

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CIRRUS LOGIC, INC. and
OMNIVISION TECHNOLOGIES, INCORPORATED, and
TEXAS INSTRUMENTS INCORPORATED
Petitioners,

v.

GREENTHREAD, LLC,
Patent Owner.

IPR2024-00001¹
U.S. Patent No. 10,734,481

PATENT OWNER'S SUR-REPLY

¹ Texas Instruments Incorporated, which filed a petition in IPR2024-00772, has been joined as a party to this proceeding.

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EXHIBIT LIST

Exhibit No.	Description	Submitted Previously?
Ex. 2001	<i>Greenthread, LLC v. Intel Corp.</i> , No. 6:22-cv-00105-ADA, Dkt. 1 (Complaint) (W.D. Tex. Jan. 27, 2022)	X
Ex. 2002	Definition of “privity” in Black’s Law Dictionary (11 th ed. 2019) available from Westlaw at westlaw.com	X
Ex. 2003	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 38 (First Amended Complaint for Patent Infringement) (W.D. Tex., filed Apr. 29, 2022)	X
Ex. 2004	<i>Greenthread, LLC v. Intel Corp.</i> , No. 6:22-cv-00105-ADA, Dkt. 113 (Redacted Memorandum Opinion and Order) (W.D. Tex. Dec. 27, 2022)	X
Ex. 2005	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 38-8 (Greenthread’s Amended Preliminary Infringement Contentions) (W.D. Tex., filed Apr. 29, 2022)	X
Ex. 2006	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 38-12 (Exs. D-1, D-2, D-3, D-6 to Greenthread’s Preliminary Infringement Contentions) (W.D. Tex., filed Apr. 29, 2022)	X
Ex. 2007	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 49 (Notice of Appearance of Additional Counsel) (W.D. Tex., filed June 9, 2022)	X
Ex. 2008	Petition (Paper 1) in <i>Sony Group Corp. v. Greenthread, LLC</i> , IPR2023-00376	X

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Exhibit No.	Description	Submitted Previously?
Ex. 2009	<i>Greenthread, LLC v. Dell Inc.</i> , No. 6:22-cv-105-ADA, Dkt. 120 (Second Amended Complaint)	X
Ex. 2010	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 135 (Motion for Admission Pro Hac Vice of L. Popovski on Behalf of Sony) (W.D. Tex., filed January 30, 2023)	X
Ex. 2011	Email communication from Patent Owner's counsel to Petitioners' counsel dated October 20, 2023	X
Ex. 2012	Email Attachment – Cirrus Logic Technical Support Article Number 000207340	X
Ex. 2013	Email Attachment - Cirrus Logic Investor Presentation as of April 28, 2015	X
Ex. 2014	Email Attachment - GlobalFoundries 2022 Capital Markets Day, available at https://investors.gf.com/static-files/65f5f1b9-2aea-47a3-8455-10413c6560f4	X
Ex. 2015	Email Attachment - Intel RealSense Product Family D400 Series, dated 2019	X
Ex. 2016	Email communication from Petitioners' counsel to Patent Owner's counsel dated October 24, 2023	X
Ex. 2017	Email communication from Patent Owner's counsel to Board, copying Petitioners' counsel dated November 1, 2023	X
Ex. 2018	<i>Greenthread, LLC v. Cirrus Logic, Inc.</i> , No. 1:23-cv-00369 (Supplemental Preliminary Infringement Contentions) (W.D. Tex., served Oct. 13, 2023)	X
Ex. 2019	<i>Greenthread, LLC v. Cirrus Logic, Inc.</i> , No. 1:23-cv-00369, Dkt. 29 (Scheduling Order) (W.D. Tex. Aug. 18, 2023)	X

Exhibit No.	Description	Submitted Previously?
Ex. 2020	Article entitled “Cirrus Logic Helps Ease PC Industry Transition to New MIPI SoundWire® Interface” available at https://investor.cirrus.com/news-and-events/investor-news/news-details/2023/Cirrus-Logic-Helps-Ease-PC-Industry-Transition-to-New-MIPI-SoundWire-Interface/default.aspx	X
Ex. 2021	<i>Greenthread, LLC v. Intel Corp.</i> , 6:22-cv-00105-ADA, Dkt. 120-8, Greenthread’s Amended Preliminary Infringement Contentions (W.D. Tex., filed Jan. 23, 2023)	X
Ex. 2022	Confidential agreement	X
Ex. 2023	CS42L42, Low Power Audio Codec with SoundWire and Audio Processing, available at https://www.cirrus.com/pubs/proBulletin/cs42l43-cs36l56-bulletin.pdf	X
Ex. 2024	Cirrus Logic Immersive PC Audio Solution, available at https://www.cirrus.com/pubs/proBulletin/cs42l43-cs36l56-bulletin.pdf	X
Ex. 2025	Cirrus Logic – What Drives Our Success, available at https://investor.cirrus.com/company-overview/what-drives-our-success/default.aspx	X
Ex. 2026	Cirrus Logic, Inc. Terms and Conditions of Sale, available at https://www.cirrus.com/legal/productterms/	X
Ex. 2027	<i>Greenthread, LLC v. OmniVision Technologies Inc.</i> ; 2:23-cv-212, Dkt. 1 (Complaint) (E.D. Tex May 10, 2023)	X
Ex. 2028	Confidential declaration	X

