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Paper 48
Date: December 18, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

JIANGU SMARTSENS TECHNOLOGY CO., LTD. AND
SMARTSENS TECHNOLOGY (US) INC.,
Petitioner,

v.

OMNIVISION TECHNOLOGIES, INC.,
Patent Owner.

IPR2019-01263
Patent 7,145,122 B2

Before MICHAEL P. TIERNEY, *Vice Chief Administrative Patent Judge*, CHRISTOPHER L. CRUMBLEY, and SHELDON M. McGEE, *Administrative Patent Judges*.

CRUMBLEY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Original Claims Unpatentable
Granting-in-Part Patent Owner's Motion to Amend
Denying Patent Owner's Motion to Exclude
35 U.S.C. § 318(a); 37 C.F.R. § 42.64(c)

I. INTRODUCTION

In this *inter partes* review, instituted pursuant to 35 U.S.C. § 314, Jiangu Smartsens Technology Co., Ltd. and Smartsens Technology (US) Inc. (collectively, "Petitioner") challenge the patentability of claims 1–30 of U.S. Patent No. 7,145,122 B2 (Ex. 1001, "the '122 patent"), owned by OmniVision Technologies, Inc. ("Patent Owner"). Patent Owner proposes substitute claims 31–60, to be entered if we find claims 1–30 unpatentable.

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses issues and arguments raised during trial. For the reasons discussed below, we determine that Petitioner has shown by a preponderance of the evidence that claims 1, 2, 4–12, 14–22, and 24–30 of the '122 patent are unpatentable, but has not met its burden as to claims 3, 13, or 23. We grant Patent Owner's motion to amend as to proposed substitute claims 31, 32, 34–42, 44–52, and 54–60, but do not reach proposed substitute claims 33, 43, or 53.

A. Procedural History

On June 24, 2019, Petitioner requested an *inter partes* review of claims 1–30 of the '122 patent. Paper 3 ("Pet."). Patent Owner filed a Preliminary Response. Paper 7. On December 20, 2019, we instituted an *inter partes* review of the challenged claims. Paper 15 ("Decision on Institution" or "Dec. on Inst."). Following institution, Patent Owner filed a Patent Owner Response (Paper 17, "PO Resp."), Petitioner filed a Reply (Paper 26, "Pet. Reply"), and Patent Owner filed a Sur-Reply (Paper 32, "PO Sur-Reply").

Patent Owner also filed a contingent Motion to Amend, requesting entry of proposed substitute claims 31–60 if we were to determine that originally issued claims 1–30 were unpatentable. Paper 19. Petitioner filed an Opposition (Paper 25), and we issued a Preliminary Guidance as to the Motion to Amend. Paper 28. In response, Patent Owner filed a Revised Motion to Amend requesting entry of revised proposed substitute claims 31–60 (Paper 30, "Mot. Amend"), Petitioner filed an Opposition (Paper 34, "Opp. Amend"), Patent Owner replied (Paper 40, "Amend Reply"), and Petitioner sur-replied (Paper 45, "Amend Sur-Reply").

Petitioner relied upon the declaration testimony of R. Michael Guidash (Ex. 1008) to support the Petition. Petitioner submitted additional declarations of Mr. Guidash with its Reply and Opposition to the Motion to Amend (Ex. 1018) and with its Opposition to the Revised Motion to Amend. (Ex. 1028). Patent Owner took cross-examination of Mr. Guidash via deposition on three occasions and submitted the transcripts (Exs. 2004, 2017, 2025). Patent Owner relied upon the declaration testimony of Albert Theuwissen (Ex. 2010) to support its Response and Motion to Amend, submitted a second declaration of Dr. Theuwissen in support of its revised Motion to Amend (Ex. 2018), and submitted a third declaration of Dr. Theuwissen (Ex. 2026) along with its Reply on the revised Motion to Amend. Petitioner took cross-examination of Dr. Theuwissen via deposition and submitted the transcript (Ex. 1026).

Patent Owner filed a Motion to Exclude, seeking to exclude from the record Exhibits 1004 and 1017, and all expert testimony based thereon. Paper 42, "Mot. Exclude." Petitioner filed an Opposition (Paper 43, "Opp. Exclude") and Patent Owner filed a Reply (Paper 46, "Exclude Reply").

Oral hearing was requested by both parties. Papers 36, 37. We heard argument on October 19, 2020, and a transcript of the hearing has been entered into the record. Paper 47 ("Tr.").

B. Related Proceedings

Both parties confirm that there is no pending litigation involving the '122 patent. Pet. 3; Paper 5, 2.

C. The '122 Patent

The '122 patent, entitled "Imaging Sensor Using Asymmetric Transfer Transistor," issued December 5, 2006, from an application for patent filed June 14, 2004. Ex. 1001, [22], [45], [54]. The '122 patent describes imaging sensors based on complementary metal oxide semiconductor (CMOS) technology, wherein incident light is collected by photodiodes arranged in an array of pixels. *Id*. at 1:23–25. The incident light is converted into electrons which are collected in a potential well, and which at some point in time are then converted into a signal that is used to generate an image. *Id*. at 1:40–43.

Figure 1 of the '122 patent depicts a prior art CMOS image sensor pixel and its supporting circuitry:

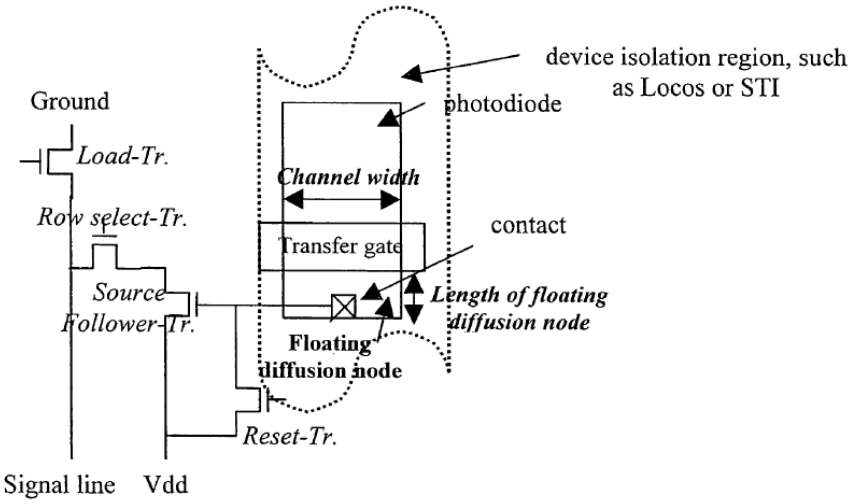


FIG. 1

The prior art pixel depicted in Figure 1 comprises a photodiode, a transfer gate, and a floating diffusion node. *Id*. at 3:12–15. Surrounding these elements is a device isolation region which insulates the pixel from interference by adjoining pixels. *Id*. According to the '122 patent, prior art pixels had widely-spread depletion regions on both sides of the floating diffusion node, which caused considerable performance degradation because of large parasitic capacitance for the floating diffusion node. *Id*. at 3:16–23. The '122 patent proposes to address these problems by reducing the capacitance of the floating diffusion node, thus improving the sensitivity of the image sensor. *Id*. at 2:48–51.

The '122 patent purports to achieve these goals by modifying the geometry of the pixel components, such that the channel width of the floating diffusion node is different than the channel width of the photodiode. *Id*. at 3:48–50. In one embodiment, depicted in Figure 3 of the patent, the channel width of the floating diffusion node is less than the channel width of the photodiode:

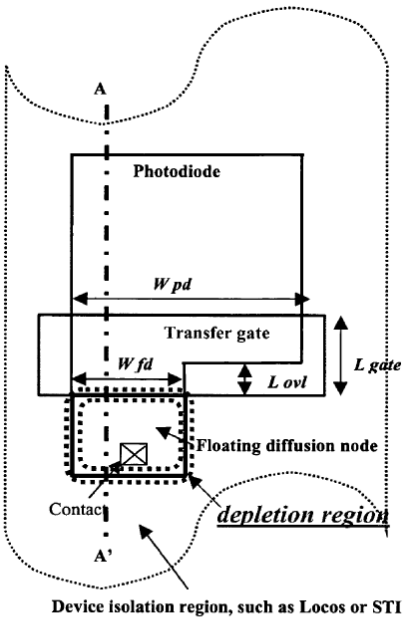


FIG. 3

Figure 3 of the ’122 patent depicts a photodiode having channel width W_{pd}, and floating diffusion node having channel width W_{fd}. The patent also discloses that the device isolation must overlap with the transfer gate, but that the overlap length L_{ovl} is less than the transfer gate length L_{gate}. *Id*. at 4:13–16. The ’122 patent states that device performance is unaffected by the position of the floating diffusion node relative to the photodiode; in another embodiment of the patent, shown in Figure 4, the floating diffusion node is disposed closer to the center of the photodiode. *Id*. at 3:51–62.

In another embodiment of the ’122 patent, the channel width of the floating diffusion node is greater than the channel width of the photodiode. *Id*. at 4:54–56, Fig. 8. The patent states that this arrangement is effective in lowering noise and image lag. *Id*. at 4:63–66.

D. The Challenged Claims

Petitioner challenges claims 1–30 of the '122 patent, of which claims 1, 11, and 21 are independent. Claim 1, reproduced below, is illustrative of the subject matter of the challenged claims:

> 1. A solid-state imaging apparatus, comprising:
>
> a semiconductor substrate;
>
> a device isolation region formed on the semiconductor substrate;
>
> a photoelectric conversion element surrounded by the device isolation region and having a first channel width;
>
> a detection section surrounded by the device isolation region and having a second channel width different than the first channel width; and
>
> a transfer gate having a transfer gate length and positioned between the photoelectric conversion element and the detection section, wherein the transfer gate overlaps with the device isolation region to define an overlap length in the direction of the transfer gate length, the overlap length being less than the transfer gate length.

Ex. 1001, 5:32–47.

Claims 11 and 21 are substantively similar to claim 1, with claim 11 reciting a "CMOS imaging sensor" in its preamble in place of the "solid-state imaging apparatus" of claim 1. *Id*. at 6:7–24, 6:51–64. Claim 21 is structurally the same as claim 1, but uses slightly different terminology (e.g., "active pixel" instead of "solid-state imaging apparatus," "photoelectric element" instead of "photoelectric conversion element"). *Id*. at 6:51–64. The parties do not separately argue the independent claims or distinguish their scopes in any way. To the extent our analysis herein focuses on claim 1, it should be understood to apply equally to the other independent claims.

Claims 2–10 depend from claim 1, while claims 12–20 depend from claim 11 and claims 22–30 depend from claim 21. Each of the three sets of

dependent claims is identical; in other words, the added limitation of claim 2 is the same as that added by claims 12 and 22. Neither party argues the sets of dependent claims individually, and our analysis herein as to claims 2–10 should be understood to apply equally to claims 12–20 and 22–30.

E. The Proposed Substitute Claims

Patent Owner's Revised Motion to Amend proposes substitute claims 31–60 to replace original claims 1–30 if they are found unpatentable. Mot. Amend 2–3. Claim 31 replaces claim 1, claim 41 replaces claim 11, and claim 51 replaces claim 21. *Id*. The proposed substitute dependent claims follow the dependencies of the original dependent claims. *Id*.

Proposed substitute claim 31 is illustrative of the amendments to the claims:

> 31. A solid-state imaging apparatus, comprising:
>
> a semiconductor substrate;
>
> a device isolation region <u>comprising dielectric material</u> formed on <u>and extending into</u> the semiconductor substrate;
>
> a photoelectric conversion element surrounded by the device isolation region and having a first channel width;
>
> a detection section surrounded by the device isolation region and having a second channel width different than the first channel width <u>and extending into the semiconductor substrate</u>; and
>
> a transfer gate having a transfer gate length and positioned between the photoelectric conversion element and the detection section, wherein the transfer gate overlaps with the device isolation region to define an overlap length in the direction of the transfer gate length, the overlap length being less than the transfer gate length<u>, and</u>
>
> <u>wherein the dielectric material abuts at least a periphery of the detection section, extends into the semiconductor substrate at a depth that is greater than that of the detection section, and is</u>

> omitted where the detection section allows for charge transfer.

