petitioner is disinterested in the EDTX Litigation and distinct from Qorvo. Pet. 74. But the evidence shows Petitioner is highly involved in the EDTX Litigation and tightly coupled with Qorvo:

- Petitioner supplies materials to Qorvo. Ex. 2019 at 3-6, 12-20.
- Petitioner filed this Petition four-and-a-half months after Akoustis subpoenaed Petitioner's subsidiary in the EDTX Litigation. Ex. 2004 (Subpoena); Ex. 2003 (Corp Disclosure). Petitioner's subsidiary filed a motion to quash that subpoena, which the EDTX court is overseeing. Ex. 2002 (Misc. Docket Sheet).
- Petitioner relies on a subset of Qorvo's prior art references for the claims asserted in the EDTX Litigation. *Compare* Ex. 2005 at 19-20 (listing Urashima and Guo as charted references), 9 (listing Ashby as prior art) *with* Pet. 5 (listing Grounds including Urashima, Guo, and Ashby).
- Petitioner and Qorvo filed nearly identical petitions just weeks apart. *Compare* Petition *with* Ex. 2007 (Qorvo Petition). Qorvo seeks to join Petitioner here. Ex. 2023 (Motion).
- Petitioner and Qorvo share an expert in their nearly identical petitions and in Qorvo's Delaware case against Akoustis. *Compare* Pet. 2 (noting Dr. Stan Shanfield is Petitioner's expert) *with* Ex. 2007 (Qorvo Petition) at 2

(noting Dr. Shanfield is Qorvo’s expert) *and* Ex. 2025 (Del. Docket Sheet)
(showing Qorvo’s disclosure of Dr. Shanfield in district court).

Thus, given the totality of the circumstances here, this factor supports denial of institution.

Factor 6: the merits of the Petition are weak. The final factor supports denial because there is no “compelling challenge” of invalidity on the merits of the Petition. Ex. 2024 (Interim Procedure) at 4 (“compelling, meritorious challenges will be allowed to proceed at the PTAB even where district court litigation is proceeding in parallel”). As shown below, Petitioner’s arguments on the merits do not meet the high standard required. *Id.* (“Compelling, meritorious challenges are those in which the evidence, if unrebutted in trial, would plainly lead to a conclusion that one or more claims are unpatentable by a preponderance of the evidence.”); *see also Vector Flow, Inc. v. HID Glob. Corp.*, IPR2023-00353, Paper 8 at 23-24 (PTAB July 27, 2023) (same). Thus, this factor supports denial of institution.

B. The Urashima-based Grounds 1-4 fail to establish obviousness of the challenged claims 1-24.

Petitioner fails to establish obviousness of the ’360 Patent’s independent claims (1 and 18) for its Urashima-based Grounds 1-4.

1. Petitioner fails to establish that Urashima renders obvious challenged independent claim 1 (Ground 1).

Independent claim 1 includes the following limitations relevant to Petitioner's failure as to Ground 1:

- b) pre-treating a surface of the substrate with at least one group III reactant or at least one group II reactant at an elevated growth temperature prior to introducing a group V reactant or a group VI reactant;
- c) introducing a group V reactant or a group VI reactant to grow a nucleation layer on the surface of the substrate; and
- d) growing a buffer layer on said nucleation layer, said buffer layer providing a surface upon which said epitaxial layer is grown.

'360 Patent at Claim 1. These limitations require: (b) pretreatment with at least one group II/III reactant before introducing a group V/VI reactant; (c) introducing a group V/VI reactant to grow a nucleation layer; and (d) growing a buffer layer that will provide a surface for an epitaxial layer.

Petitioner's argument fails as to Urashima's alleged (b) pretreatment followed by the alleged (c)/(d) nucleation and buffer layers. Claim 1 requires that at least one group II/III material is kept on after (b) pretreatment when the group V/VI material is introduced for the (c)/(d) nucleation and buffer layers. '360 Patent at claim 1. The claim does not say that all group II/III materials are turned off, but says "introducing a group V reactant or a group VI reactant to grow a nucleation layer on the surface

of the substrate” and then “growing a buffer layer on said nucleation layer.” *Id.* The specification of the '360 Patent says the same:

- Abstract (“A single step process for nucleation and subsequent epitaxial growth on a lattice mismatched substrate is achieved by pre-treating the substrate surface with at least one group III reactant or at least one group II reactant prior to the introduction of a group V reactant or a group VI reactant. ... Once the pre-treatment of the surface is complete, a group V reactant or a group VI reactant is introduced to the growth chamber to commence the deposition of a nucleation layer.”)
- 1:53-57 (“In a preferred embodiment, a lattice mismatched substrate is pre-treated with a group III reactant or a group II reactant at an elevated growth temperature prior to the addition of a group V reactant or a group VI reactant and the growth of a nucleation layer.”)
- 2:25-30 (“This single step process for nucleation and subsequent growth of an epitaxial layer on a lattice mismatched substrate is achieved by pre-treating a surface of the substrate with at least one group III reactant or at least one group II reactant prior to the introduction of a group V or a group VI reactant.”)