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Exhibit No.	Description	Submitted Previously?
Ex. 2029	<i>Greenthread, LLC v. OmniVision Technologies Inc.</i> , 2:23-00212, Preliminary Infringement Contentions for OmniVision Technologies Inc.	X
Ex. 2030	Deep Dive Teardown of the PlayStation VR2 CFIZVR1 VR Headset, available at https://www.techinsights.com/blog/deep-dive-teardown-playstation-vr2-cfi-zvr1-vr-headset	X
Ex. 2031	Intel RealSense Product Family D400 Series, dated September 2023	X
Ex. 2032	Confidential declaration	X
Ex. 2033	GlobalFoundries Annual Report on Form 20-F for the fiscal year ended December 31, 2022, available at https://investors.gf.com/static-files/cc73efd0-09c1-442a-b4dd-0bcb74610e31	X
Ex. 2034	Confidential agreement	X
Ex. 2035	TechInsights Report on Sony Xperia 5111	X
Ex. 2036	TechInsights Report Ad	X
Ex. 2037	Email communication from Petitioners' counsel to Patent Owner's counsel dated between January 9, 2024 through January 10, 2024	X
Ex. 2038	Email communication from Petitioners' counsel to Patent Owner's counsel dated between October 20, 2023 through October 31, 2023	X

Exhibit No.	Description	Submitted Previously?
Ex. 2039	<i>Greenthread, LLC v. Intel Corp.</i> , No. 6:22-cv-00105-ADA, Dkt. 7 (summons returned executed) (W.D. Tex. Feb. 7, 2022)	X
Ex. 2040	Petition (Paper 2) in <i>Sony Group Corp. v. Greenthread, LLC</i> , IPR2023-00324	X
Ex. 2041	Petition (Paper 3) in <i>Sony Group Corp. v. Greenthread, LLC</i> , IPR2023-00325	X
Ex. 2042	Petition (Paper 1) in <i>Sony Group Corp. v. Greenthread, LLC</i> , IPR2023-00375	X
Ex. 2043	<i>Greenthread, LLC v. OmniVision Technologies Inc.</i> ; 2:23-cv-212 (OmniVision's Responses and Objections to Greenthread's Fourth Set of Common Interrogatories)	X
Ex. 2044	Email communication from Petitioners' counsel to Patent Owner's counsel dated between November 28, 2023 through December 6, 2023	X
Ex. 2045	Samsung Supplier List, dated June 8, 2022, available at https://image-us.samsung.com/SamsungUS/home/pdf/062822/2022_Supplier_List_220608_F.pdf	X
Ex. 2046	Email communication to Petitioners' counsel attaching production dated October 5, 2023	X
Ex. 2047	Email communication to Petitioners' counsel attaching production dated June 30, 2023	X
Ex. 2048	<i>Greenthread, LLC v. Samsung Electronics Co., Ltd. et al</i> , EDTX-2-19-cv-00147, Dkt. 1 (Complaint) (E.D.Tex., April 30, 2019)	X

Exhibit No.	Description	Submitted Previously?
Ex. 2049	<i>Greenthread, LLC v. Samsung Electronics Co., Ltd. et al</i> , EDTX-2-19-cv-00147, Dkt. 6 (Order granting Motion for Extension of Time, and Waiver of Foreign Service Requirement) (E.D.Tex., May 31, 2019)	X
Ex. 2050	Correspondence from Patent Owner's counsel to Petitioners' counsel dated May 4, 2023	X
Ex. 2051	Webpage from DigiKey for Cirrus Logic CS35L41 (https://www.digikey.com/en/products/detail/cirrus-logic-inc/CS35L41-CWZR/16377919)	X
Ex. 2052	Webpage from DigiKey for Cirrus Logic CS40L25 (https://www.mouser.com/ProductDetail/Cirrus-Logic/CS40L25-CWZR?qs=xZ%2FP%252Ba9zWqYWfeisEtcaTA%3D%3D)	X
Ex. 2053	Webpage from Mouser for Cirrus Logic CS40L25 (https://www.mouser.com/ProductDetail/Cirrus-Logic/CS40L25-CWZR?qs=xZ%2FP%252Ba9zWqYWfeisEtcaTA%3D%3D)	X
Ex. 2054	Webpage from ArduCam for OmniVision OV9282 (https://www.arducam.com/product/ov9282-monochrome-globalshutter-camera-module-depthai-oak/)	X
Ex. 2055	Webpage from Uctronics for OmniVision OV9282 (https://www.uctronics.com/ov9282-monochrome-global-shutter-camera-module-depthai-oak.html)	X
Ex. 2056	Excerpts of the Deposition Transcript of Scott Warrick taken on June 7, 2024 along with marked Exhibits 3-5 in <i>Greenthread, LLC v. Cirrus Logic, Inc.</i> , 1:23-cv-00369-DC (W.D. Tex.)	X

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Exhibit No.	Description	Submitted Previously?
Ex. 2057	Declaration of Dr. Alexander Glew	X
Ex. 2058	Transcript of Deposition of Dr. Sanjay Banerjee taken on July 19,2024	X
Ex. 2059	Excerpts from Chen, J. Y., <u>CMOS Devices and Technology for VLSI</u> , Prentice-Hall (1990)	X
Ex. 2060	U.S. Patent No. 5,384,476 (“Nishizawa”)	X
Ex. 2061	CV of Dr. Alexander Glew	X
Ex. 2062	U.S. Patent No. 8,421,195	X
Ex. 2063	U.S. Patent No. 9,190,502	X
Ex. 2064	U.S. Patent No. 11,121,222	X
Ex. 2065	U.S. Patent No. 10,510,842	X
Ex. 2066	U.S. Patent No. 11,316,014	X
Ex. 2067	File History of U.S. Patent No. 8,421,195	X
Ex. 2068	File History of U.S. Patent No. 9,190,502	X
Ex. 2069	File History of U.S. Patent No. 11,121,222	X