Id. at Appx. A, 1.

F. Instituted Grounds

We instituted an *inter partes* review of all claims challenged in the Petition on the following grounds of unpatentability:

Claims Challenged	**35 U.S.C. §[1]**	**Reference(s)**
1, 2, 4–7, 10–12, 14–17, 20–22, 24–27, 30	102(a)	KR '197[2]
3, 13, 23	103(a)	KR '197 "in view of the knowledge of a person having ordinary skill in the art"
8, 9, 18, 19, 28, 29	103(a)	KR '197, He[3]
1, 2, 4–7, 9–12, 14–17, 19–22, 24–27, 29–30	103(a)	Lee '767,[4] Lee '666[5]

[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284 (September 16, 2011), included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Because the '122 patent issued from an application filed before March 16, 2013, we apply the pre-AIA versions of the statutory bases for unpatentability.

[2] Korean Patent Publication No. 2004-0029197 to Lee, published April 6, 2004 (Ex. 1004). Petitioner filed an English translation of the reference as Ex. 1017, and Patent Owner filed its own English translation of the abstract as Ex. 2001. Unless the parties indicate a relevant substantive difference between the translations, we refer herein to Ex. 1017.

[3] U.S. Patent No. 6,462,365 B1 to He et al., issued October 8, 2002 (Ex. 1007).

[4] U.S. Patent Application Publication No. 2002/0008767 A1 to Lee, published January 24, 2002 (Ex. 1005).

[5] U.S. Patent Application Publication No. 2003/0127666 A1 to Lee, published July 10, 2003 (Ex. 1006).

Claims Challenged	35 U.S.C. §[1]	Reference(s)
3, 13, 23	103(a)	Lee '767, Lee '666, "in view of the knowledge of a person having ordinary skill in the art"
8, 18, 28	103(a)	Lee '767, Lee '666, He

Pet. 4. Petitioner alleges that KR '197 and Lee '666 are prior art to the '122 patent under 35 U.S.C. § 102(a), while Lee '767 and He are prior art under § 102(b). *Id.* at 10, 12, 13, 15. Patent Owner disputes that KR '197 is prior art to the '122 patent, but does not otherwise challenge the prior art status of the asserted references.

II. MOTION TO EXCLUDE

Patent Owner's Motion to Exclude seeks to exclude Exhibits 1004 and 1017, which are Korean-language and English translations of the KR '197 references, as well unspecified portions of "all expert testimony based thereon." Mot. Exclude 3. Patent Owner's objections arise from the fact that the originally-filed version of KR '197 was inadvertently accompanied by a machine translation, instead of a certified English translation. *Id*. at 1. We previously summarized and addressed these objections in our Order granting Petitioner's Motion to Correct the Petition (Paper 14), and need not repeat them herein. Patent Owner's Motion to Exclude does not raise new objections to this correction, and notes that it is "submitted to preserve Patent Owner's objections of record." Mot. Exclude. 1.

To the extent Patent Owner's arguments are coextensive with those made in connection with its opposition to the Motion to Correct, we find them no more persuasive that we did when we granted the Motion to Correct. In addition, the arguments made by Patent Owner do not appear to be of the kind that are appropriate in a Motion to Exclude, which is intended

to address the *admissibility* of evidence before the Board, as opposed to procedural objections. *See* Consolidated Trial Practice Guide[6] at 7–8 (Nov. 21, 2019) ("[T]he parties will be authorized to file motions to exclude evidence believed to be inadmissible. Admissibility of evidence is generally governed by the Federal Rules of Evidence."). Indeed, we note that Patent Owner's Motion does not include any citation to the Federal Rules of Evidence, or any allegation that the objected-to exhibits are inadmissible.

For these reasons, we *deny* Patent Owner's Motion to Exclude.

III. UNPATENTABILITY OF ORIGINAL CLAIMS

A. Claim Construction

For petitions such as this one, filed after November 13, 2018, claims "shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b)," which is articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (amending 37 C.F.R. § 42.100(b) effective November 13, 2018) (now codified at 37 C.F.R. § 42.100(b) (2019)). Under the *Phillips* standard, the "words of a claim 'are generally given their ordinary and customary meaning,'" which is "the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective filing date of the patent application." *Phillips*, 415 F.3d at 1312–13 (quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996). Only those terms in controversy need to be construed and only to the extent necessary to resolve the

[6] *Available at* https://www.uspto.gov/TrialPracticeGuideConsolidated

controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

In our Institution Decision, we determined that no term of the challenged claims required an express construction. Dec. on Inst. 8. During trial, the parties' dispute focused on the meaning of the phrase "surrounded by the device isolation region," and we address the proper construction of this term below. We have reviewed all remaining constructions proposed by Petitioner and Patent Owner and determine that resolution of this matter does not require construction of any other term. To the extent any term of the proposed substitute claims requires construction, we discuss it below in the context of the Motion to Amend.

Surrounded by the device isolation region

In our Institution Decision, we noted that the parties appeared to dispute whether the detection region of KR '197 is surrounded by a device isolation region. Dec. on Inst. 18. But we noted that neither party had proposed an express construction for "surrounded by," and the '122 patent provided no explicit definition. *Id*. On the record at the time, and in the absence of briefing as to the meaning of "surrounded by" in the context of the patent, we were "unwilling to conclude that the field oxide film of KR '197 does not 'surround' the floating diffusion region[7] FD, as that term is used in the '122 patent." *Id*. at 18–19.

In its Response, Patent Owner contends that "surrounded by the device isolation region" means "abutting the device isolation region on all

[7] As discussed below, Petitioner identifies the floating diffusion node of KR '197 as corresponding to the detection region of the claims.

sides except where the photoelectric conversion element or detection node connects to a gate." PO Resp. 23 (citing Ex. 2010 ¶ 92) (emphasis omitted). Petitioner counters that the term does not require "abutting," and that the plain and ordinary meaning of "surrounded by the device isolation region" is that "the device isolation region encircles the [photodiode/floating diffusion node], except for the region(s) where charge must flow." Pet. Reply 1–2 (emphasis omitted). The primary distinction between the parties' constructions, therefore, is whether a region that is "surrounded by" another region requires that those two regions abut each other, or if it is merely sufficient for one to encircle the other.

Starting with the '122 patent itself, neither party argues that the context of the claim language provides any indication as to the meaning of the term. Rather, the parties focus on a passage from the written description which is the only instance of "surrounded by" used in the patent outside the claims. That passage reads:

> In the embodiments illustrated in FIGS. 3 and 4, since the floating diffusion node is surrounded by the device isolation region such as Locos or STI, the depletion region does not expand beyond the isolation region, specifically, in the direction of the transfer gate width. Thus, parasitic capacitance between transfer gate and floating node is effectively decreased.

Ex. 1001, 4:4–10. Figures 3 and 4, referenced in the passage, depict:

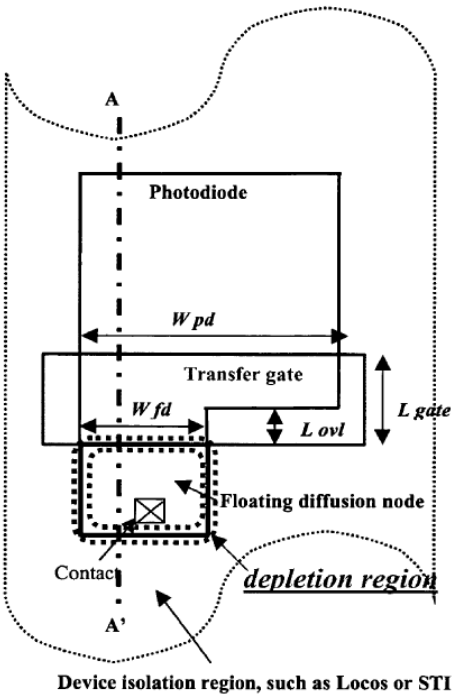


FIG. 3

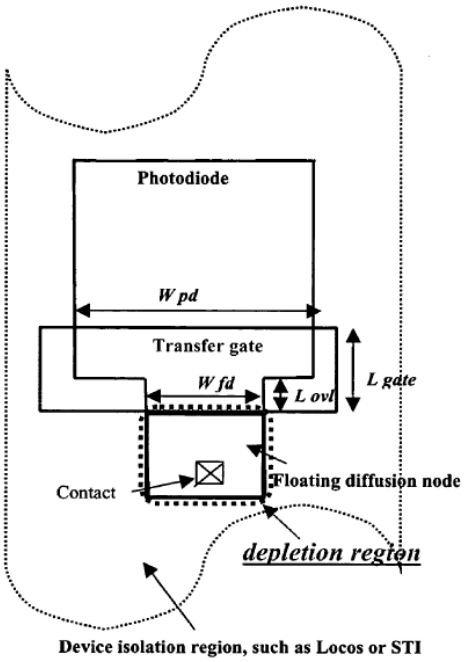


FIG. 4

Figures 3 and 4 depict a floating diffusion node "surrounded by" the device isolation region. Petitioner notes that these embodiments are contrasted with the prior art device depicted in Figure 2, which has "widely spread depletion regions, coupled with the transfer gate, [that] will create large parasitic capacitance for the floating diffusion node, causing considerable performance degradation." Pet. Reply 4 (citing Ex. 1001, 3:20–23). According to Petitioner, this indicates that the decrease in parasitic capacitance that is the goal of the '122 patent can be achieved by "simply shrinking the size of the depletion region," and that abutment of the floating diffusion node to the device isolation region is not indicated as required to reduce capacitance. *Id*. Petitioner notes that Figures 3 and 4 in fact show, through placement of a dashed line, that the depletion region extends beyond the floating diffusion node and prevents abutment with the device isolation region. *Id*. at 5–6.

Patent Owner directs us to Figures 7A and 7B of the '122 patent, which allegedly show that in Figure 3 the depletion region is reduced by having the floating diffusion node abut the isolation region barrier. PO Resp. 23–34.

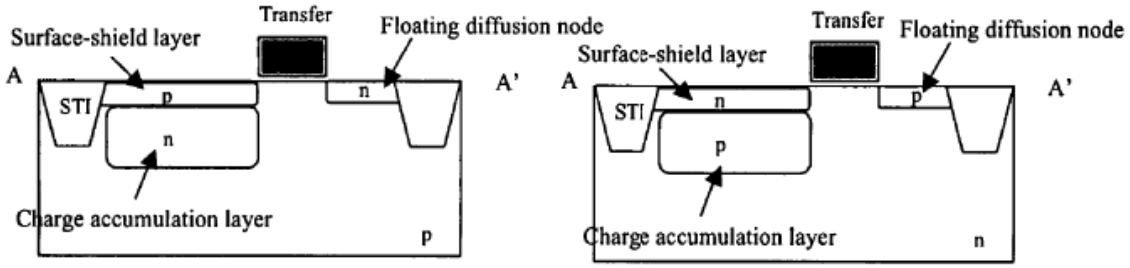
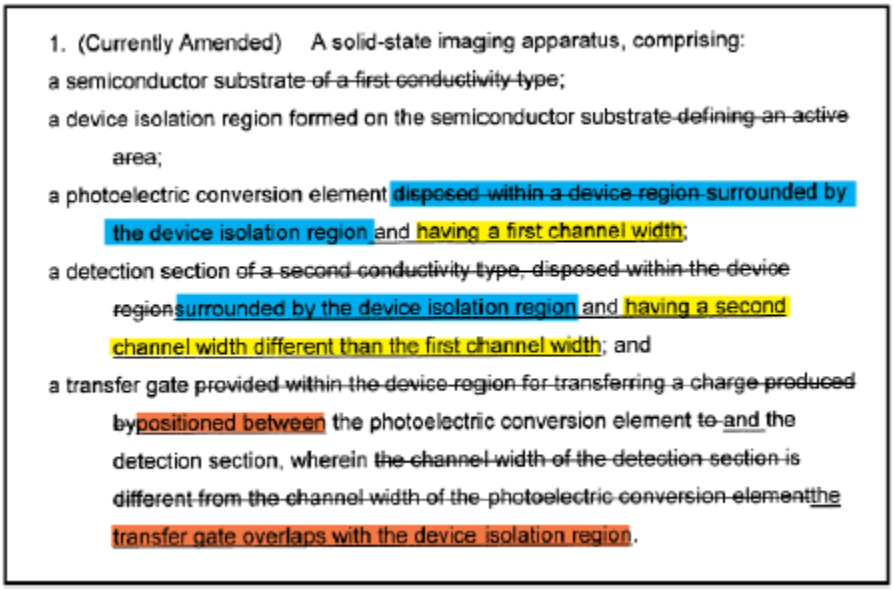


FIG. 7A *FIG. 7B*

Figures 7A and 7B of the '122 patent are "schematic diagrams" of two possible cross-sectional views along the line A-A' in Figure 3. Ex. 1001, 4:41–42. The figures depict a floating diffusion node abutting an STI device isolation region (unlabeled). *Id.* Petitioner, citing Mr. Guidash, counters that these cross-sectional views are referred to as "schematic diagrams," meaning they "only show[] general concepts, and are not representative of the actual, detailed physical structures of the image sensor." Pet. Reply 9 (citing Ex. 1018 ¶ 25).