- 2:47-50 (“At least one group III reactant or at least one group II reactant is introduced into a growth chamber at an elevated growth temperature to pre-treat the surface of the substrate”)
- 2:56-58 (“Once the pre-treatment is complete, the group V reactant or the group VI reactant is introduced to begin the growth of the nucleation layer.”)
- 3:15-25 (“After the growth temperature has stabilized, an aluminum reactant and a gallium reactant are introduced into the growth chamber to pre-treat the surface of the substrate. ... Once the pre-treatment of the surface is complete, a nitrogen source, preferably ammonia, is introduced into the growth chamber to commence the deposition of a nucleation layer.”)
- 3:65-4:7 (“3. After the temperature has stabilized, the aluminum reactant and the gallium reactant, preferably TEG and TMA, are introduced into the growth chamber. 4. Ammonia is then switched into the growth chamber, forming $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($x=0.06$ for SiC, and $x=0.15$ for sapphire) on the metal rich substrate surface. Around 20 nm of AlGaN is grown.”)

Figure 1 of the '360 Patent, too, shows that at least one group-III reactant continues to flow after pretreatment. As shown in the figure, the aluminum (TMA) continues to flow after pretreatment when NH_3 is turned on in the upper panel, and both the

aluminum (TMA) and gallium (TEG) continue to flow when NH_3 is turned on after pretreatment in the lower panel.

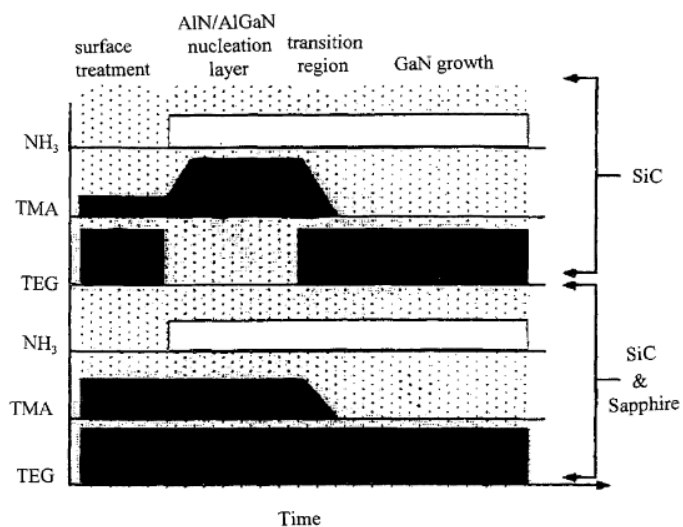


FIG. 1

Id. at Fig. 1. Applicant's December 8, 2006 office action similarly pointed out that claim 1's "pre-treating step includes subjecting the surface of the substrate to at least one group III reactant or at least one group II reactant prior to introducing a group V reactant or a group VI reactant." *Id.* at 47 (emphasis original).

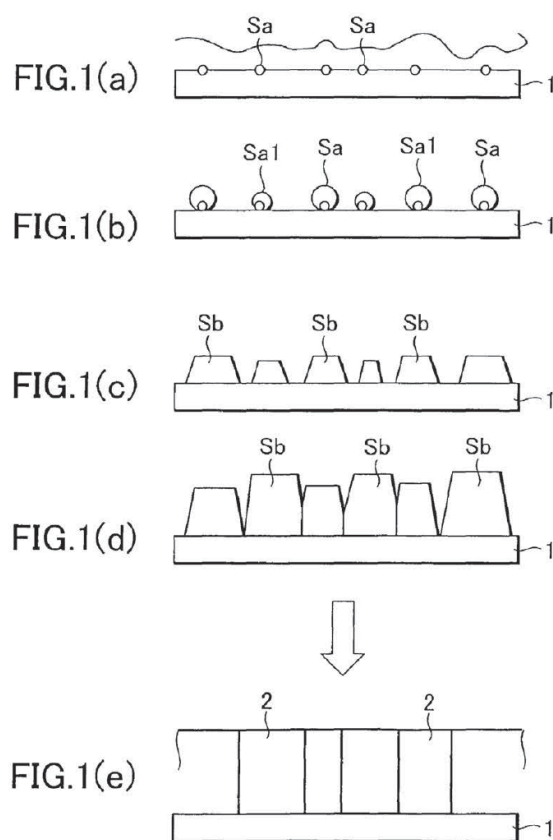
Claim 18 shows that the applicant knew how to explain when a flow would be turned off. In claim 18, unlike claim 1, there is a requirement of "c) stopping a flow of the first group III reactant" before "d) introducing a nitrogen source to grow a nucleation layer on the surface of the substrate." '360 Patent at claim 18. Claim 18 similarly requires "f) stopping the flow of the second group III reactant" before "g) growing a buffer layer on said nucleation layer" *Id.* Thus, the plain and ordinary

meaning of claim 1 requires that at least one group II/III material is kept on after the step of (b) pretreatment when the group V/VI material is introduced for the (c)/(d) nucleation and buffer layers.