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Exhibit No.	Description	Submitted Previously?
Ex. 2070	File History of U.S. Patent No. 10,510,842	X
Ex. 2071	File History of U.S. Patent No. 11,316,014	X
Ex. 2072	Declaration of Mohan Rao	X
Ex. 2073	Statista Information	X
Ex. 2074	<i>Greenthread, LLC v. Cirrus Logic Inc.</i> , No. 1:23-cv-369-DC-DTG, Dkt. 53 (Claim Construction Order and Memorandum in Support Thereof) (W.D. Tex. Mar. 13, 2024)	X
Ex. 2075	<i>Greenthread, LLC v. Samsung Electronics Co., Ltd. Et Al.</i> , 2:19-cv-00147, Dkt. No. 67 (Claim Construction Memorandum Opinion and Order) (E.D. Tex. Apr. 20, 2020)	X
Ex. 2076	<i>Intel Corp. v. Greenthread LLC</i> , IPR2023-00420, Ex. 1003 (Dr. Blalock Declaration), Dec. 28, 2022	X
Ex. 2077	<i>Greenthread, LLC v. Cirrus Logic, Inc.</i> , No. 1:23-cv-00369-DC, Dkt. 86 (W.D. Tex. Jul. 11, 2024)	X
Ex. 2078	Transcript of Deposition of Dr. Sanjay Banerjee dated December 6, 2024	

I. INTRODUCTION²

A gradient alone does not “aid carrier movement.” Petitioners’ expert, Dr. Banerjee, testified that without knowing the cumulative effect of multiple forces and fields, it is impossible to determine carrier movement, as that term is ordinarily understood. Since Dr. Banerjee did not consider these other forces in his analysis, the Petition fails.

To save their case, Petitioners’ Reply advances a new theory based on a novel claim construction that was not in the Petition. Petitioners now argue that *Greenthread* has “mischaracterized” the claim and that “aiding carrier movement” does not refer to the flow of carriers in a semiconductor device, but rather the constant, random, thermal—a.k.a. “Brownian”—vibration of individual electrons. That theory and claim construction make no sense and should be rejected as an improper new argument.

The specification and claim language speak of moving electrons “from” one location “to” another to influence the operation of the device, not individual electrons vibrating. Furthermore, Dr. Banerjee said that the net effect of “Brownian”

² Greenthread, LLC (“Patent Owner,” “PO,” or “Greenthread”) submits this Sur-Reply to the Petition for *Inter Partes* Review (“Petition”) (Paper 1). This Sur-Reply is timely filed in accordance with the parties’ stipulation. Paper 35.

motion is precisely zero, because “statistically you have as many electrons moving to the right as to the left.” Ex. 2078 (Banerjee Dep. Tr.), 104:11-14. The number of electrons at any one place at any one time is not affected by Brownian motion. There is no evidence that a POSITA would have been concerned with net zero motion. Regardless, the Petition fails even under this new claim construction. Dr. Banerjee testified that his construct is purely theoretical, because it is not possible to know the movement of individual electrons. If Dr. Banerjee cannot say how or where individual electrons move, Petitioners cannot show that the prior art meets the claim limitations under their construction.

Finally, Dr. Banerjee levels heavy criticism at Greenthread’s expert, Dr. Glew. None of it is credible. Dr. Glew’s position is vindicated by Dr. Banerjee’s numerous admissions that the flow of carriers in a semiconductor device is affected by many forces and fields. The principal difference between the experts is Dr. Banerjee’s faulty claim construction. Moreover, Dr. Banerjee revealed during his deposition that he has a previously undisclosed significant financial relationship with

Texas Instruments—one of the parties that has joined Petitioners’ IPRs.³ Dr. Banerjee’s testimony is not to be trusted.

II. ARGUMENT

A. The Petition fails to show the “aid carrier movement” limitation in the prior art.

The Petition fails, because Petitioners’ expert admitted that (1) numerous forces act on carriers, (2) carrier motion is determined by the sum of these forces, and (3) he did not analyze any forces except the gradient itself. Since Petitioners cannot say whether, when, or in which direction a carrier in the prior art devices would move, they have failed to carry their burden of showing that the prior art renders obvious the “aid carrier movement” limitation.

Numerous forces act on carriers: Dr. Banerjee testified repeatedly that to determine carrier movement in a semiconductor, a POSITA must look at the net forces and net fields acting on the carriers.

Q. [T]o determine movement of an electron in a semiconductor, you have to look at a number of factors, correct?

A. Yes.

³ Petitioner Texas Instruments is joined to the following IPR proceedings from Petitioners Cirrus Logic and OmniVision: IPR2024-00001, IPR2024-00017, IPR2024-00018, IPR2024-00019.

...

Q. What are some of the factors you have to look at?

A. Well, as I mentioned, **there's three broad categories of forces.**

Ex. 2078, 80:18-81:5. According to Dr. Banerjee, those categories are (1) "periodic crystalline potential" (*id.* at 82:9-12), (2) "externally applied forces or a built-in electric field" (*id.* at 83:19-84:1) and (3) "random forces, ... such as lattice vibrations or static random forces due to structural defects in the crystal." *Id.* at 84:16-21. Dr. Banerjee provided numerous examples of specific forces, including temperature (*id.* at 138:11-16), magnetic fields (*id.* at 138:20), the Hall effect (*id.* at 140:11-21), the gate (even with no voltage applied) and gate oxide (*id.* at 219:16-220:20, 222:19-22).

Carrier motion is determined by the sum of the forces: Dr. Banerjee also repeatedly testified that to determine carrier motion, a POSITA must look to the sum of all of the forces acting on a carrier.

Q. When you're trying to determine net motion, you want to look at the vector sum of all of the different fields, correct?

A. Yes.

Q. Because the vector sum determines the net movement, correct? ...

A. Yes.

Ex. 2078, 183:15-22; 113:18-114:13 (“Q. So when you have multiple forces, you have to look at the vector sum? A. To get the net motion, yes.”); 110:8-15 (“You either do a vector sum of the built-in static electric fields to the doping gradient, as well as the externally applied fields, which can change from, you know, one situation to the other”); 251:6-8 (“Net movement as in drift velocity would depend on the vector sum.”)