Both parties also direct us to the prosecution history of the '122 patent. Patent Owner notes that claim 1 of the patent was amended during prosecution from "disposed within a device region surrounded by the device isolation region" to simply "surrounded by the device isolation region." PO Resp. 24 (citing Ex. 1002, 44–51). According to Patent Owner, this amendment "demonstrates a clear intent to not merely have the combination to be within a space overall confined by a device isolation barrier." *Id.*

Petitioner contends that Patent Owner reads too much into a "non-descript claim amendment." Pet. Reply 10. Petitioner explains that the amendment indicated by Patent Owner was made to overcome a rejection in light of Miyagawa (Ex. 1003), and the language change indicated by Patent Owner was only part of the amendment, as shown in the following highlighted annotations:



1. (Currently Amended) A solid-state imaging apparatus, comprising:
a semiconductor substrate ~~of a first conductivity type~~;
a device isolation region formed on the semiconductor substrate ~~defining an active area~~;
a photoelectric conversion element ~~disposed within a device region surrounded by~~ the device isolation region and having a first channel width;
a detection section ~~of a second conductivity type, disposed within the device region~~surrounded by the device isolation region and having a second channel width different than the first channel width; and
a transfer gate ~~provided within the device region for transferring a charge produced by~~positioned between the photoelectric conversion element ~~to~~ and the detection section, wherein ~~the channel width of the detection section is different from the channel width of the photoelectric conversion element~~the transfer gate overlaps with the device isolation region.

Id. at 11. Petitioner highlights an excerpt from page 46 of Exhibit 1002 showing an amendment to claim 1, with blue highlights showing the portion of the amendment cited by Patent Owner. Petitioner contends that the applicant's argument to overcome the Examiner's rejection was based on the contention that Miyagawa did not disclose an overlap with the device isolation region, and the amendments to the claims highlighted in orange were intended to distinguish over the prior art. *Id*.. According to Petitioner, the yellow- and blue-highlighted amendments, including the "surrounded by" amendment cited by Patent Owner, is merely "necessary to put the orange edits in context." *Id*. Petitioner observes that the prosecution history

contains no discussion of "surrounded by" or suggestion that the term has anything to do with abutment. *Id*. at 12.

Upon review, we decline to import into the claim any requirement that the device isolation region must abut the detection region. We do not find sufficient evidence to conclude that the ordinary meaning of "surrounded by" requires abutment, or that there was special usage of the term in the field of art that a person of ordinary skill in the art would understand. Nor does the written description of the '122 patent provide clear evidence that the patentee intended to act as his or her own lexicographer, by redefining the term with the "clarity, deliberateness, and precision" required. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). The passage that Patent Owner relies so heavily upon (Ex. 1001, 4:4–10) merely describes an embodiment shown in Figures 3 and 4, as opposed to defining the scope of the invention as a whole. And in any event, the passage uses "surrounded by" to refer to the fact that the "depletion region does not expand beyond the isolation region," which does not directly define anything about the detection region—an entirely different region than the "depletion region" mentioned in the phrase. We decline to find this sort of implicit reference to rise to the level of clear lexicography.

Nor are we persuaded by the prosecution history that the phrase "surrounded by" was used to distinguish over the prior art. We agree with Petitioner that there were multiple amendments to the claims made at the same time in response to the rejection over Miyagawa, and that the applicant's arguments were focused on whether Miyagawa showed overlap between the regions, not whether one region was surrounded by another. Even if "surrounded by" had been a reason for overcoming the Miyagawa

rejection, however, there is no clear evidence that a definition requiring abutment was contemplated by either the Examiner or the applicant.

For these reasons, we decline to adopt Patent Owner's proposed construction of "surrounded by" that would require one region to abut the other, without any intervening regions. That said, we are also hesitant to adopt Petitioner's proposed construction that requires only that one region encircle the other, because it places no restriction on the distance at which such encircling takes place. The plain and ordinary meaning of "surrounded by" is that one thing encircles another thing, but also implies some degree of proximity between the regions. Nevertheless, because there is no dispute that, even if the regions at issue here are not abutting, they are in close proximity, we need not reach the question of the degree of proximity required.

B. Level of Ordinary Skill in the Art

Factors pertinent to a determination of the level of ordinary skill in the art include "(1) the educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) educational level of workers active in the field." *Envtl. Designs, Ltd. v. Union Oil Co*., 713 F.2d 693, 696–697 (Fed. Cir. 1983) (citing *Orthopedic Equip. Co. v. All Orthopedic Appliances, Inc.,* 707 F.2d 1376, 1381–82 (Fed. Cir. 1983)). Not all such factors may be present in every case, and one or more of these or other factors may predominate in a particular case. *Id*. Moreover, "[t]hese factors are not exhaustive but are merely a guide to determining the level of ordinary skill in the art." *Daiichi Sankyo Co. v. Apotex, Inc*., 501 F.3d 1254, 1256 (Fed. Cir. 2007). In determining a level

of ordinary skill, we also may look to the prior art, which may reflect an appropriate skill level. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). Additionally, the Supreme Court informs us that "[a] person of ordinary skill is also a person of ordinary creativity, not an automaton." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007).

To establish the level of ordinary skill, Petitioner relies on the Declaration of Mr. Guidash. Pet. 15–16 (citing Ex. 1008 ¶¶ 61–62). Mr. Guidash testifies that a person having ordinary skill in the art would have at least a bachelor's degree in electrical engineering or a related field, as well as two to three years of experience designing, manufacturing, and/or testing image sensors. Ex. 1008 ¶ 61. Dr. Theuwissen defines the person of ordinary skill as having a bachelor's degree in electrical engineering, physics, or a related field and four or more years of experience in image sensor design. Ex. 2010 ¶ 53. The experts' definitions of the level of skill are not appreciably different, nor do the parties make any argument that relies on a dispute regarding the level of skill. We adopt the level of skill as defined by the parties' experts.

C. Principles of Law

To prevail in challenging Patent Owner's claims, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e) (2012); 37 C.F.R. § 42.1(d). In order to find a claim anticipated, we must find not only that all elements of a claim are disclosed within the four corners of a single prior art reference, but that the elements are "arranged as in the claim." *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008).

A claim is unpatentable under 35 U.S.C. § 103 if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR*, 550 U.S. at 406. The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when available, evidence such as commercial success, long felt but unsolved needs, and failure of others. *Graham v. John Deere Co*., 383 U.S. 1, 17–18 (1966); *see also KSR*, 550 U.S. at 407 ("While the sequence of these questions might be reordered in any particular case, the [*Graham*] factors continue to define the inquiry that controls.").

The Supreme Court made clear that we apply "an expansive and flexible approach" to the question of obviousness. *KSR*, 550 U.S. at 415. Whether a patent claiming the combination of prior art elements would have been obvious is determined by whether the improvement is more than the predictable use of prior art elements according to their established functions. *Id*. at 417. Reaching this conclusion, however, requires more than merely showing that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc*., 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, obviousness additionally requires that a person of ordinary skill at the time of the invention "would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention." *Id*.

D. Anticipation by KR '197

Petitioner contends that claims 1, 2, 4–7, 10–12, 14–17, 20–22, 24–27, and 30 are anticipated by the disclosure of KR '197. Pet. 29–59.

1. KR '197

KR '197, entitled "CMOS Image Sensor and Manufacturing Method Thereof," describes a method of manufacturing CMOS image sensors that "reduc[es] a capacitance of a floating diffusion region while ensuring an overlap margin for a contact." Ex. 1017, Abstract. KR '197 describes a "typical CMOS image sensor" having a photodiode, transfer transistor, and floating diffusion region, as depicted in Figure 1a below:

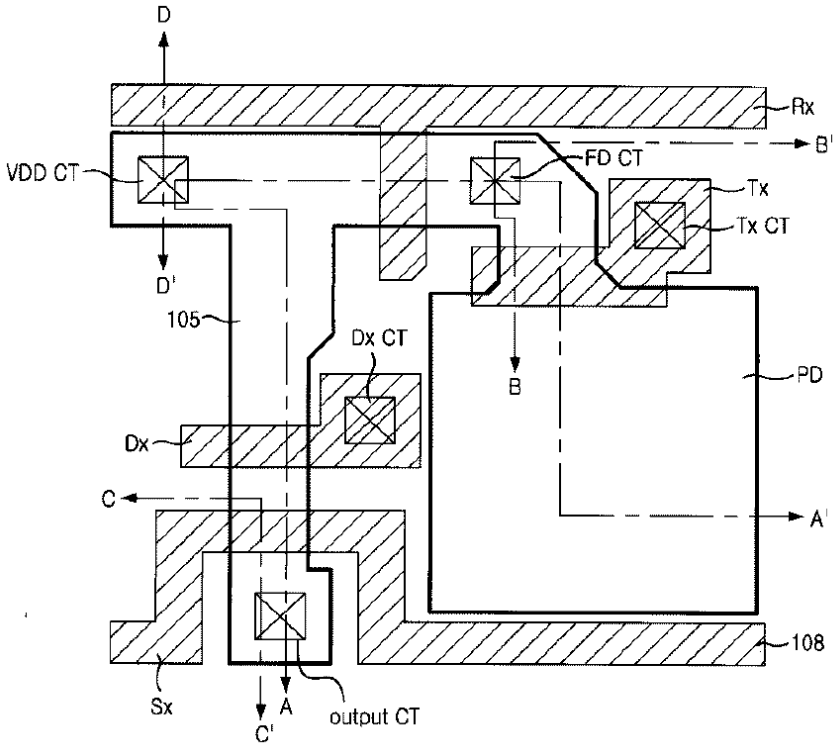


Figure 1a of KR '197 is a plan view of a typical CMOS image sensor having photodiode PD, transfer transistor Tx, and floating diffusion region FD. *Id*. at 2. "[T]he photodiode (PD) has a relatively large region and its region is narrowed from the photodiode (PD) to the floating diffusion region

(FD) while giving a bottle neck effect." *Id*. Figure 1b of KR '197 depicts a cross-section along line A-A' of Figure 1a:

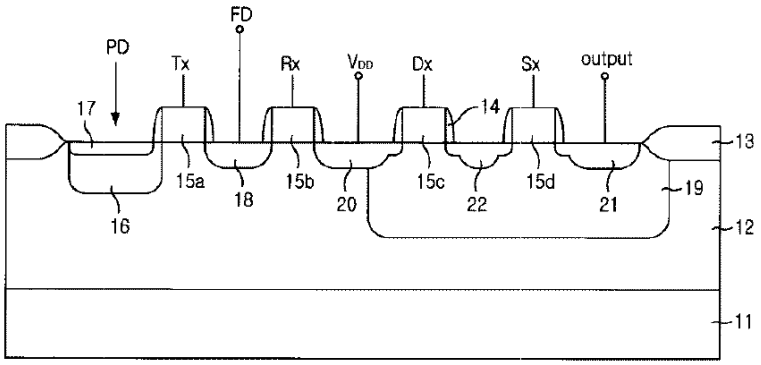


Figure 1b shows that photodiode PD, transfer transistor Tx, and floating diffusion region FD are formed on p-type epitaxial layer 12 on p-type substrate 11. *Id*. at 3. At both ends of line A-A', Figure 1b shows the placement of field oxide film 13 that is used "for inter-element separation." *Id*.