Unlike the '360 Patent, Urashima is clear that its group-V nitrogen material *should not* be introduced along with any metals (such as group-III gallium):

If the step of nitriding the metal nuclei takes place in an atmosphere containing metal material, the crystallinity of the gallium nitride-based compound semiconductor grown in the following step will be degraded. Therefore, *the nitriding step should be performed in an atmosphere that does not contain metal material.*

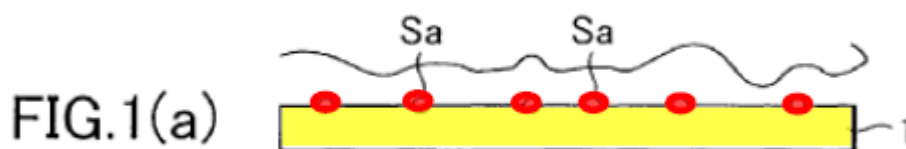
Ex. 1004 at [0123] (emphasis added). Indeed, Urashima performs the nitriding step in “an atmosphere...that contains ammonia or hydrazine as the nitrogen source”, *Id.* at [0085], [0107]-[0108]. Nothing in the Petition shows a contrary explanation of or teaching from Urashima. *See* Pet. 20-26. Urashima Figure 1(a)-(e) and its corresponding discussion shows that Urashima simply flows nitrogen after its initial aluminum-rich droplets are deposited in step 1(a) with the objective “that Group III metal particles nitrided in the second step have a polycrystalline and/or noncrystalline structure and include unreacted metal.” *Id.* at [0085].



This is unlike the simultaneous flows of one or more of both group II/III and group V/VI materials claims in the '360 Patent. Petitioner's evidence from Urashima fails to teach or render obvious the claimed (b) pretreatment followed by the alleged (c)/(d) nucleation and buffer layers.

Moreover, Petitioner's theory as to the claimed (b) pretreatment is insufficient. Pet. 17-19; *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1336 (Fed. Cir. 2020) ("it is the petition ... that defines the metes and bounds of an inter partes review.") (citing *SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018)). According to Petitioner, Urashima includes the claimed (b) pretreatment because

Urashima includes “a first step of depositing particles.” Pet. 17-18. Petitioner includes the below annotated Figure 1(a) from Urashima showing those “deposit[ed] particles” in red.



Pet. 18 (coloring added to Urashima Figure 1(a) by Petitioner). Petitioner thus alleges that Urashima discloses this pretreating through “depositing particles” on *a part* of “a surface of the substrate.” Pet. 17-19.

However, the claims state that the (b) pretreatment is of “a surface of the substrate” and not merely *a part* of “a surface of the substrate.” ’360 Patent at claim 1. The specification sections quoted as (c)/(d) nucleation and buffer layer require the same, and applicant’s December 8, 2006 office action response similarly focuses on (b) pretreatment being of “a surface of the substrate” and not merely *a part* of “a surface of the substrate.” Ex. 1002 at 47 (“The pre-treating step includes subjecting ***the surface*** of the substrate....”). Indeed, the specification of the ’360 Patent makes clear that the patent wants (b) pretreatment that focuses on a reaction causing an “aluminum saturated surface” and not merely “depositing particles.” ’360 Patent at 1:65-2:2. Petitioner’s customer and would-be co-Petitioner previously suggested that there is a distinction between the plain meaning of “a surface of the substrate”

and *a part* of “a surface of the substrate.” It originally proposed (but now dropped) a construction for “a surface of a substrate” that would read in the *a part* language: “an area on the substrate’s surface upon which a layer may be grown.” Ex. 2006 (Joint CC Statement). But that is not the construction Petitioner puts forth here, and Petitioner’s theory from Urashima therefore fails as to the claimed (b) pretreatment.

Thus, Petitioner’s Urashima arguments fail to render obvious claim 1, and Ground 1 fails.

2. Petitioner fails to establish that Urashima combined with Manabe renders obvious challenged independent claim 18 (Ground 4).

Independent claim 18 includes the following limitations relevant to Petitioner’s failure as to Ground 4:

- b) pre-treating a surface of the substrate with at least a first group III reactant and a second group III reactant at a growth temperature of 900 to 1100° C. prior to introducing a nitrogen source;
- c) stopping a flow of the first group III reactant;
- d) introducing a nitrogen source to grow a nucleation layer on the surface of the substrate;
- e) resuming the flow of the first group III reactant and reducing a flow of the second group III reactant;
- f) stopping the flow of the second group III reactant; and

g) growing a buffer layer on said nucleation layer, said buffer layer providing a surface upon which said epitaxial layer is grown.