Dr. Banerjee did not analyze the forces to determine carrier movement:

Finally, Dr. Banerjee admitted that he did not find the “vector sum” or the magnitude of any electric field in the prior art. Ex. 2078, 211:20-212:3 (“[Y]ou didn't calculate a magnitude for the electric field due to the doping profile in any of the prior art references, did you? A. I did not.”); 212:19-213:1 (“Q. When you were analyzing the prior art references, you never calculated the magnitude for any of the electric fields, correct? A. I did not calculate those.”). Since Dr. Banerjee admitted that analysis of multiple forces are necessary to determine whether and in what direction carriers will move in a device, but failed to analyze those other forces, the Petition necessarily fails to demonstrate that the prior art teaches the claimed subject matter.

B. Petitioners advance a new theory and incorrect claim construction in their Reply.

Recognizing the deficiency in the Petition, Petitioners argue that, under a new claim construction, Dr. Banerjee did not need to analyze other forces. According to Petitioners, “carriers do not need to overcome any opposing forces before they

move” because carriers “are *constantly moving* (i.e., in “Brownian” motion) due to thermal effects.” Reply (Paper 55), 8. According to Petitioners, the claims are directed to constant random Brownian motion and Greenthread “misconstrue[ed] ‘carrier movement’ in the claims to mean *net movement of carriers*, i.e., net current.” Reply, 12 n. 8 (emphasis in original); *see also* Ex. 1060, ¶95.

Petitioners’ new theory and claim construction is procedurally improper and wrong. Nothing in the Petition discusses “Brownian” motion or says that the claims can be met because electrons are “constantly moving in random paths, due to thermal effects.” Ex. 1060, ¶19. All of this is new, and improper, in Petitioners’ Reply.

This argument was not something Greenthread could have anticipated. Despite years of litigation against a host of defendants and dozens of IPRs, no one has previously argued that the claims cover “Brownian” motion. The Board should decline to consider this novel theory. Since this undisclosed theory is apparently the basis of Dr. Banerjee’s testimony, the Board should disregard that as well. *M & K Holdings, Inc. v. Samsung Elecs. Co.*, 985 F.3d 1376, 1385 (Fed. Cir. 2021).

In addition to being procedurally infirm, Petitioners’ new theory and claim construction are implausible. Neither Petitioners nor Dr. Banerjee point to *anything* outside of Dr. Banerjee’s *ipse dixit* declaration to support their argument that “aid carrier movement” refers to Brownian motion. The specification is sensibly concerned with the movement of carriers as it affects the operation of a

semiconductor device. For example, specification speaks to “to sweep[ing] ... unwanted minority carriers from the active circuitry at the surface” and “accelerat[ing] towards the surface when programming of memory cells is executed.” Ex. 1001 at 14 (emphasis added). The specification does not discuss random Brownian motion.

Dr. Banerjee’s testimony confirms that random Brownian motion is irrelevant to the concerns recited in the specification. According to Dr. Banerjee, random electron motion in one direction is “counterbalanced by movement of carriers in the opposite direction.” Ex. 1060, ¶25. Thus, “[t]he random motion of electrons leads to zero net displacement of a group of electrons.” *Id.* at ¶19 (emphasis added). Petitioners do not explain how random motion that “will all cancel out” would be relevant to a POSITA or the issues recited in the specification. Ex. 2078, 246:1-2.

Dr. Banerjee also confirmed that a POSITA *would not* be concerned with Brownian motion, and *would* be concerned with net motion. During his deposition, Dr. Banerjee admitted that looking at individual carriers is “not the correct viewpoint.” Ex. 2078, 271:20-272:4. The contradiction between Dr. Banerjee’s deposition testimony on this point and the assertions in Dr. Banerjee’s supplemental declaration is startling. In his supplemental declaration, he said that “the claims do not speak to the net movement of carriers,” Ex. 1060, ¶95, but at his deposition he admitted that “You should look at the elect[ron] ensemble and what’s happening to

the center of gravity ... of the ensemble” (Ex. 2078, 271:20-272:4), because “*nobody can look at the trajectory of individual electrons or holes.*” Ex. 2078, 239:20-240:3.

Cirrus Logic’s 30(b)(6) witness, Scott Warrick, also testified to the opposite understanding of the claims from what Petitioners now assert. When asked about the effect of a doping gradient in one of Cirrus’ products, he did *not* mention Brownian motion. Mr. Warrick—like Dr. Banerjee during his deposition—referred to other forces and fields. Ex. 2056, 72:6-8, 95:2-5, 96:1-13. Petitioners argue that Mr. Warrick was confused, because “Greenthread never established” what part of the gradient Mr. Warrick was testifying about. Reply, 14. The argument is inconsistent with the record. Mr. Warrick was directed to a particular point in a specific page from Greenthread’s complaint and infringement contentions. Ex. 2056, 93:19-94:13. The videographer zoomed in on the relevant portion. *Id.* Mr. Warrick then testified that he understood that the particular point on the page was showing a dopant gradient. *Id.* There was no confusion.

Regardless, any confusion is irrelevant. According to Petitioners, *any* gradient aids random “Brownian” movement. If Mr. Warrick shared that understanding, mattered, he should have said that the gradient aided carrier movement—regardless of which gradient he was looking at. The fact that he could not say whether the gradient *in an accused product* met the “aid carrier movement” limitation shows that Petitioners have one claim construction for district court and another for the PTAB.

This is a classic “effort[] to twist claims, like a nose of wax, in one way” for validity and another for infringement, which the Board should reject. *Data Engine Techs., LLC v. Google LLC*, 10 F.4th 1375, 1381 (Fed. Cir. 2021).