The remainder of KR '197 describes the method of making CMOS image sensors. In one step of the method, a first mask is formed by applying a photoresist over the entire surface of the substrate and patterning the photoresist film. *Id*. at 5. Figure 4 is a plan view of a portion of the substrate after forming the first mask:

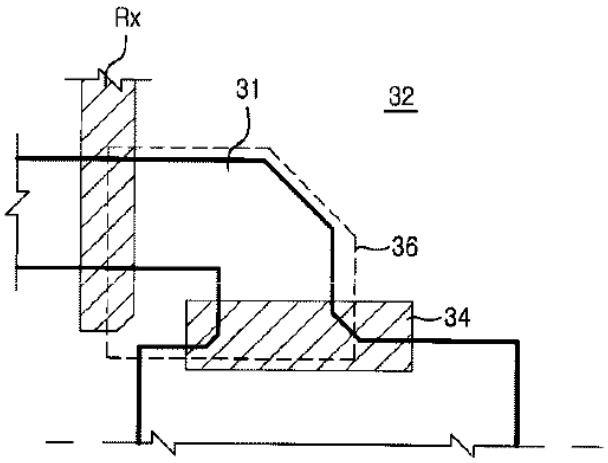


Figure 4 depicts first mask 36 covering a part of p-type epitaxial layer 31 and field oxide film 32.[8] *Id*.

2. Availability of KR '197 as Prior Art

Patent Owner contends that the publication of KR '197 does not precede the date of invention of the '122 patent, and therefore is not prior art. PO Resp. 30. To antedate KR '197, Patent Owner must establish either (1) prior reduction to practice of the claimed invention or (2) prior conception coupled with reasonable diligence from just prior to the publication date of KR '197 until reduction to practice or constructive reduction to practice (namely, the filing of a patent application). *See ATI Techs. ULC v. Iancu*, 920 F.3d 1362, 1369 (Fed. Cir. 2019). Patent Owner makes no claim that the invention was actually reduced to practice,[9] so we focus on the second route to establishing antedation, conception and reasonable diligence.

To support its antedation argument, Patent Owner submits evidence that the invention was conceived prior to the publication date of KR '197, namely April 6, 2004, and the inventor exercised reasonable diligence

[8] At one point, the translation of KR '197 submitted by Petitioner identifies the field oxide film in Figure 4 as (31). *See* Ex. 1017, 5, fourth paragraph. This appears to be a typographical error in the translation. Elsewhere in the translation, field oxide film is designated with (32) (*id*. at 4, seventh paragraph, 5, seventh and eighth paragraphs), and this is corroborated by the machine translation (Ex. 1004, 23) (citation is to exhibit page numbering, not original document).

[9] At one point, Patent Owner notes that the invention disclosure form submitted by the applicants to their attorney alleged that a prototype was created "at the end of [2003]." PO Resp. 32 (citing Ex. 2007, 7). But Patent Owner provides no evidence to support this hearsay statement, and does not rely on the prototype as evidence of actual reduction to practice.

between that date and June 4, 2004, the date the application that issued as the '122 patent was filed. *Id*. at 31. Patent Owner submits an invention disclosure form the applicants provided to their patent attorney, Chun M. Ng, on March 30, 2004 (Ex. 2007), that allegedly shows that the applicants had conceived of their invention by that date. Mr. Ng also submits a declaration, testifying that after receiving the invention disclosure his firm worked to prepare a patent application, resulting in a first draft on June 2, 2004 and a filed application on June 14, 2004. Ex. 2008 ¶¶ 6–7. Mr. Ng testifies that this was a "customary time period" in the industry for preparing a patent application, and he is unaware of any delay on the part of his firm or the individuals involved in preparing the application. *Id*. ¶¶ 8–9. Patent Owner contends that Mr. Ng's testimony establishes reasonable diligence between March 30, 2004 and June 14, 2004, and emphasizes that short period of time (sixty-six days) between these dates. PO Resp. 33.

Petitioner responds that Patent Owner's evidence is insufficient to establish antedation, as it is based entirely on the declaration of Mr. Ng. Pet. Reply 15. With regard to conception, Petitioner observes that neither Mr. Ng, Dr. Theuwissen, nor Patent Owner itself provides any evidence or argument mapping the invention that was disclosed on March 30, 2004 to the claims as issued in the '122 patent. *Id*. at 15–16. Petitioner argues that Patent Owner has improperly left to the Board the task of comparing the disclosed invention to the issued claims. *Id*. at 16. Regarding diligence, Petitioner argues that Mr. Ng's testimony is insufficient to establish reasonably continuous diligence during the critical period. *Id*. at 17–18. Petitioner notes that Mr. Ng provided no details as to the time or dates that his firm worked on the patent application, merely stating that there was no delay in its preparation. *Id*. at 18.

Patent Owner disputes that it did not provide a claim mapping between the invention disclosure and the '122 patent, directing us to the testimony of Dr. Theuwissen that was submitted along with its Response. PO Sur-Reply 21 (citing Ex. 2010[10] ¶¶ 31–34, 133). And on the question of diligence, Patent Owner argues that the "purpose of the diligence requirement is to show that the invention was not abandoned or set aside," and Mr. Ng's testimony is sufficient to establish that the applicants neither abandoned nor set aside their invention. PO Sur-Reply 22–23 (citing *ATI Techs.,* 920 F.3d at 1373).

Upon review, we are not convinced that Patent Owner has established facts sufficient to find antedation of KR '197. With regard to conception, Patent Owner did not set forth in its Response facts sufficient to establish that all elements of the claims of the '122 patent were disclosed in the invention disclosure form on March 30, 2004. First, we note that the passage of the Response devoted to conception does not provide any sort of analysis of the claims or how their limitations are met by the disclosure. PO Resp. 30–33. We understand Patent Owner's argument to be that Dr. Theuwissen provided this analysis in his Declaration. But the Response's discussion of conception contains no citation to Dr. Theuwissen's testimony, citing only to the testimony of Mr. Ng and its supporting documentation. *Id*. at 32. Even if Patent Owner had provided some sort of citation to Dr. Theuwissen, there is no discussion of his analysis of conception in the brief itself. Our Rules prohibit incorporation by reference of arguments from one document into another. 37 C.F.R. § 42.6(a)(3).

[10] Patent Owner's citation is to Exhibit 2007, but that is the declaration of Mr. Ng. From context, it is clear that Patent Owner intended to cite the testimony of Dr. Theuwissen, Exhibit 2010.

In its Sur-Reply, Patent Owner attempted to provide the citations and argument that were missing from its Response. PO Sur-Reply 21. We do not consider waiting until the Sur-Reply to provide the evidence and argument required for Patent Owner's antedation claim to be proper procedure in an *inter partes* review. Nevertheless, even if we were to consider Dr. Theuwissen's testimony, we would not be convinced that Patent Owner has established conception. The first portions of Dr. Theuwissen's testimony cited (¶¶ 31–34) contain conclusory statements such as "All of the subject matter in the claims as issued and as potentially amended as discussed below can be found in the invention disclosure form as well as in the '122 patent." Ex. 2010 ¶ 34. The most detailed discussion provided by Dr. Theuwissen compares the figures of the patent with those appearing in the invention disclosure form, and the discussion in the written description with the disclosure form. *Id*. ¶¶ 32–33. But at best, this establishes that the figures and written description of the patent are supported by the disclosure; it says nothing about whether the *claims* of the patent were disclosed.

Finally, Patent Owner's Sur-Reply directs us to paragraph 133 of Dr. Theuwissen's testimony, which contains a claim chart comparing the limitations of the *proposed substitute claims* set forth in Patent Owner's initial Motion to Amend to the disclosure in the patent, as well as the invention disclosure form. PO Sur-Reply 21; Ex. 2010 ¶ 133. This is in the context of establishing, in support of the Motion to Amend, that the proposed substitute claims have sufficient written description support. Ex. 2010 ¶ 133. The issue of antedation is not mentioned, nor is prior conception. While it is possible that these claim charts, to the extent they contain the limitations of the original issued claims of the '122 patent, could

also be mined for information about whether the invention disclosure form established conception as to these original claims, Patent Owner simply has not presented this information in a cogent and detailed manner that does not require the Board to act as archaeologists with the record. *See Cisco Sys. Inc. v. C-Cation Techs., LLC*, IPR2014-00454, Paper 12 at 10 (PTAB Aug. 29, 2014) (informative) (quoting *DeSilva v. DiLeonardi*, 181 F.3d 865, 866–67 (7th Cir. 1999) ("[a] brief must make all arguments accessible to the judges, rather than ask them to play archaeologist with the record.").

Turning to the evidence of reasonable diligence, we also find Patent Owner's showing to be lacking. While we are mindful that a patent owner must only show reasonably continuous diligence, not a continuous exercise of reasonable diligence (*see ATI*, 920 F.3d at 1370), Mr. Ng's testimony suffers from a number of defects. First, we note that Mr. Ng testifies only generally about his firm's efforts to prepare the patent application at issue here, stating that he is "unaware of any delay on the part of [the applicant], my firm, or any individuals." Ex. 2008 ¶ 9. But the fact that Mr. Ng is unaware of any delay does not mean that not delay occurred. And Mr. Ng provides no evidence as to the work conducted by his firm, such as billing records, that would establish the dates on which the patent application was prepared. While Mr. Ng testifies that three months was a "customary time period" for preparing a patent application in the industry at the time, customary time periods generally are far less useful than knowing what the customs of Mr. Ng and his firm were at the time. Mr. Ng provides no testimony as to whether it was his custom to generally work on patent applications in the order they were received, or how he prioritized work during the relevant period.

When evaluating an attorney's diligence in preparing a patent application, we recognize that "it may not be possible for a patent attorney to begin working on an application at the moment the inventor makes the disclosure, because the attorney may already have a backlog of other cases demanding his attention." *Bey v. Kollonitsch*, 806 F.2d 1024, 1028 (Fed. Cir. 1986). But an attorney should be able to show that any backlog of work was "take[n] up in chronological order and carrie[d] out expeditiously." *Rines v. Morgan*, 250 F.2d 365, 369 (CCPA 1957). For this reason, the Federal Circuit has required that an "attorney has the burden of keeping good records of the dates when cases are docketed as well as the dates when specific work is done on the applications," in order to "show that unrelated cases are taken up in chronological order." *Bey*, 806 F.2d at 1028.

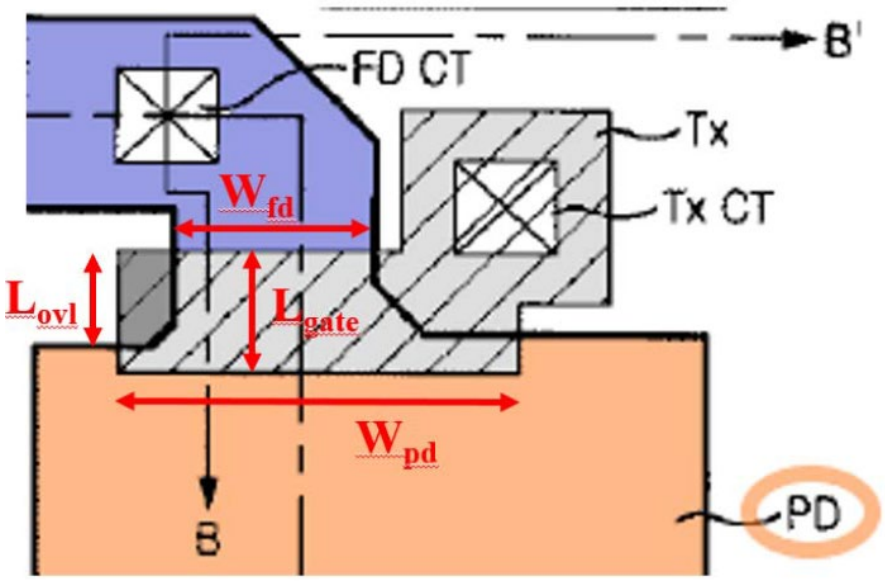
In this case, there is no question that Mr. Ng's testimony fails to provide any specific evidence about his firm's efforts to prepare the particular patent application in question here. Nor have we been provided sufficient evidence regarding Mr. Ng's typical practices that would allow us to assume that the application was prepared in a way that meets the requirements for reasonable diligence. Mr. Ng's statement that he is unaware of any delay in preparing the application is simply insufficient to meet the requirements for antedating a prior art reference.