'360 Patent at Claim 18. These limitations require: (b) pretreatment with at least two group III reactants before introducing a group V/VI reactant; (c)(d) forming a nucleation layer by introducing a nitrogen reactant after stopping one of at least two group III reactants; and (e)(f)(g) growing a buffer layer that will provide a surface for an epitaxial layer by resuming the stopped group III reactant and stopping another group III reactant.

Petitioner's argument fails as to the (b) pretreatment followed by (c)(d)/(e)(f)(g) nucleation and buffer layers. As discussed for claim 1, Urashima is clear that its group-V nitrogen material *should not* be introduced along with any metals (such as group-III gallium).

If the step of nitriding the metal nuclei takes place in an atmosphere containing metal material, the crystallinity of the gallium nitride-based compound semiconductor grown in the following step will be degraded. Therefore, ***the nitriding step should be performed in an atmosphere that does not contain metal material.***

Ex. 1004 at [0123] (emphasis added). Petitioner suggests modifying Urashima with Manabe, but fails to confront this express teaching of Urashima. Pet. 46-50. Petitioner's hindsight-based use of Manabe to use Urashima as Urashima expressly disavows is inappropriate. Urashima therefore fails to teach or render obvious the

formation of (c)(d) nucleation and (e)(f)(g) buffer layers after the (b) pretreatment as claimed.

Moreover, Petitioner’s theory as to the claimed (b) pretreatment is deficient. Pet. 44-46; *Koninklijke Philips*, 948 F.3d at 1336. As discussed with respect to claim 1, Petitioner’s theory as to Urashima “depositing particles” on *a part* of “a surface of the substrate” is insufficient. Petitioner’s failures for claim 1’s (b) pretreatment—Petitioner does not rely on Manabe for (b) pretreatment—apply equally here to claim 18’s (b) pretreatment.

Thus, Petitioner’s Urashima-Manabe arguments for claim 18 fail to render obvious the (b) pretreatment followed by (c)(d)/(e)(f)(g) nucleation and buffer layers, and Ground 4 therefore fails.

Moreover, even if such a combination is plausible (and it is not), the institution of an *inter partes* review remains discretionary even if a petition presents a reasonable likelihood of success as to one claim (which the Petition has *not* done), as the Board must make “a binary choice—either institute review or don’t.” *SAS Institute Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018). Thus, Patent Owner submits, institution is unwarranted for this claim that is not asserted in the EDTX Litigation.

3. Petitioner's remaining arguments for challenged claims 2-17 and 19-24 fail because they depend on Petitioner's insufficient arguments for the independent claims (Grounds 1-4).

The remaining Grounds 1-4 challenged claims are dependent claims 2-17 and 19-24. Pet. 5 (Grounds 1-4). Because Petitioner fails to meet its burden as to both independent claims, it fails to meet its burden as to the dependent claims.

C. The Guo-based Grounds 5-6 fail to establish obviousness of challenged claims 1-14 and 17.

As to challenged claims 1-4 and 6-14, Petitioner's Guo-based Grounds 5-6 fail because Guo is not prior art to those claims. As to challenged claims 5 and 17, Petitioner's Guo-based Ground 6 fails because Petitioner's combination of Guo and Ashby is nothing more than impermissible hindsight.

1. Guo is not prior art to challenged claims 1-4 and 6-14 (Grounds 5-6).

As discussed in Section III.A above, Drs. Shealy and Smart did significant work related to the '360 Patent while at Cornell in the late 1990s that led to the conception and reduction to practice of their invention. On the other hand, Petitioner asserts that Guo is prior art under Pre-AIA 35 U.S.C. § 102(a) with a filing date of November 25, 2003 and publication date of June 24, 2004. Assuming *arguendo* that Guo is 102(a) prior art, challenged claims 1-4 and 6-14 were conceived of and reduced to practice years before Guo.

Conception and reduction to practice dates are tightly coupled here where the

inventors were not involved in merely theoretical work, but instead, according to Dr. Smart and his thesis, did “[o]ver 300 epitaxial runs” leading up to and after the first successful preflow (or pretreatment) on December 31, 1997—between June 19, 1997 and May 10, 2000. Ex. 2011 (Smart Thesis) at 105, Appendix B. The inventors submitted their invention disclosure to Cornell shortly after, in September 2000. Ex. 2012 (IDS).

The chart below summarizes the evidence showing that challenged claims 1-4 and 6-14 were conceived of and reduced to practice before Guo. The chart includes quotations and evidence from three sources: (a) the September 2000 invention disclosure (IDS, Ex. 2012); (b) Dr. Smart’s binder of “run logs” reflected in his thesis (Run Log Binder, Ex. 2013); and (c) Dr. Smart’s thesis (Thesis, Ex. 2011). While Dr. Smart’s thesis is dated 2006, it reflects work done in the 1997-2000 time period and is corroborated by at least the IDS and Run Log Binder. The evidence shows challenged claims 1-4 and 6-14 were both conceived of and reduced to practice in the late 1990s, but at least by September 28, 2000.