Finally, two district courts have rejected Petitioners’ position. Rather than offering a reasoned disagreement with the courts’ opinions, Petitioners’ resort to obvious mischaracterizations. *See* Reply, 14-16. Regarding the WDTX order, Petitioners say that “sufficiently graded” “*may*” not refer to the magnitude of the slope. Reply, 15. But the very next sentence from the Court’s order contradicts that reading. The Court said it was referring to a “minimum graded concentration of dopants, i.e., a graded concentration of dopants that is below this minimum will not aid in the movement of minority carriers and thus is not a graded concentration.” Ex. 2074, 39-40.

The language from EDTX is equally clear. “[T]he slope [of the gradient] has both a direction and a magnitude and [d]efendant [*incorrectly*] suggests that the direction of the drift electric field depends solely on ***the direction*** of the slope of the graded concentration.” Ex. 2075, 15 (explaining that) (emphasis in original). If Petitioners had a sound basis to disagree with the district courts, they could have explained it. Their tactic of mischaracterizing the courts’ clear holdings shows that they have no support for their position.

C. The Petition fails under Petitioners’ “Brownian” claim construction.

Even under Petitioners’ new claim construction, Dr. Banerjee’s admissions doom the Petition. The claims require “[1] aid[ing] carrier movement [2] from the first surface to the second surface of the substrate.” As to [1], Dr. Banerjee claims that any electric field would necessarily aid the movement of electrons in Brownian motion. Ex. 2078, 210:16-17. But, when Dr. Banerjee addressed Brownian motion in his textbook, he took a different position. There, he said that “the force [of an electric field] may be insufficient to alter appreciably the random path of an individual electron.” Ex. 1062A, 99 (PDF page 50) (emphasis added). Dr. Banerjee does not explain this contradiction or how one could determine when an electric field would be sufficient to alter the random path of an electron. Since Dr. Banerjee fails to explain the contradiction in his two positions, his conclusions are unsupportable.

As to [2], Dr. Banerjee admitted that “[i]t’s not possible to find the starting point of any individual” carrier (Ex. 2078, 241:22-242:3) and “nobody can look at the trajectory of individual electrons or holes.” *Id.* at 239:20-240:3. If Dr. Banerjee cannot determine the location or path of travel of individual charge carriers, he cannot say whether they are in the “active region” (or “surface”) and whether they move “from” the active region (or surface). If Dr. Banerjee does not know that, Petitioners cannot carry their burden.

D. Petitioners’ “device claim” argument fails.

Petitioners claim that Greenthread “miscasts” its device claims as method claims. Reply, 17. Petitioners are incorrect. The Petition fails, because it does not grapple with physical properties of the prior art devices that affect whether they are “reasonably capable of operating so as to meet the claim limitations.” *ParkerVision, Inc. v. Qualcomm Inc.*, 903 F.3d 1354, 1361 (Fed. Cir. 2018). Greenthread is not arguing that the claims might be met in some modes of operation, but not met in others. Rather, Greenthread is pointing to aspects of the prior art devices that the Petition did not address, but which bear on whether the claim limitation is met. Since Petitioners bear the burden of proof, their failure to address relevant facts is fatal.

For example, Dr. Banerjee testified that the gate electrode and gate oxide on a transistor can create a countervailing electric field that would be present in the active region (or surface). Ex. 2078, 219:16-220:20, 222:19-22; 223:20-224:1. This field exists whether or not a voltage is applied to the gate. *Id.* at 222:4-13. These are “built-in” “structural” features of transistors, not modes of operation. *Id.* at 219:19-220:2. Dr. Banerjee did not consider the effect of these device components on the electric field created by the prior art dopant gradient. *Id.* at 224:2-8. Indeed, Dr. Banerjee admitted that it was *impossible* to conduct that analysis that with the information in the prior art. *Id.* By failing to consider how “built-in” “structural” features of the prior art work, Dr. Banerjee’s fails to answer the question whether

the prior art device was “reasonably capable of operating so as to meet the claim limitations.” *ParkerVision*, 903 F.3d at 1361.

The same logic applies to all of the factors affecting carrier movement that Dr. Banerjee failed to analyze. For example, he did not address the slope of the dopant gradient, the resistance of silicon, or whether the prior art would have “structural defects in the crystal.” Ex. 2078, 84:16-21. These are all permanent physical features of the prior art, relevant to how it would have been “capable of operating.” It is Petitioners’ burden to show how the prior art is “capable of operating,” but they chose to perform a narrow analysis focused on Greenthread’s supposed admissions. The result is a Petition that fails.

E. Dr. Banerjee has a previously undisclosed financial relationship with one of the Petitioners.

Dr. Banerjee, a university professor, depends on research funding from private industry for his career advancement. Ex. 2078, 29:4-7, 29:14-30:4. He said that obtaining research funding is “more important than being a good teacher.” *Id.* at 30:3-4.

Currently, Dr. Banerjee has only two active private grants. Ex. 2078, 44:13-19; Ex. 1004, 11. One those two grants—which is *not disclosed on his CV*—came from Texas Instruments (“TI”), who has paid Dr. Banerjee’s lab \$90,000, just this year. Ex. 2078, 46:22-47:7; Ex. 1004, 5-11. Greenthread is currently asserting the challenged patents against TI in parallel district court case. TI also has joined four

of Petitioners' seven IPRs and joined other IPRs covering all of the asserted patents. The conflict of interest is flagrant, but apparently was not a concern for Petitioners or Dr. Banerjee. He says he plans to pursue additional funding from TI. Ex. 2078, 49:15-50:1.