For these reasons, we find that Patent Owner has not antedated the publication date of KR '197, and therefore the reference is prior art to the claims of the '122 patent.

3. Independent Claims 1, 11, and 21

Having established that KR '197 is prior art, and that the claims of the '122 patent do not require that the device isolation region abut the detection

section, resolution of this ground of unpatentability is rather straightforward. Petitioner provides analysis setting forth how the disclosure of KR '197 allegedly meets each element of claims 1, 11, and 21 and supports its analysis with the testimony of Mr. Guidash. Pet. 29–59; Ex. 1008. For example, for claim 1, Petitioner identifies how KR '197 discloses a semiconductor substrate (p-type epitaxial layer 31), a device isolation region (field oxide film 32), a photoelectric conversion element (photodiode PD), a detection section (floating diffusion region FD), and a transfer gate (transfer transistor Tx). Pet. 29–38. Mr. Guidash provides an annotated version of Figure 1a of KR '197 (reproduced below) that shows how the channel widths of the photoelectric conversion element (W_{pd}) and the detection section (W_{fd}) are different, and how the length of the overlap of the transfer gate and device isolation region (L_{ovl}) is less than the length of the transfer gate (L_{gate}):



Annotated Figure 1a shows photodiode PD having channel width W_{pd}, floating diffusion region FD having channel width W_{fd}, transfer gate Tx having length L_{gate} and overlap length of L_{ovl}. Ex. 1008 ¶ 71–75.

Similar analysis is provided for claims 11 and 21. Pet. 39–55. For these limitations of the independent claims, Patent Owner does not provide a substantive response or contend that the art does not disclose the limitations as Petitioner contends. We have reviewed the uncontested assertions of Petitioner on these points and find that KR '197 discloses these limitations of the independent claims.

Regarding the question of whether the detection section is "surrounded by" the device isolation region, Patent Owner contests whether KR '197 discloses this limitation. PO Resp. 41–44. But this argument is grounded in Patent Owner's proposed construction of "surrounded by" as requiring abutment of the two regions, which we have not adopted. As properly construed, the claims require only that the device isolation region proximately encircles the detection section. To address this element of the claims, Petitioner relies on the combined disclosures of Figures 1a and 4 of KR '197, along with the corresponding portions of the disclosure. Pet. 32–34. Petitioner contends that Figure 4 is "an enlarged version of the area surrounding the transfer gate (Tx)" and "teaches that the photodiode is surrounded by the device isolation region (field oxide film)." *Id*. at 33. Mr. Guidash testifies that a person of ordinary skill in the art reading KR '197 would understand that "the PD is surrounded by the field oxide film (device isolation region) by considering the teaching from Figure 1a with that from Figure 4 (an enlarged version of the area surrounding the transfer gate (Tx))." Ex. 1008 ¶ 68. With regard to the detection section, Petitioner states that "[t]he detection section is also surrounded by the device isolation region," and refers back to its analysis that the photodiode is surrounded by the device isolation region. Pet. 35; *see also* Ex. 1008 ¶ 71.

Viewing the record as a whole, we find that the device isolation region of KR '197 proximately encircles its detection section, as shown in Figure 4 of the reference. Patent Owner's argument to the contrary is that there is a "gap" between KR '197's device isolation barrier 32 and its floating diffusion node 39a, and therefore the regions do not abut (PO Resp. 43 (citing Ex. 1017, Fig. 2; Ex. 2010 ¶ 101 (providing annotated version of Figure 2). But because the claims as properly construed do not require abutment, this argument has no purchase. Petitioner has adequately established that the device isolation region surrounds the detection section of KR '197.

Conclusion as to Claims 1, 11, and 21

Having reviewed Petitioner's evidence as to the undisputed limitations of the independent claims, and having resolved the dispute over the "surrounded by" limitation in Petitioner's favor, we find that KR '197 discloses all limitations of claim 1. We reach the same conclusion as to claims 11 and 21, which the parties analyze identically[11] to claim 1.

4. Dependent Claims

Claims 2, 12, and 22 specify that the channel width of the detection section is less than the channel width of the photoelectric conversion element.[12] Petitioner contends that this is depicted in Figure 1a of KR '197,

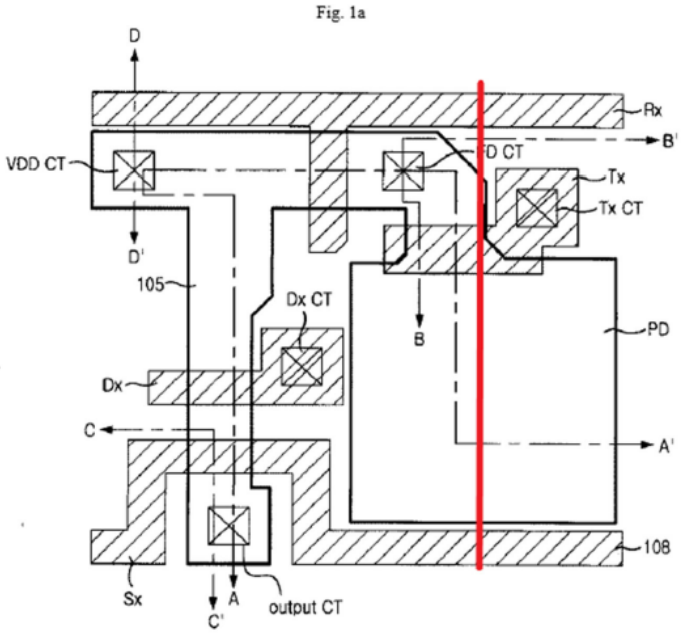
[11] Claims 11 and 21 recite that the detection section is "disposed within" or "formed in" an active area, rather than being "surrounded by" a device isolation region. The parties treat these terms as synonymous (PO Resp. 29; Pet. Reply 14), and we see no reason to do otherwise.

[12] The terminology of these dependent claims differ somewhat, because the terminology of the independent claims differ slightly, as we discussed above. Neither party argues that the difference in terminology affects our analysis, so for simplicity we use the terminology of claim 1. Our analysis

as shown in the annotated figure reproduced above. Pet. 55 (showing W_{pd} is less than W_{fd}). In addition, we note that KR '197 states explicitly that "the photodiode (PD) has a relatively large region and its region is narrowed from the photodiode (PD) to the floating diffusion region (FD) while giving a bottle neck effect." Ex. 1017, 2.

Claims 4, 14, and 24 recite that "the detection section has any geometric shape." Ex. 1001, 5:54–55, 6:31–32, 7:4–6. Petitioner notes that the floating diffusion region of KR '197 is a polygon, which is a geometric shape. Pet. 56.

Claims 5, 15, and 25 require that the detection section be asymmetric with respect to a line passing through the length of the photoelectric section, and that the photoelectric section is symmetric as to that line. Petitioner cites to the testimony of Mr. Guidash (*id*. at 57), who provides an annotated version of Figure 1a of KR '197 showing such a line (Ex. 1008 ¶ 104):



herein should be understood to apply equally to the other dependent claim sets.

Annotated Figure 1a of KR '197, above, shows a line bisecting photodiode PD. Claims 6, 16, and 26 are similar to the foregoing, but require that the line equally divide the photoelectric section. Again, Petitioner relies on the above annotated Figure 1a prepared by Mr. Guidash. Pet. 57–58.

Claims 7, 17, and 27 specify that the transfer gate covers an area in which the channel width of the detection section is not the same as the channel width of the photoelectric section. Petitioner relies on the annotated Figure 1a prepared by Mr. Guidash (Ex. 1008 ¶ 108), which shows that W_{pd} is not the same as W_{fd}. Pet. 58–59.

Claims 10, 20, and 30 require that the photoelectric element is a photodiode. Petitioner directs us to the disclosure of KR '197, which refers to photodiode PD. Pet. 59; Ex. 1017, 2.

Patent Owner has not argued any of these dependent claims separately from the independent claims, or dispute Petitioner's interpretation of KR '197 as meeting the limitations of the dependent claims other than the "surrounded by" limitation of the independent claims discussed above. Reviewing Petitioner's unchallenged evidence, we find that KR '197 discloses the additional elements of the dependent claims.

5. Conclusion

Based on our review of the record, we find that a preponderance of the evidence supports the conclusion that claims 1, 2, 4–7, 10–12, 14–17, 20–22, 24–27, and 30 are anticipated by the disclosure of KR '197.

E. Obviousness Over KR '197 and the Knowledge of a Person of Ordinary Skill in the Art

Petitioner contends that claims 3, 13, and 23 would have been obvious over KR '197 in view of the knowledge of a person of ordinary skill in the

art. Pet. 60–62. Petitioner notes that these claims are, in essence, the opposite of dependent claims 2, 12, and 22, in that they require that the channel width of the detection section is *more than* the channel width of the photoelectric conversion element (as opposed to less than in claims 2, 12, and 22). *Id*. at 60. According to Petitioner, this limitation was known in the art. *Id*.

As we noted in our Institution Decision, Petitioner bases its arguments, not on any explicit disclosure in the cited prior art, but instead on the testimony of its expert Mr. Guidash. *Id*. at 61. Mr. Guidash testifies that "merely flipping the widths of the subject channel is a design choice" and that some applications require larger pixels, which in turn would require a larger floating diffusion node width so that the node would have increased capacitance. Ex. 1008 ¶¶ 111–112. As an alternative reason, Mr. Guidash states that making the floating diffusion node wider than the photodiode would help with charge transfer. *Id*. ¶ 113.

We previously found that Petitioner's showing on this ground was insufficient, as it relies only on the testimony of Mr. Guidash and not a prior art disclosure. Dec. on Inst. 22–23 (citing *Consolidated Trial Practice Guide*, November 2019, 36 (available at https://go.usa.gov/xpv5n)). In response, Petitioner argues that the width of the channel is a "design choice" with three options: "make the FDN larger than the PD; make the FDN the same size as the PD; or make the FDN smaller than the PD." Pet. Reply 27. While this may be the case, the mere existence of options does not necessarily mean that choosing between those options was a "design choice," without some evidence that a person of ordinary skill in the art would have considered it to be such. Here, while Mr. Guidash testifies that the channel width was a design choice, he does not support this conclusory

assertion with any record evidence, or even point out recognition in the prior art that modifying the channel width would have been a result-effective variable. Ex. 1008 ¶¶ 111–114. In this sense, the present case is distinguishable from those that Petitioner cites, where the prior art identifies possible options. Pet. Reply 27 (citing *Arthrex, Inc. v. Smith & Nephew, Inc.*, 935 F.3d 1319, 1329 (Fed. Cir. 2019) ("The Board correctly found that West expressly identifies two possible methods for making a rigid support…")).

We cannot conclude, based on the evidence presented by Petitioner, that claims 3, 13, and 23 would have been obvious over KR '197.

F. Obviousness Over KR '197 and He

Petitioner contends that claims 8, 9, 18, 19, 28, and 29 would have been obvious over the combined disclosures of KR '197 and He. Pet. 62–64. Patent Owner does not provide any argument as to this ground of unpatentability, other than to rely on its prior arguments regarding the failure of KR '197 to disclose the "surrounded by" limitation. PO Resp. 41–44. Patent Owner has not provided us with any evidence of objective indicia of nonobviousness.