<u>Claim Limitation</u>	<u>Evidence¹</u>
[1pre] 1. A process for growing an epitaxial layer on a lattice mismatched substrate comprising the steps of:	<u>IDS:</u> Page 1: “Title of Invention Single step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates ”

¹ All emphases in the chart has been added by Patent Owner.

	Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed.” <u>Run Log Binder:</u> Pages 19-20 (describing “Run #iii333” process using SiC and sapphire substrates with GaN) <u>Thesis:</u> Page 103: “The lack of suitable GaN substrates for homoepitaxy makes the growth of device-quality heterostructures in this material system difficult. Efforts have been directed towards producing nucleation and buffer layers on mismatched substrates such as sapphire, SiC, and Silicon.” Page 104: “A single, high temperature process has been developed using $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films as nucleation layers on both sapphire and SiC which results in highly resistive GaN buffer layers.” Page 105: “Over 300 epitaxial runs were done on sapphire and SiC substrates as listed in Appendix B for the custom nitride system described in Chapter 1. This chapter discusses sapphire and SiC substrate issues, nucleation strategies, metallic preparation of the substrate surface, AlGaN nucleation and GaN growth optimization.”
[1a] a) providing a substrate;	<u>IDS:</u> Page 1: “Title of Invention Single step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates”

	<u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using SiC and sapphire) <u>Thesis:</u> Page 104: “A single, high temperature process has been developed using $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films as nucleation layers on both sapphire and SiC which results in highly resistive GaN buffer layers.” Page 105: “Undoped AlGaN / GaN heterostructures were grown on either c-plane sapphire or SiC (both 4H semi-insulating and 6H n-type) substrates”
[1b] b) pre-treating a surface of the substrate with at least one group III reactant or at least one group II reactant at an elevated growth temperature prior to introducing a group V reactant or a group VI reactant;	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGaN Buffer”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four

	minutes later “NH₃ [ammonia] into tube AlGaN Buffer”) <u>Thesis:</u> Page 114: “Heteroepitaxial growth of GaN and related alloys on severely mismatched substrates require thin layers to provide nucleation sites to initiate crystal growth. When optimized, these nucleation layers accommodate the strain between the substrate and epitaxial layers caused by lattice and thermal mismatches, while still maintaining crystallographic registration of the epitaxial films to the substrate lattice structure.” Page 119: “A single flow, single pressure, high temperature nucleation process is achieved by introduction of the group III reactants only (OM-Preflow) into the growth chamber at growth temperature of 1040° C to wet the substrate surface prior to any actual crystal growth.” Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.” Page 223 (Appendix B): “[Run] III304 12/31/97 High Temperature Nucleation on SiC 4 minute OM [organometallic] preflow prior to growth”
[1c] c) introducing a group V reactant or a group VI	<u>IDS:</u>

reactant to grow a nucleation layer on the surface of the substrate; and	Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_{0.99}N Buffer” with “V/III RATIO” of “900”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” and four minutes later “NH₃ [ammonia] into tube AlGa_{0.99}N Buffer”) <u>Thesis:</u> Page 121: “Once the group III soak of the surface is completed, the Nitrogen source (ammonia) [Group V] is introduced to the growth chamber.” Page 121: “4) The ammonia is then switched into the cell, forming Al_xGa_{1-x}N (x=0.06 for SiC, and 0.15 for sapphire) on the metal rich substrate surface. Around 20 nm of AlGa_{0.99}N is grown.”
[1d] d) growing a buffer layer on said nucleation layer, said buffer layer providing a surface upon	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates

which said epitaxial layer is grown.	has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “GaN Layer” with “V/III RATIO” of “1800” after “AlGaN Buffer” with “V/III RATIO” of “900”) Page 20 (noting “Ramp out AL down to 2%” about 20 minutes after “NH3 [ammonia] into tube AlGaN Buffer”) <u>Thesis:</u> Page 121: “The Aluminum is then graded out and GaN buffer can then be grown.” Pages 121-122: “5) The Aluminum is then ramped down to 0.0 in 30 seconds, and then switched out of the cell. 6) This results in GaN deposition, providing a buffer layer on which other GaN-based materials can subsequently be deposited without any change in chamber temperature.”
2. The process of claim 1, wherein said substrate is selected from the group consisting of silicon, sapphire and SiC.	<u>IDS:</u> Page 1: “Title of Invention Single step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates”

	<u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using SiC and sapphire) <u>Thesis:</u> Page 104: “A single, high temperature process has been developed using $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films as nucleation layers on both sapphire and SiC which results in highly resistive GaN buffer layers.” Page 105: “Undoped AlGaN / GaN heterostructures were grown on either c-plane sapphire or SiC (both 4H semi-insulating and 6H n-type) substrates”
3. The process of claim 1, wherein said group III reactant is selected from the group consisting of a gallium reactant, an aluminum reactant, a boron reactant, and an indium reactant.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGaN Buffer”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four minutes later “NH₃ [ammonia] into tube AlGaN Buffer”) <u>Thesis:</u> Page 119: “The Aluminum reacts with the surface providing the needed nucleation sites while the