Dr. Banerjee has ample motive to color his testimony to favor his TI patron. This is not a close call. Dr. Banerjee said that his fundraising prowess is why he made tenure, and without such funding, he said his lab would "collapse." *Id.* at 49:15-50:8; *see also id.* at 29:4-7, 29:18-30:5. Moreover, Dr. Banerjee apparently changed his views on electron motion when drafting his supplemental declaration. His 2006 textbook says that individual electrons do not necessarily change their movement in response to an electric field. Ex. 1062A, 99 (PDF page 50). Now, Dr. Banerjee takes a different position—more favorable to TI—that individual electrons *always* move in response to any electric field.

His financial interests are not the only issue with Dr. Banerjee's credibility. At the beginning of his deposition, Dr. Banerjee said that he understood that coaching during breaks is not allowed. Ex. 2078, 7:12-22. Then, after Dr. Banerjee admitted to the enormous flaws in Petitioners' theories, he and Petitioners' lawyers took a 40 minute break. *Id.* at 339:1-20. When they returned, Petitioners conducted a leading re-direct, posing yes-no questions about whether Dr. Banerjee agreed with his declaration. *See, e.g., id.* at 313:19-314:2; 315:8-11; 318:22-319:2. When it came

time for do re-cross, Greenthread's counsel asked what Dr. Banerjee did during the break. Ex. 2078, 337:17-338:8. Dr. Banerjee testified that he spent half of the break conferring with Petitioners' counsel. *Id.* at 339:1-20. When counsel asked whether the consultation related to the substance of Dr. Banerjee's testimony, Petitioners' counsel asserted privilege and instructed him not to answer the questions. Ex. 2078, 339:21-345:18. Dr. Banerjee's plainly coached re-direct is improper and should be given no weight. *Flir Systems, Inc. v. Leak Surveys, Inc.*, IPR2014-00411, Paper 45, p. 7-8.

F. Kawagoe's graded dopant concentration does not "aid carrier movement from ... the active regions."

Kawagoe does not meet the "from ... the active regions" (or "surface") claim limitations. The Petition confirms that Kawagoe's alleged teaching about moving electrons "refers to electrons produced in the large substrate body below the wells." Pet., 32 n.10. The carriers Kawagoe discusses are "prevented from entering the p-well," and are thus below it. Response (Paper 47), 16. Since Petitioners also admit it is not proposing to modify Kawagoe (Reply, 21), Petitioners must show that [1] a gradient *in the active region* (or surface) of Kawagoe [2] creates an electric field in *the active region* (or surface) that [3] would move carriers downward *from that region*. Petitioners do not—and cannot—do that.

First, Dr. Banerjee said that there is not "enough information in Kawagoe to" calculate the electric field in Kawagoe's active region and that he didn't attempt to

do that. Ex. 2078, 211:7-13. Dr. Banerjee said that he can't determine the starting point of any electrons, so he cannot say whether any carriers move "from" the active region (or surface). *Supra* Section II(C).

Second, Petitioners cannot rely on a teaching about the electrons and electric field at the bottom of Kawagoe's p-well (i.e. the field "prevent[ing] [electrons] from entering the p-well") to reach a conclusion about electrons and fields at the top in Kawagoe's active region (or surface). According to Dr. Banerjee, an electric field outside the active region does not affect carriers in the active region. *See* Ex. 2078, 265:4-266:20 ("that electric field [in Kamins] doesn't extend all the way to the surface. Therefore, there cannot be any drift velocity of the holes due to that electric field."). Since Kawagoe has no teachings about the electric field in its active region (or surface), it fails to disclose the claim limitation.⁴

⁴ Greenthread has argued that "Kawagoe's electrons are in the wrong place." Petitioners mischaracterize this as suggesting that Kawagoe does not have carriers in the active region (or surface), because they cannot deny that the electrons *Kawagoe is discussing* are in the wrong place to provide the prior art teaching they need.

G. The Petition does not identify an “active region” in Kawagoe with a “second doping type.”

The active region in the transistor Petitioners mapped in Kawagoe is p-type. Response, 23. The substrate Petitioners mapped is also, p-type. *Id.* However, the claims require that the active region have doping *opposite* to the substrate. Hence, Petitioners’ mapping of Kawagoe fails to meet the claim limitations.

Petitioners now assert that the claim limitation is satisfied, because the source and drain have doping “opposite” the substrate. Reply, 24. That is incorrect. “[T]he source and drain are formed by counter-doping, *doping opposite the active region.*” Ex. 1069, 27:25-28:2 (emphasis added). The claims refer to the source and drain as a “device” and the active region as a “region,” with distinct doping. *Id.* at 28:11-19 (“Would you consider the source and drain part of the active region? ... A: ... The claim language describes transistors formed in at least one of the first active region or second active region. It describes the transistors as a device, and the active region is a region. So it’s sort of like apples and oranges.”).

Dr. Banerjee’s declaration supporting Petitioners is entirely conclusory and simply parrots their brief. His reading also renders the claim language requiring opposite doping types superfluous, because he concludes that *every* active region has both n and p doping. *See* Ex. 1060, ¶101.

As a fallback position, Petitioners argue that a *different* transistor in Kawagoe—not the one mapped in the Petition—would satisfy the claim limitations.

This is improper. *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d at 1381. Even if part of a prior art reference is discussed in the Petition, it cannot be used to satisfy a claim element when the Petition does not use it for that purpose. *Oren Techs., LLC v. Proppant Express Invs. LLC*, No. 2019-1778, 2021 WL 3120819, at *4 (Fed. Cir. July 23, 2021).

H. Greenthread’s supposed “admissions” do not support Petitioners.

Petitioners’ Reply repeats numerous strawmen from the Petition about Greenthread’s supposed admissions, all of which should be disregarded.