Claims 8, 18, and 28 specify that the device isolation region is STI, while claims 9, 19, and 29 specify that the region is Locos. Petitioner concedes that KR '197 does not explicitly state how its field oxide region is formed, but that STI and Locos are two of a limited number of options for doing so that would have been known at the time of the invention. Pet. 62, 64. In addition, Petitioner relies on the disclosure of He, which states that STI and Locos are the two field oxide layers that are typically used as an insulating oxide region. *Id*. at 62 (citing Ex. 1007, 2:63–67). Petitioner

asserts that the person of ordinary skill, seeking to make the image sensor of KR '197, would have noted that the reference does not disclose the method of making its field oxide film and, therefore, would have looked to a reference such as He to supply this missing disclosure. *Id*. at 63.

On this record, we find that a person of ordinary skill in the art would have combined the disclosures of KR '197 and He in order to supply details missing from KR '197, specifically the material used for the field oxide layer. We further find that the combined disclosures would have taught the additional limitations of claims 8, 9, 18, 19, 28, and 29. For these reasons, we conclude that the subject matter of claims 8, 9, 18, 19, 28, and 29 would have been obvious over the combined disclosures of KR '197 and He.

G. Obviousness Over Lee '767 and Lee '666

Petitioner contends that claims 1, 2, 4–7, 9–12, 14–17, 19–22, 24–27, and 29–30 would have been obvious over the combined disclosures of Lee '767 and Lee '666. Pet. 64–92. We begin by addressing the portions of the disclosures Petitioner relies upon, followed by an analysis of the arguments for obviousness.

1. Lee '767

Lee '767, entitled "Pixel Layout for CMOS Image Sensor," relates to a "novel CMOS image unit pixel layout having a photodiode including an optically optimized square image sensing region." Ex. 1005, Abstract. Notably, Figure 3 of Lee '767 (reproduced below) is very similar to Figure 1a of KR '197:

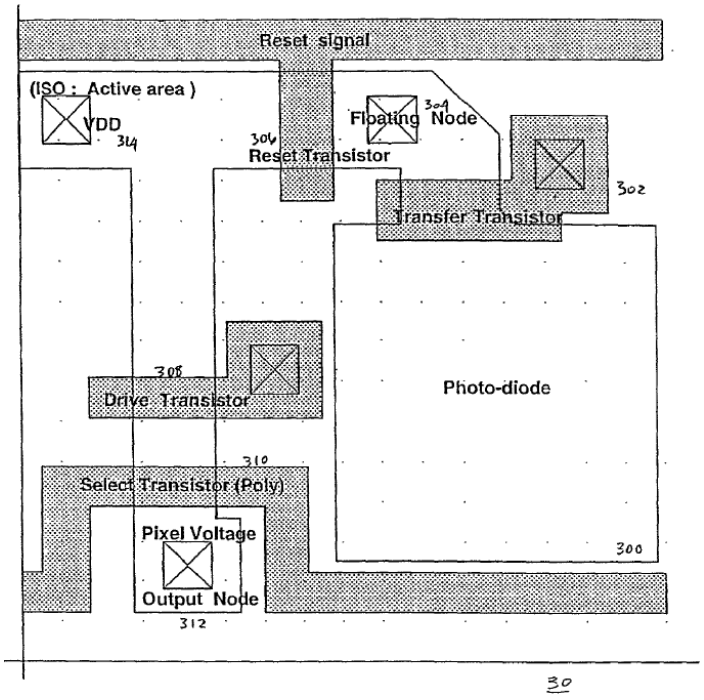
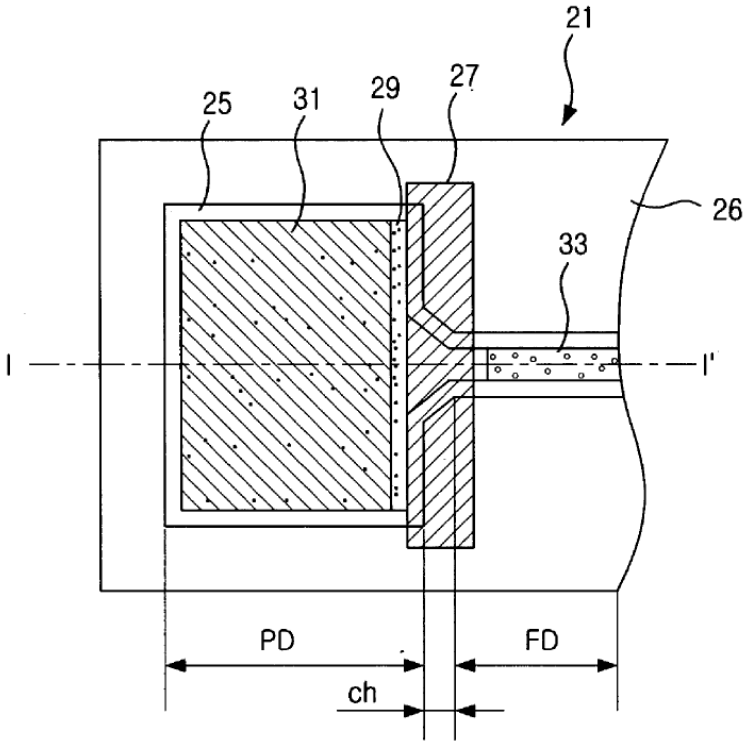


Figure 3 of Lee '767 depicts unit pixel 30 comprising image sensing area 300 (labeled "Photo-diode"), transfer transistor 302, and floating node 304. *Id*. ¶ 25, Fig. 3. The arrangement of these elements appears to be identical to that disclosed in KR '197. Petitioner also directs us to the notation "(ISO : Active Area)" in the top left corner of Figure 3 of Lee '767. According to Mr. Guidash, a person of ordinary skill in the art would recognize that "ISO" refers to an isolation region. Ex. 1008 ¶ 127.

2. Lee '666

Lee '666, entitled "Image Sensor and Method for Fabricating the Same," relates to a "an image sensor capable of suppressing the dark current due to crystalline defects occurring at an edge of a field oxide layer." Ex. 1006, [54], [57]. The image sensor of Lee '666 includes: a semiconductor substrate; an active area including a photodiode area; a floating diffusion area; and a field area for electrically isolating the active area. *Id*. at [57]. The floating diffusion area has "a smaller area than the photodiode area and

a channel area having a bottle-neck structure connecting to the photodiode area and the floating diffusion area." *Id*. Figure 3 of Lee '666 is reproduced below:



In Figure 3 of Lee '666, the CMOS image sensor comprises substrate 21, field oxide layer 26, photodiode PD, gate electrode 27, and floating diffusion area FD. The field oxide layer of Lee '666 is fabricated using Locos. *Id*. ¶ 106.

3. Reason to Combine

Petitioner contends that a person of ordinary skill in the art would have combined the disclosures of Lee '767 and Lee '666, and arrived at the claimed invention. Pet. 75–76. In particular, Petitioner contends that the skilled artisan would have recognized that Lee '767 relates to the design and layout of a pixel of a CMOS image sensor, but the reference lacks information regarding the manufacture of such a sensor. *Id*. at 75. The

artisan, according to Petitioner, would have, therefore, turned to a reference such as Lee '666 that relates to a method of making a CMOS image sensor. *Id*. In addition, as will be developed below, Petitioner notes that it relies on Lee '666 primarily to "point out the existence of basic features of a CMOS image sensor that a [person of ordinary skill in the art] would have readily understood." *Id*. at 76.

Patent Owner disputes that a person of ordinary skill in the art would have combined the disclosures of Lee '767 and Lee '666. PO Resp. 52. According to Patent Owner, Petitioner's articulated reason to combine the references is grounded in the need to suppress generation of dark current at the edges of a field oxide layer, but that this is not the purpose of the '122 patent, which is directed to minimizing detection node capacitance. *Id*. Patent Owner also notes that Lee '767 focuses on features of the pixel such as its square shape, as opposed to features specified in the '122 patent such as the overlap between the device isolation region and the transfer gate, and the relationship between the channel widths of the photodiode and the floating diffusion node. *Id*. at 52–53.

Patent Owner, however, does not address the rationale to combine Petitioner actually articulates—namely, that a skilled artisan wanting to manufacture Lee '767's CMOS image sensor would have looked to Lee '666's manufacturing process for CMOS image sensors. We find that this is a reasonable and sufficient reason why a person of ordinary skill in the art would have combined the references. Patent Owner's arguments to the contrary are not persuasive, as they are directed to features of the '122 patent, not the reason to combine that was articulated by Petitioner. Notably, Patent Owner's argument regarding the reason to combine focuses almost exclusively on the differences between Lee '767 and the '122 patent;

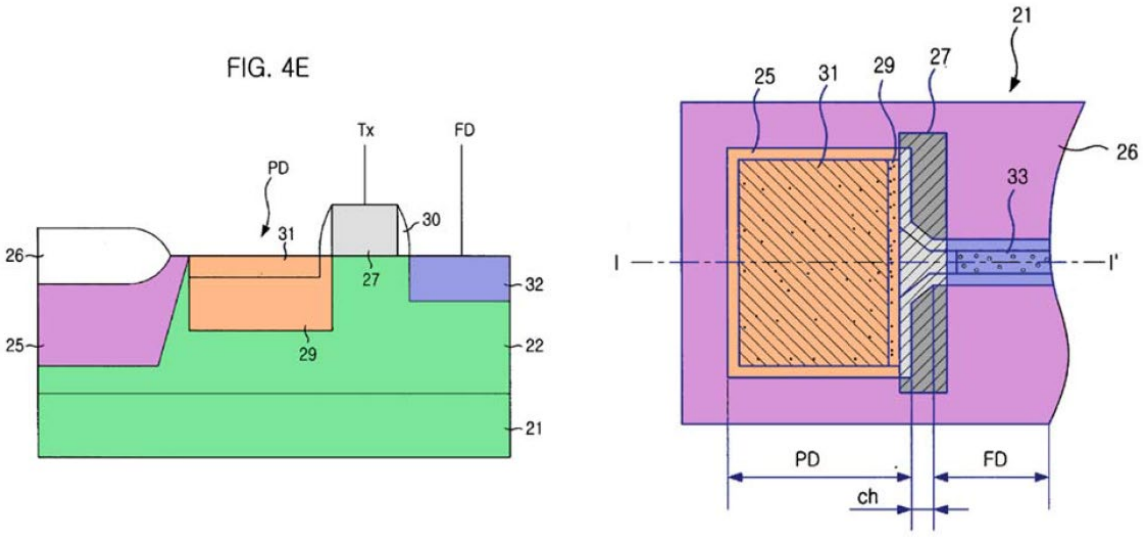
the combination of Lee '767 and Lee '666 is only mentioned once. *Id*. In any event, the fact that Lee '767 does not focus on the same problem as the '122 patent is not conclusive as to the obviousness inquiry. *See KSR*, 550 U.S. at 420 (error to assume "that a person of ordinary skill attempting to solve a problem will be led only to those elements of prior art designed to solve the same problem").

4. Independent Claims

Petitioner provides analysis setting forth how the disclosures of Lee '767 and Lee '666 allegedly teach each element of claims 1, 11, and 21, and supports its analysis with the testimony of Mr. Guidash. Pet. 64–85; Ex. 1008. For the most part, Petitioner's analysis is similar to that provided for KR '197, and due to the similarities between the disclosures of KR '197 and Lee '767, we need not go into great detail on the claim limitations that Patent Owner does not dispute. With respect to all claim limitations not specifically discussed below, we find that Petitioner's unchallenged assertions are supported by the evidence of record. We, thus, turn to the disputed limitations.

Detection region surrounded by the device isolation region

As with the ground based on KR '197, Petitioner states that "[b]oth LEE '767 and LEE '666, as discussed above, show the floating diffusion node surrounded by the device isolation region," referring back to a discussion of a prior limitation of the claims. Pet. 72. That discussion relies on two annotated figures provided by Mr. Guidash (reproduced below) that show the device isolation region highlighted in lavender:



On the left, annotated Figure 4E of Lee '767 shows field oxide film 25, while on the right, annotated Figure 3 of Lee '666 shows field oxide film 26. Ex. 1008 ¶ 125.