	Gallium prepares the Aluminum saturated surface for subsequent AlGa_N or Ga_N growth. In the case of a thin Al_(x)Ga_(1-x) nucleation layer where the Aluminum mole fraction is varied from 0.03 to 0.97 depending on the substrate material used.” Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.” Page 223 (Appendix B): “[Run] III305 [Date] 1/4/98 [Description] AlGa_N Calibration, New Nucleation [Results] HT nucleation scheme, 4 minute TMA & TEG preflow”
4. The process of claim 3, wherein said group III reactant is selected from the group consisting of triethyl gallium, trimethyl gallium, triethylaluminum, trimethyl aluminum, triethylboron, trimethylboron, triethylindium and trimethylindium.	<u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_N Buffer”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four minutes later “NH₃ [ammonia] into tube AlGa_N Buffer”) <u>Thesis:</u>

	Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.” Page 223 (Appendix B): “[Run] III305 [Date] 1/4/98 [Description] AlGa_N Calibration, New Nucleation [Results] HT nucleation scheme, 4 minute TMA & TEG preflow”
6. The process of claim 1, wherein said step of pre-treating includes pre-treating the surface of the substrate with an aluminum reactant and a gallium reactant.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_N Buffer”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four

	minutes later “NH₃ [ammonia] into tube AlGa_N Buffer”) <u>Thesis:</u> Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.”
7. The process of claim 6, wherein said nucleation layer is AlN or AlGa_N.	<u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_N Buffer” with “V/III RATIO” of “900”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” and four minutes later “NH₃ [ammonia] into tube AlGa_N Buffer”) <u>Thesis:</u> Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are

	introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds. 4) The ammonia is then switched into the cell, forming $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($x=0.06$ for SiC, and 0.15 for sapphire) on the metal rich substrate surface. Around 20 nm of AlGaN is grown.”
8. The process of claim 1, wherein said buffer layer is GaN.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “GaN Layer” with “V/III RATIO” of “1800” after “AlGaN Buffer” with “V/III RATIO” of “900”) Page 20 (noting “Ramp out AL down to 2%” about 20 minutes after “NH3 [ammonia] into tube AlGaN Buffer”) <u>Thesis</u> Page 105: “Over 300 epitaxial runs were done on sapphire and SiC substrates as listed in Appendix B for the custom nitride system described in Chapter 1. This chapter discusses sapphire and SiC substrate issues, nucleation strategies, metallic preparation of the substrate surface, AlGaN nucleation and GaN growth optimization.” Page 121: “The Aluminum is then graded out and GaN buffer can then be grown.”

	Pages 121-122: “5) The Aluminum is then ramped down to 0.0 in 30 seconds, and then switched out of the cell. 6) This results in GaN deposition, providing a buffer layer on which other GaN-based materials can subsequently be deposited without any change in chamber temperature.”
9. The process of claim 1, wherein said epitaxial layer includes a compound selected from the group comprising AlN, GaN, AlGa_N, BGaN, BInN, BAlN, CdTe, and ZnS.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “GaN Layer” with “V/III RATIO” of “1800” after “AlGa_N Buffer” with “V/III RATIO” of “900” and followed by “AlGa_N cap layer” with “V/III RATIO” of “900”) Page 20 (noting “Ramp out AL down to 2%” about 20 minutes after “NH₃ [ammonia] into tube AlGa_N Buffer”) <u>Thesis</u> Page 122: “6) This results in GaN deposition, providing a buffer layer on which other GaN-based materials can subsequently be deposited without any change in chamber temperature.”
10. The process of claim 1, further comprising the step of preheating said substrate in hydrogen prior to pre-treating the surface of the	<u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake”)

substrate with at least one group III reactant or at least one group II reactant.	Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” after a “Start bake. 10 min.” entry at “temp” of “1055”) <u>Thesis:</u> Page 105: “Undoped AlGa_N / Ga_N heterostructures were grown on either c-plane sapphire or SiC (both 4H semi-insulating and 6H n-type) substrates” Page 105: “All substrates are then subjected to 1100° C clean for 10 minutes under H₂ just prior to growth.” Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface.”
11. The process of claim 1, wherein said elevated growth temperature is 900 to 1100° C.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of Ga_N-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_N Buffer”)

	Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four minutes later “NH3 [ammonia] into tube AlGaN Buffer”) <u>Thesis:</u> Page 119: “A single flow, single pressure, high temperature nucleation process is achieved by introduction of the group III reactants only (OM-Preflow) into the growth chamber at growth temperature of 1040° C to wet the substrate surface prior to any actual crystal growth.” Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface. 2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C 3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.”
12. The process of claim 11, wherein the step of introducing a group V reactant or a group VI reactant includes growing a nucleation layer at a growth temperature of 900 to 1100° C. and the step of growing a buffer layer includes growing a buffer layer at a growth temperature of 900 to 1100° C.	<u>IDS:</u> Page 1: “Title of Invention Single step, high temperature GaN-Base Nucleation Process on Sapphire, SiC and Silicon Substrates” Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed. The single flow, single pressure, high temperature process involves a surface

treatment prior to epitaxial growth that allows complete coalescence of the epitaxial film within the first 200 Å of growth. This process eliminates the large temperature ramps and complex flow requirements of the commonly used two-step nucleation technologies.”