First, Petitioners argue that the examiner in a final office action stated that “any magnitude of the drift electric field, however small, reads on the claim” and that Greenthread did not dispute this representation. Reply, 3. But, in response to Examiner’s Final Office Action, Greenthread immediately filed a Notice of Appeal and conducted an interview. Ex. 1016, 149-150; 156-159. The examiner did not repeat the same argument in any subsequent Office Action. *See generally* Ex. 1016, 160-391. In fact, later in prosecution, the examiner noted that carrier movement “is affected by multiple forces and fields” which must be evaluated to determine whether a gradient would aid carrier movement. Ex. 1016, 270. The examiner did not argue that the claims *at issue here* read on any electric field.

Petitioners also claim that Greenthread “disagreed” with the Examiner’s statement that carrier movement is affected by multiple forces and fields. Reply, 3.

This is incorrect. Greenthread disagreed with the Examiner's conclusion that the claim at issue there (which never issued) should be rejected, but was not disagreeing with the relevant part of the Examiner's statement. A gradient is not the only force acting on a carrier, as Dr. Banerjee admits. *Supra* Section II(A). The other claim elements modify the gradient and are an "additional parameter" so that a gradient alone does not satisfy the claim limitation. Response, 13.

Further, even if Greenthread had disagreed with the Examiner, the Examiner never changed his position that a carrier "is affected by multiple forces and fields" besides the gradient. The claims that ultimately issued are different than the ones that were the subject of the relevant office action. Ex. 1016, 270. Estoppel only applies if "the party was successful in getting a court [or agency] to adopt its earlier position." *Sherwin-Williams Co. v. PPG Indus., Inc.*, No. 2022-2059, 2024 WL 3534113, at *9 (Fed. Cir. July 25, 2024). Greenthread cannot be estopped based on statements that failed to persuade the Examiner to adopt the position that Petitioners now attribute to Greenthread. *Solomon v. Overton's Inc.*, No. CIV.A. 2-02-CV-60TJW, 2003 WL 25782758, at *2 (E.D. Tex. Dec. 9, 2003) ("An applicant's arguments..., should they ultimately persuade the examiner, may inform the scope of the issued claims...) (emphasis added).

Further, Petitioners argue that Greenthread admitted that the claims do not require a "particular slope." Reply, 4. Again, Petitioners mischaracterize.

Greenthread has never argued that the claims require a particular slope, in the sense that only specific numerical values would satisfy the claims. The claims require a slope that will “aid carrier movement.” The value of that slope necessary to “aid carrier movement” will vary based on other factors, including the factors Petitioners failed to address in their Petitions. Two district courts have agreed with Greenthread that magnitude is relevant, without reading a “specific slope” into the claims. Ex. 2074 (WDTX *Markman* Order), 39-40; *Greenthread*, 2020 WL 1911200 at *9.

Petitioners argue that, in prosecution, Greenthread represented that “relative slope” means “nothing more than the fact that one-side is relatively lower than the other side.” Reply, 5 (citing Ex. 1070, 9). But Petitioners leave out the rest of what Greenthread said, that the relative slope is required to create “a suitable aiding drift electric field, to help the holes (minority carriers in a p-n-p transistor) traverse from emitter to collector.” Ex. 1070, 11. This is no different than the WDTX claim construction order, which says that the “graded concentration has to be sufficiently graded to result in a ‘static unidirectional electric drift field....’” Ex. 2074 (WDTX *Markman* Order), 39-40. Moreover, Dr. Banerjee agrees that the slope affects the strength of the electric field. Ex. 2078, 205:10-14.

Petitioners repeat their argument that Greenthread has said that “charge carriers will move.” Reply, 6-7. The quote comes from the background section of a claim construction brief, where Greenthread was explaining a phenomenon called

“carrier drift.” Ex. 1020, 2. *By definition*, carrier drift *is* carrier movement. Ex. 2057, ¶33.⁵ Greenthread’s explanation, therefore, assumed the conditions under which carrier drift occurred. Greenthread was not saying that a gradient could cause drift even if other forces overwhelmed the gradient. No reasonable reader would construe Greenthread’s statements as Petitioners do. Greenthread included the identical statement that “carriers will move” in a claim construction brief, and the District Court did not construe Greenthread’s statements as Petitioners do. Ex. 1020, 2. Rather, the Court said, consistent with Greenthread’s argument here, that “the graded concentration has to be sufficiently graded” to cause movement. Ex. 2074 (WDTX *Markman* Order), 39.

Petitioners again suggest that Greenthread has said that the claims do not require any particular result. Reply, 7. Again, Petitioners mischaracterize. Greenthread said “the claims require that the graded dopants create an electric field that aids movement of the carriers.” Ex. 1020, 37. Petitioners failed to analyze the

⁵ The textbook cited in the Petition confirms that drift is a category of carrier movement. Ex. 1008B, 143 (“Some of these electrons...will drift out...”); Ex. 1008C, 34 (“electrons are likewise drifted toward the surface”); 116 (“carrier transport in the channel by both drift and diffusion current”); 194 (“The current at the drain is given by the product of the carrier density and the drift velocity.”).

facts necessary to determine whether the prior art met those claim limitations, but that does not mean that the claim limitations can be disregarded.

Petitioners likewise mischaracterize Greenthread’s wheelchair ramp analogy. Reply, 7. A ramp can have many slopes and still “aid movement,” but a ramp that’s covered in snow or ice does not “aid movement.” Petitioners’ blinkered approach to dopant gradients is like saying a ramp aids movement because it has some (unknown) slope, without asking whether the ramp is blocked.

Petitioners repeat the argument that Patent Owner admitted that an “inherent ‘built-in’ unidirectional electric field” that moves carriers. But Petitioners do not address the rest of Greenthread’s statement. Greenthread added that the movement of carriers “[d]epend[s] on the particular slope of the graded concentration of dopant[s].” Ex. 1016, 289. Greenthread’s statements go to the *sufficiency* of dopant grading to achieve aiding carrier movement.