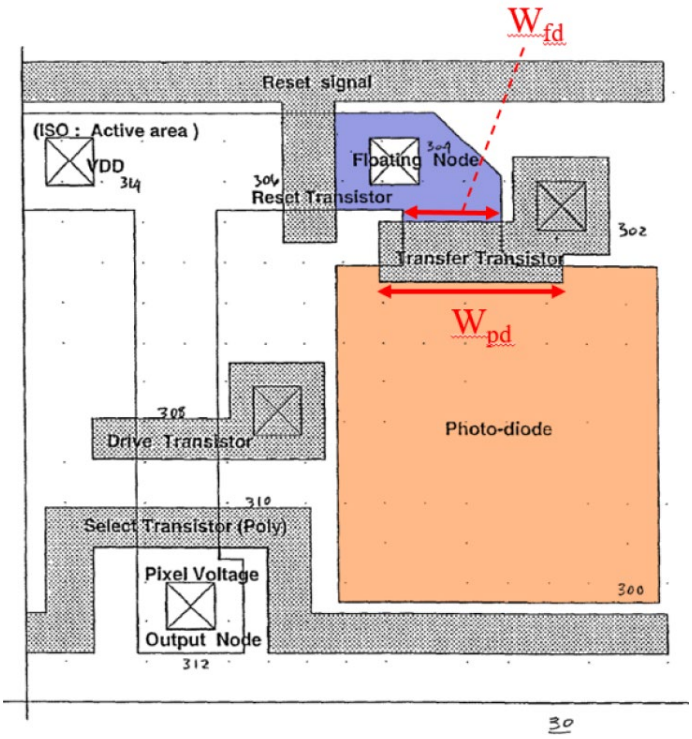
Patent Owner's argument that the device isolation region does not surround the detection section is similar to the argument made in regard to KR '197. According to Patent Owner, Petitioner's argument is based solely on a "generic line in a pixel layout view" that "does not inform a person of ordinary skill in the art whether the floating diffusion node itself is bounded by the dielectric barrier to avoid the depletion region and parasitic capacitance." PO Resp. 48. Noting that Lee '767 does not include any cross-sectional view of its device, Patent Owner contends that there is insufficient basis to conclude that the device isolation region abuts the detection section. *Id*. For the same reasons discussed above in the context of KR '197, we find this argument, based on a claim construction we have not adopted, to be unpersuasive.

Reviewing Petitioner's evidence as to Lee '767 and Lee '666, the preponderance of the evidence shows that the device isolation region

proximately encircles the detection section, and therefore the latter is "surrounded by" the former within the meaning of the claims.

The Relative Channel Widths

Patent Owner also disputes whether the combined references disclose that the channel widths of the photoelectric conversion element and the detection section are different. For this limitation, Petitioner relies on Figure 3 of Lee '767, and provides the following annotated version supplied by Mr. Guidash:



Annotated Figure 3 of Lee '767 shows channel width W_{pd} and channel width W_{fd}. Ex. 1008 ¶ 133. According to Petitioner, the "second channel width is of a different length than the first channel width, as can be seen in the annotated version of Figure 3." Pet. 72.

Patent Owner counters, as it did prior to institution, that it is improper to rely on a visual examination of Figure 3 of Lee '767 to establish the relative widths of the channels, because the reference does not indicate that

the figure is drawn to scale. PO Resp. 49–52. Quoting *Hockerson-Halberstadt, Inc. v. Avia Grp. Int'l,* 222 F.3d 951, 956 (Fed. Cir. 2000), Patent Owner contends that "[i]t is well established that patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue." PO Resp. at 50. Patent Owner observes that Lee '767 is "completely silent" as to the widths of the channels, and therefore it is improper to rely on the figures as establishing even relative dimensions. *Id*. at 51.

Upon consideration, we maintain our determination at institution that the lack of any statement in Lee '767 that its figures are drawn to scale does not necessarily prevent all reliance on the relative sizes of the channel widths depicted. Though *Hockerson-Halberstadt* cautions against the use of not-to-scale figures to "define the precise proportions of the elements" or "show particular sizes," 222 F.3d at 956, that is not the sort of reliance Petitioner places on Figure 3 of Lee '767. It is important to remember that the claims of the '122 patent do not define a particular ratio between the first and second channel widths, or require any specific measurement; rather, they simply require that the channel widths be *different*. This is a reasonable conclusion that a person of ordinary skill in the art would draw from an examination of Figure 3, and distinguishes this case from others relied on by Patent Owner such as *Nystrom v. TREX Co., Inc.*, 424 F.3d 1136 (Fed. Cir. 2005). In *Nystrom*, the Federal Circuit found that it was error to rely on the figures of a reference to establish a specific ratio of two measurements. *See id*. at 1149. Here, by contrast, Petitioner relies on Figure 3 for the simple proposition that the first channel width is different than the second.

In any event, Petitioner also directs us to evidence beyond Figure 3 of Lee '767 that supports the conclusion that a person of ordinary skill in the

art would have understood that the channel widths should be different. As noted above, Lee '666 discusses the presence of a "bottle-neck effect" that results from the difference in the area between the photodiode and the floating diffusion region. Ex. 1006 ¶ 15. Petitioner relies on this disclosure, along with Figure 3 of Lee '767, to support its contention regarding the relative channel widths. Pet. 72. The Federal Circuit has held that it is proper for the Board to rely on relative dimensions of the elements depicted in a figure, when those findings have support beyond the figures alone. *See Collabo Innovations, Inc. v. Sony Corp*., 778 F. App'x 954, 960 (Fed. Cir. 2019) (non-precedential) ("Yoshino and other record evidence further suggest a technical benefit from using an upper opening that is narrower than the chip, and thus also narrower than the lower opening."). Here, Lee '666's discussion of the bottle-neck effect is "other record evidence" that "suggest[s] a technical benefit" from having a difference between the channel width at the photodiode and at the floating diffusion node.

On this record, it is reasonable to conclude from Figure 3 of Lee '767, as well as the disclosure of Lee '666, that the combined references would have taught or suggested to the skilled artisan that the first channel width and the second channel width are different.

Conclusion as to Claims 1, 11, and 21

For the foregoing reasons, we are persuaded that Petitioner's analysis, as supported by Mr. Guidash's testimony, sufficiently supports the conclusion that the combined disclosures of Lee '767 and Lee '666 teach or suggest all limitations of claim 1. We similarly conclude that Petitioner's analysis of claims 11 and 21, which are substantially similar to that set forth above, is sufficient. As in the KR '197 ground above, we observe that

Patent Owner does not separately argue the patentability of claims 11 and 21 apart from claim 1.

5. Dependent Claims

To establish the disclosure of the limitations of dependent claims 2, 4–7, 9, 10, 12, 14–17, 19, 20, 22, 24–27, 29, and 30, Petitioner relies primarily on Figure 3 of Lee '767 which, as we have noted above, is substantially similar to Figure 1a of KR '197. Pet. 85–91. Our analysis of these dependent claims is, therefore, also similar to that set forth above. Notably, Patent Owner again does not separately argue the dependent claims. We conclude that the evidence adequately supports Petitioner's contentions as to these dependent claims, for the same reasons set forth above in the KR '197 ground.

This ground of unpatentability also includes challenges against dependent claims 9, 19, and 29, which were not included in the KR '197 ground above. *Id.* at 91. This is due to the fact that Lee '666, unlike KR '197, discloses that its field oxide film is fabricated using Locos. *See* Ex. 1006 ¶ 106. We have reviewed Petitioner's evidence as to these dependent claims and find its assertions sufficiently supported.

H. Obviousness Over Lee '767, Lee '666, and the Knowledge of a Person of Ordinary Skill in the Art

Petitioner contends that claims 3, 13, and 23 would have been obvious over Lee '767 and Lee '666 in view of the knowledge of a person of ordinary skill in the art. Pet. 92. This argument explicitly refers back to the arguments made in relation to the KR '197 ground above, and Petitioner asserts again that "varying the widths of the PD and FDN channels is merely a design choice." As discussed above, we do not find these arguments persuasive. The combined references do not provide any more support for

Mr. Guidash's conclusory design choice testimony than KR '197 provides. Therefore, we conclude that Petitioner has not established unpatentability on this ground by a preponderance of the evidence.

I. Obviousness Over Lee '767, Lee '666, and He

Petitioner contends that claims 8, 18, and 28 would have been obvious over the combined disclosures of Lee '767, Lee '666, and He. Pet. 92–94. Again, Petitioner's arguments on this ground are identical to those made in regard to the ground above involving KR '197 and He, and rely on He's disclosure that STI is a typically-used field oxide layer. *Id*. Patent Owner provides no arguments against this ground of unpatentability, other than incorporating by reference its arguments against the Lee '767 and Lee '666 obviousness ground above. PO Resp. 55. Our analysis is the same as the prior ground, and we find Petitioner has proven by a preponderance of the evidence that the combined disclosures of the references teach all elements of the dependent claims, and that the skilled artisan would have had reason to combine the relied-upon disclosures to arrive at the claimed subject matter.

IV. PATENT OWNER'S REVISED MOTION TO AMEND

Patent Owner filed a Revised Contingent Motion to Amend requesting that, in the event claims 1–30 were found unpatentable, we enter proposed substituted claims 31–60. Mot. Amend 2. As we have concluded that claims 1, 2, 4–12, 14–22, and 24–30 are unpatentable, we now turn to consider proposed substitute claims 31, 32, 34–42, 44–52, and 54–60. Because original claims 3, 13, and 23 have not been shown to be unpatentable, we do not consider proposed substitute claims 33, 43, or 53.

A. Applicable Law

In an *inter partes* review, amended claims are not added to a patent as of right, but rather must be proposed as a part of a motion to amend. 35 U.S.C. § 316(d) (2018). The Board must assess the patentability of proposed substitute claims "without placing the burden of persuasion on the patent owner." *Aqua Prods., Inc. v. Matal*, 872 F.3d 1290, 1328 (Fed. Cir. 2017) (en banc); *see Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 15 at 3–4 (PTAB Feb. 25, 2019) (precedential). Subsequent to the issuance of *Aqua Products*, the U.S. Court of Appeals for the Federal Circuit issued a decision in *Bosch Automotive Service Solutions, LLC v. Matal*, 878 F.3d 1027 (Fed. Cir. 2017) ("*Bosch*"), as well as a follow-up order amending that decision on rehearing. *See Bosch Auto. Serv. Sols., LLC v. Iancu*, No. 2015-1928 (Fed. Cir. Mar. 15, 2018) (Order on Petition for Panel Rehearing).

In accordance with *Aqua Products*, *Bosch*, and *Lectrosonics*, a patent owner does not bear the burden of persuasion to demonstrate the patentability of the substitute claims presented in the motion to amend. Rather, ordinarily, "the petitioner bears the burden of proving that the proposed amended claims are unpatentable by a preponderance of the evidence." *Bosch*, 878 F.3d at 1040 (as amended on rehearing); *Lectrosonics*, Paper 15 at 3–4. In determining whether a petitioner has proven unpatentability of the substitute claims, the Board typically focuses on "arguments and theories raised by the petitioner in its petition or opposition to the motion to amend." *Nike, Inc. v. Adidas AG*, 955 F.3d 45, 51 (Fed. Cir. 2020).

Notwithstanding the foregoing, a patent owner's proposed substitute claims must meet the statutory requirements of 35 U.S.C. § 316(d) and the

procedural requirements of 37 C.F.R. § 42.121. *Lectrosonics*, Paper 15 at 4–8. Accordingly, a patent owner must demonstrate: (1) the amendment proposes a reasonable number of substitute claims; (2) the proposed claims are supported in the original disclosure (and any earlier filed disclosure for which the benefit of filing date is sought); (3) the amendment responds to a ground of unpatentability involved in the trial; and (4) the amendment does not seek to enlarge the scope of the claims of the patent or introduce new subject matter. *See* 35 U.S.C. § 316(d); 37 C.F.R. § 42.121.

B. Analysis – Statutory and Regulatory Requirements

1. Reasonable Number of Substitute Claims

35 U.S.C. § 316(d)(1)(B) requires that the number of substitute claims be reasonable. *See also* 37 C.F.R. § 42.121(a)(3). Patent Owner presents 30 substitute claims, each corresponding to one original claim. Mot. Amend 3, Appx. A. This one-for-one substitution is reasonable. 37 C.F.R. § 42.121(a)(3) ("The presumption is that only one substitute claim would be needed to replace each challenged claim . . . ."). Petitioner does not assert that the Motion presents an unreasonable number of substitute claims.