Run Log Binder:

Page 19 (describing “Run #iii333” process using “OM Preflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_{0.15}N Buffer”)

Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” at “temp” of “1034” and four minutes later “NH₃ [ammonia] into tube AlGa_{0.15}N Buffer” at “temp” of “1039” and then “Ramp out AL down to 2%” at “temp” of “1037”)

Thesis:

Page 121: “1) The substrates are heated up to 1100° C in Hydrogen for 10 minutes to clean the surface.

2) After 10 minutes, the temperature is decreased to the growth temperature of 1040° C

3) After the temperature has stabilized, the group III reactants (namely TEG and TMA) are introduced into the growth chamber. For sapphire substrates the TMA/TEG ratio is set at 0.15, while for SiC, it is fixed at 0.06. The substrates are exposed for 100 seconds.

4) The ammonia is then switched into the cell, forming Al_xGa_{1-x}N (x=0.06 for SiC, and 0.15 for sapphire) on the metal rich substrate surface. Around 20 nm of AlGa_{0.15}N is grown.

5) The Aluminum is then ramped down to 0.0 in 30 seconds, and then switched out of the cell.

	6) This results in GaN deposition, providing a buffer layer on which other GaN-based materials can subsequently be deposited without any change in chamber temperature.”
13. The process of claim 1, wherein said group V reactant is a group V hydride.	<u>IDS:</u> Page 1: “A single step process technique for the nucleation and subsequent epitaxial growth of GaN-based materials on mismatched substrates has been developed.” <u>Run Log Binder:</u> Page 19 (describing “Run #iii333” process using “OM Prewflow” with a “V/III RATIO” of “0” after an initial “H₂ bake” and before “AlGa_{0.06}N Buffer” with “V/III RATIO” of “900”) Page 20 (noting “TMA [trimethyl aluminum] ON” and “TEG [triethylgallium] ON” before “om preflow 4 min” and four minutes later “NH₃ [ammonia] into tube AlGa_{0.06}N Buffer”) <u>Thesis:</u> Page 121: “Once the group III soak of the surface is completed, the Nitrogen source (ammonia) [Group V] is introduced to the growth chamber.” Page 121: “4) The ammonia is then switched into the cell, forming Al_xGa_{1-x}N (x=0.06 for SiC, and 0.15 for sapphire) on the metal rich substrate surface. Around 20 nm of AlGa_{0.06}N is grown.”
14. The process of claim 13, wherein said group V hydride is selected from the group consisting of ammonia, arsine, and phosphine.	See Claim 13 evidence.

Given the inventors' much-earlier conception and reduction to practice of challenged claims 1-4 and 6-14, Guo is not prior art to those claims under 102(a) and cannot be used to render those claims obvious.

2. Petitioner fails to establish that Guo combined with Ashby renders obvious challenged claims 5 or 17 (Ground 6).

The remaining challenged claims for Guo-based Grounds 5-6 are dependent claims 5 and 17:

5. The process of claim 1, wherein said group II reactant is a cadmium reactant or a zinc reactant.

* * *

17. The process of claim 1, wherein said group VI reactant is a tellurium reactant or a sulfur reactant.

Pet. 5 (Grounds); '360 Patent at Claims 5 and 17. These dependent claims require the use of group II and VI reactants—specific group II and VI reactants—that Petitioner implicitly acknowledges are absent from Guo. Pet. 68-71. Petitioner thus turns to Ashby. *Id.*

Petitioner's basis for combining Guo and Ashby, like the combination itself, is pure hindsight and fails to properly consider Guo and Ashby. Boiled down, Petitioner's basis for combining Guo and Ashby is that (a) Guo fails to discuss group II or group VI reactants; (b) Guo says "[n]umerous variations and combinations of the features set forth above can be utilized without departing from the present

invention as defined by the claims”; and (c) Ashby mentions the use of group II and group VI reactants. Pet. 68-69. Petitioner provides no basis for believing a POSITA would have been motivated to make the specific modifications suggested, or that there would be any expectation that the proposed modifications would have worked. Instead, Petitioner treats Guo as a plug-and-play reference that permits unlimited modifications.