I. Greenthread’s supposed “admissions” do not justify Petitioners’ new claim construction.

As explained above, Greenthread’s supposed admissions are simply Petitioners’ mischaracterizations. Regardless, they can be disregarded. Petitioners are essentially attempting a reverse prosecution history disclaimer to broaden the claims beyond their plain and ordinary meaning to encompass the prior art, which the Federal Circuit rejects. Prosecution history is not the best source for determining the meaning of claim language. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1317 (Fed.

Cir. 2005). And representations during prosecution cannot enlarge the claims. *Biogen, Inc. v. Berlex Lab'ys, Inc.*, 318 F.3d 1132, 1140 (Fed. Cir. 2003). Greenthread is not “dismissing the importance prosecution history generally,” (Reply, 4) but simply stating the law regarding how prosecution history should be applied in claim construction. Petitioners may disagree with the law, because it does not help their case, but it is still the law.

Second, even if the Board is inclined to treat Greenthread’s statements as “admissions,” those “admissions” must be weighed against Petitioners’ admissions, including Dr. Banerjee’s statement that “vector sum” is what controls carrier movement for “aid carrier movement.” *Supra* Section II(A). Petitioners bear the burden of proof. Therefore, Petitioners’ admissions are the ones that matter.

J. Petitioners’ Wieczorek-Wolf grounds fail.

Wieczorek does not say that the dopant gradient it discloses has any effect on carriers at all. Ex. 2057, ¶¶56-57. Dr. Banerjee did not cite to any portion of Wiecezorek to show that Wiecezorek’s graded dopant would move carriers in any way. Ex. 1003, ¶¶159-163; Ex. 2057, ¶56; *see generally* Ex. 1060. Nor did he calculate the slope or magnitude of any cited reference. Ex. 2078, 212:19-213:1.

Dr. Banerjee admitted that a flat or non-graded dopant concentration would not create any electric field. *Id.* at 260:6-13 (“There should not be any built-in electric fields in that flat region.”); 209:5-9. Wiecezorek, in fact, does not have a

graded dopant concentration in the active region (or surface). For doping at the active region/surface, Wieczorek says the doping “profile in the vicinity of the surface of the semiconductor device 100, as indicated by reference number 200, may have become substantially uniformly distributed.” Ex. 1006, ¶11 (emphasis added). By Dr. Banerjee’s own admission, Wieczorek cannot have an electric field from the flat dopant concentration to aid carrier movement from the active region/surface.

K. Greenthread’s specification discusses relative slope.

In an institution decision in a parallel IPR, the Board stated that “Patent Owner does not direct us to any discussion in the [specification] regarding a specific slope value that is necessary to ‘aid the movement of minority carriers.’” IPR2024-00265, Paper 22, 19. To the contrary, the Greenthread’s specification does disclose specific slopes, as Petitioners admit. Reply, 5 (“The specification also provides exemplary gradient slopes”). Greenthread cited that disclosure in its PO Response. Response, 8-9.

L. Objective indicia of non-obviousness support patentability.

Petitioners do not dispute that [REDACTED] and [REDACTED] approached Greenthread on through RPX and collectively paid \$10 million for licenses to the single family of patents at issue when they were under no threat of litigation. Ex. 2072, 2. The obvious inference is that the companies evaluated Greenthread’s patents and found them valuable. Petitioners offer no plausible alternative explanation for these

[REDACTED]

transactions. There is no evidence that either [REDACTED] or [REDACTED] ever read RPX's marketing materials, much less that they paid large sums of money to avoid litigation that was never threatened. Paying money for a patent license, when no litigation is threatened only makes sense if the licensee thinks the patent is valid and valuable. A company that paid money for invalid patents that posed no litigation risk would quickly go out of business.

The fact that Greenthread signed a license with [REDACTED] is irrelevant. That license *was* the result of litigation and [REDACTED] filing seven IPRs. Like patent challengers, patent owners consider litigation risk. Moreover, the license recites [REDACTED] sales of potentially infringing products in the U.S. Ex. 2072, 103. Given the volume of sales compared to Greenthread's other licensees, the license confirms the value of Greenthread's patents.

Finally, Petitioners' assertion that Dr. Rao did not write his declaration is irrelevant—and ironic. Dr. Rao testified that he confirmed all of the facts in his declaration and signed the same one that Greenthread's former President, Phil John, signed in related proceedings, because [REDACTED] and cannot testify. Ex. 1066, 44:17-18. By contrast, Petitioners' expert, Dr. Banerjee testified that *his* declaration was written by another expert from a prior IPR and that he failed to verify what he signed. Ex. 2058 at 54:5-17; 56:14-21; 57:13-58:5, 125:9-126:1. If any testimony is disregarded, it should be Dr. Banerjee's.

M. These proceedings are unconstitutional.

Petitioners did not address the constitutionality of these proceedings under the non-delegation doctrine. *See generally* Response, 61-63. Since Petitioners have waived their right to respond, the Petition should be dismissed.

III. CONCLUSION

For the foregoing reasons, the challenged claims should be held to be patentable over the cited art and grounds presented in the IPR proceeding.

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Respectfully submitted,

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. §42.24(d), Patent Owner hereby certifies that the word count for the foregoing **PATENT OWNER’S SUR-REPLY** is 5,585 words, which is within the 5,600 word limit set in 37 C.F.R. §42.24(c)(4). This word count does not include the table of contents, table of authorities, exhibit list, certificate of word count, and certificate of service. This word count was prepared using Microsoft Word.

Dated: December 19, 2024

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CERTIFICATION OF SERVICE

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