Petitioner’s Guo-Ashby combination analysis fails for several reasons. First, Petitioner misreads Guo’s statement that “[n]umerous variations and combinations of the features set forth above can be utilized without departing from the present invention as defined by the claims.” Ex. 1008 at [0048]. The very next sentences clarify that the anticipated modifications would still be “other nitride [group V] semiconductor structures and other III-V semiconductor structures” and that “the III-V semiconductors used in the preferred embodiments can be varied by addition of other group V elements as, for example, As and P.” *Id.* The Guo statement Petitioner relies on in no way suggests that non-group III and non-group V materials would be used. Guo simply suggests using other group III and group V materials. Thus, Petitioner’s suggestion that group II and group VI materials could be plugged in is contrary to Guo itself. *See In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380-81 (Fed. Cir. 2016) (“To satisfy its burden of proving obviousness, a petitioner cannot employ merely conclusory statements. The petitioner must instead articulate

specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.”).

Second, Petitioner fails to explain why a POSITA would look at Ashby to modify Guo in its hindsight-driven manner. As discussed in Section I.A.3 above, Guo relates to specific ways of manufacturing GaN (and possibly other group III/V combinations) on silicon substrates. Ashby on the other hand relates to a specific “cantilever epitaxy” process for use on “specially patterned substrates.” Ex. 1009 at [0002], [00014]. Petitioner fails to account for how Ashby could even be applied to Guo, which Petitioner does not allege uses a “cantilever epitaxy” process or “specially patterned substrates.” Pet. 68-69. This is significant because “[c]ombinations of references that render a prior art device inoperable, or that fundamentally change the manner of operation of the device, often will not support a finding of obviousness.” *Plas-Pak Indus., Inc. v. Sulzer Mixpac AG*, No. 13-7786, 2014 WL 203101, at *2 (PTAB. Jan. 17, 2014) (citing *In re Ratti*, 270 F.2d 810, 813 (CCPA 1959)), *aff’d*, 600 Fed. Appx. 755 (Fed. Cir. 2015). Indeed, as discussed in Section I.A.1 above, pretreatment is to be on “a surface of a substrate” and not *a part* of “a surface of a substrate.” But Ashby says it only applies its materials on “specially patterned substrates” with surface openings that allow ELO and expansion of the growing crystals laterally to reduce defects. Ex. 1009 at [0002], [00014]. The surface openings on the “specially patterned substrates” for crystal growth are only

a part of the surface. Thus, any pretreatment using Ashby occurs only on *a part* of “a surface of a substrate,” and Petitioner fails to account for how Ashby is compatible with Guo.

Third, Petitioner fails to explain why a POSITA would believe replacing Guo’s group III/V materials with Ashby’s group II/VI materials would work. Petitioner does not explain how or why the pretreatment step of the claims would work if a group II material is substituted for a group III materials. Nor does Petitioner explain how or why the epitaxial layer or buffer layer growth steps would work if group III/V materials are replaced with group II/VI materials (including whether different materials would be used for different layers). This lack of explanation highlights conclusory nature of Petitioner’s improper use of hindsight and is fatal for this Ground. *In re Magnum Oil*, 829 F.3d at 1380-81.

Fourth, Petitioner’s unexplained reliance on its Urashima-Nagata combination to suggest the Guo-Ashby combination is insufficient. Guo does not alleged that Urashima or Nagata are the same or substantially the same as Guo or Ashby, respectively. Pet. 69. Yet Petitioner improperly points back to its Urashima-Nagata motivation to combine. This unexplained reliance is insufficient, and Petitioner’s attempt to incorporate five paragraphs of its expert’s testimony by reference (Pet. 69 (citing Ex. 1003 ¶¶ 237-241)) to avoid word limits is inappropriate. 37 CFR § 42.6(a)(3) (“Arguments must not be incorporated by

reference from one document into another document.”).

Because Guo and Ashby would not be combined as Petitioner suggests, Petitioner fails to show that claims 5 and 17 are obvious under Ground 6. Even if such a combination is plausible (and it is not), the institution of an *inter partes* review remains discretionary even if a petition presents a reasonable likelihood of success as to one claim (which the Petition has *not* done). *SAS Institute Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018). Thus, Patent Owner submits, institution is unwarranted for these claims that are not asserted in the EDTX Litigation.

V. CONCLUSION

For any or all of the above-described reasons, Patent Owner respectfully requests that the Board deny institution.

Dated: June 17, 2024

Respectfully submitted,

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CERTIFICATION OF WORD COUNT

The undersigned hereby certifies that the portions of the above-captioned **PATENT OWNER'S PRELIMINARY RESPONSE** specified in 37 C.F.R. § 42.24 have 13,707 words, in compliance with the 14,000 word limit set forth in 37 C.F.R. § 42.24(b)(1). This word count was prepared using Microsoft Word 2010.

Date: June 17, 2024

Respectfully submitted,

/s/ John B. Campbell

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CERTIFICATION OF SERVICE

The undersigned hereby certifies that the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** has been served on Petitioner via email on the following counsel of record for Petitioner:

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