2. Enlargement of Scope

35 U.S.C. § 316(d)(3) requires that the amendment not seek to enlarge the scope of the claims. *See also* 37 C.F.R. § 42.121(a)(2)(ii). Patent Owner contends that the proposed substitute claims retain all features of the original claims while adding further narrowing limitations. Mot. Amend 8. Petitioner does not argue that the amendments enlarge the scope of the claims. We agree that the proposed substitute claims do not enlarge the scope of the original claims.

3. Responsive to a Ground of Unpatentability

37 C.F.R. § 42.121(a)(2)(i) specifies that a motion to amend may be denied where it "does not respond to a ground of unpatentability involved in the trial." Patent Owner contends that the additional limitations further distinguish the prior art advanced in the Petition. Mot. Amend 10. We agree that this requirement is met.

4. New Matter and Written Description Support

35 U.S.C. § 316(d)(3) additionally requires that the amendment not introduce new subject matter. *See also* 37 C.F.R. § 42.121(a)(2)(ii). 37 C.F.R. § 42.121(b) requires that a motion to amend set forth the support in the original disclosure for each substitute claim. "Importantly, to meet this requirement, citation should be made to the original disclosure of the application, as filed, rather than to the patent as issued." *Lectrosonics*, Paper 15 at 8. The test for determining compliance with the written description requirement is whether the disclosure of the application as originally filed reasonably conveys to a person of ordinary skill in the art that the inventor had possession of the claimed subject matter at the time of filing, rather than the presence or absence of literal support in the specification for the claim language. *Ariad Pharms., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc); *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1563 (Fed. Cir. 1991); *In re Kaslow*, 707 F.2d 1366, 1375 (Fed. Cir. 1983).

Patent Owner contends that the proposed substitute claims do not introduce new matter and have written description support, and provides claim charts showing where each element of the proposed substitute claims are found in the originally-filed application. Mot. Amend 10–19. Petitioner focuses its opposition on two newly-added limitations: the requirement in

claims 31 and 41 that the dielectric material "abuts at least a periphery of the detection section," and claim 51's requirement that the dielectric material is "spanning at least the sidewalls of the floating diffusion node." Opp. Amend 22–25. We address these limitations below. For the remaining limitations added to the proposed substitute claims, we find that they have adequate support in the originally-filed application and do not introduce new matter.

Dielectric material abuts at least a periphery of the detection section

For support for this limitation of claims 31 and 41, Patent Owner directs us to Figure 7A of the '122 patent, as originally filed in the application. Mot. Amend 13 (citing Ex. 1002, 150), 15. Specifically, Patent Owner observes that Figure 7A shows a dielectric material (unlabeled) abutting a floating diffusion node. *Id*. at 13. Dr. Theuwissen also testifies in support of Patent Owner's contentions, identifying Figure 7A and stating that a person of ordinary skill in the art would recognize that the device isolation region abuts the detection section. Ex. 2018 ¶¶ 3–20.

Petitioner responds that the term "abutting" does not appear in the '122 patent and is therefore unsupported by the written description. Opp. Amend 22–23. Petitioner's argument focuses on Figures 3 and 4 of the '122 patent, and Petitioner concludes by the dashed lines in these figures that the depletion region of those embodiments must extend into the area adjacent to the floating diffusion node. *Id*. As a result, Petitioner concludes, the patent does not support a requirement that the regions are "abutting." *Id*.

Upon review of the record, including the expert testimony regarding what a person of ordinary skill in the art would understand in light of the original disclosure of the '122 patent, we find that the written description supports the conclusion that the inventors had possession of the subject

matter. Specifically, Figure 7A of the patent discloses that the device isolation region and the detection section share a common boundary, and therefore can be said to be abutting. Petitioner's arguments as to Figures 3 and 4 are not persuasive, as the top-down perspective of those drawings do not provide as clear a representation of the embodiments as the cross-section of Figure 7A. With regard to Petitioner's arguments that the dashed lines of Figures 3 and 4 show that there is an intervening region between the two claimed regions, we disagree. Rather, the dashed lines both inside and outside the solid boundary line of the floating diffusion node appear to depict the tapering that is shown in Figure 7A; in other words, the dashed lines show that the diffusion node is narrower at the surface than it is at the bottom.

Dielectric material spanning at least the sidewalls of the floating diffusion node

Proposed substitute claim 51 introduces the terminology of "spanning," which does not appear in the original claims, and we have not discussed it above in connection with Petitioner's challenge to those claims. Patent Owner again relies on Figure 7A of the '122 patent for support of this limitation, claiming that the figure shows the dielectric material (the device isolation region) "abutting and spanning sidewalls of the floating diffusion region." Mot. Amend 17. Dr. Theuwissen testifies that Figure 7A shows that the dielectric isolation region spans the sides of the floating diffusion node. Ex. 2018 ¶ 21. According to Dr. Theuwissen, this "spanning," in which the dielectric is in contact with the entire side of the floating diffusion node, can be contrasted with layers such as in Miyagawa's Figure 3, which shows a "bird's beak" that contacts the depletion region at a point, but not along the remainder of the wall of the floating diffusion node. *Id*. Patent

Owner later asserted a construction of "spanning" as "the dielectric extends across the sidewalls of the floating diffusion node." Amend Reply 9–10.

Petitioner responds that, not only is the requirement of "spanning" not supported by the written description of the originally-filed application, its introduction into the claims renders them indefinite.[13] Opp. Amend 24. Again, Petitioner focuses on the fact that the term "spanning" is found nowhere in the '122 patent, and the patent provides no information as to the length to which the dielectric must "span" the floating diffusion node. *Id*.

We have reviewed the parties' arguments and the expert testimony on both sides, and conclude that Patent Owner accurately identifies the plain and ordinary meaning of "spanning." Namely, as used in proposed substitute claim 51, "spanning" means that the device isolation region extends along the entire sidewall of the floating diffusion node, as depicted in Figure 7A of the '122 patent. Because the original disclosure of the patent evidences that the inventors had such a structure in their possession at the time of filing, we find that the written description supports the amendment.

5. Conclusion as to Statutory/Regulatory Requirements

Patent Owner's motion meets the statutory requirements of 35 U.S.C. § 316(d) and the regulatory requirements of 37 C.F.R. § 42.121.

C. Analysis – Patentability of Proposed Substitute Claims

Petitioner challenges the patentability of the proposed substitute claims on the following grounds: 1) all proposed substitute claims are unpatentable as having been obvious over a combination of KR '197 with

[13] We address Petitioner's indefiniteness challenge below.

He or Hong[14]; 2) all proposed substitute claims are unpatentable as having been obvious over a combination of Lee '767 with He or Hong; and 3) claims 51–60 are unpatentable as indefinite under 35 U.S.C. § 112. Opp. Amend 6–7, 24–25.

1. Obviousness Grounds – Disclosure of He and Hong

To support its obviousness grounds, Petitioner provides a claim chart setting forth where each limitation of the proposed substitute claims is allegedly disclosed by the prior art. Opp. Amend 7–20. The dispute between the parties, however, focuses on the final clause of the proposed independent claims; for proposed claim 31, this clause recites:

> wherein the dielectric material abuts at least a periphery of the detection section, extends into the semiconductor substrate at a depth that is greater than that of the detection section, and is omitted where the detection section allows for charge transfer.

Mot. Amend 4 (emphasis omitted). Petitioner concedes that the primary references relied upon in the Petition do not disclose all aspects of this claim clause; namely, KR '197 does not disclose that the dielectric material abuts the detection section (Opp. Amend 7), whereas Lee '767 does not disclose the "abutting" limitation or the depth of the dielectric material. *Id*. For these elements, Petitioner relies on either He or Hong.

He, discussed above, discloses a CMOS image sensor having a photodiode, a transfer gate, and a reset transistor. Ex. 1007, Abstract. He discusses the desirability of having an active pixel sensor that has low dark current, and that possible sources of dark current include surface damage to

[14] U.S. Patent No. 7,078,746 B2 to Hong, issued July 18, 2006, filed July 15, 2003 (Ex. 1027). Petitioner asserts that Hong is prior art to the '122 patent under 35 U.S.C. § 102(e) (Amend Opp. 5), a contention that Patent Owner does not dispute.

the photodiode as well as the boundary between the sensor and the field oxide (FOX) layer, which corresponds to the device isolation region of the '122 patent. *Id*. at 1:30–36, 3:25–34. He proposes covering the surface of the photodiode with an overlying structure to protect against surface damage and reduce dark current. *Id*. at Abstract. Figure 4 of He depicts an exemplary embodiment of the invention:

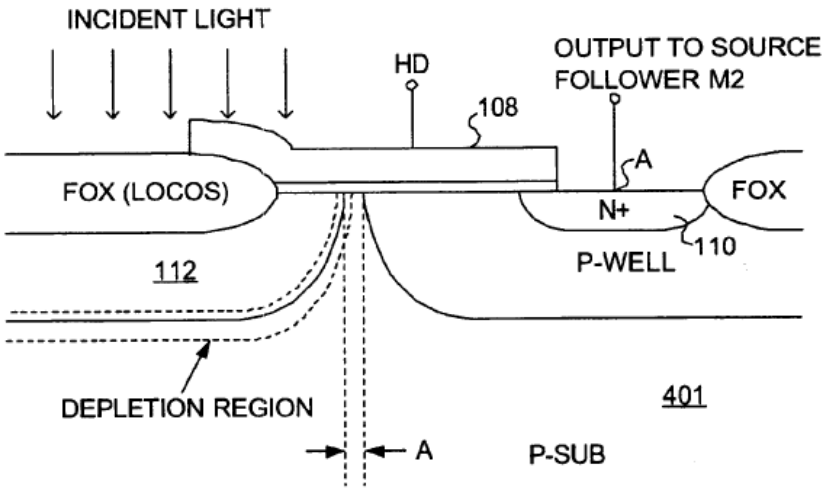


FIGURE 4

Figure 4 of He depicts active pixel 401 having photodiode 112, transfer gate 108 and output node A 110. *Id*. at 3:55–67. The output node, which corresponds to the detection section of the '122 patent, is bordered by a FOX region. *Id*.

Hong discloses in Figure 1A a conventional CMOS image sensor comprising a photodiode, a transfer gate, and a floating diffusion region. Ex. 1027, 1:30–37. A cross-section along the line 1B-1B of Figure 1A is depicted in Figure 1B of Hong:

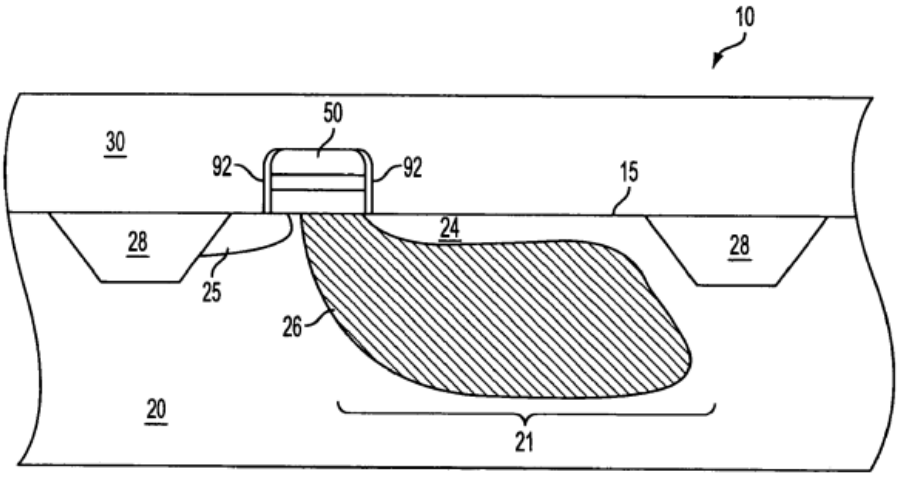


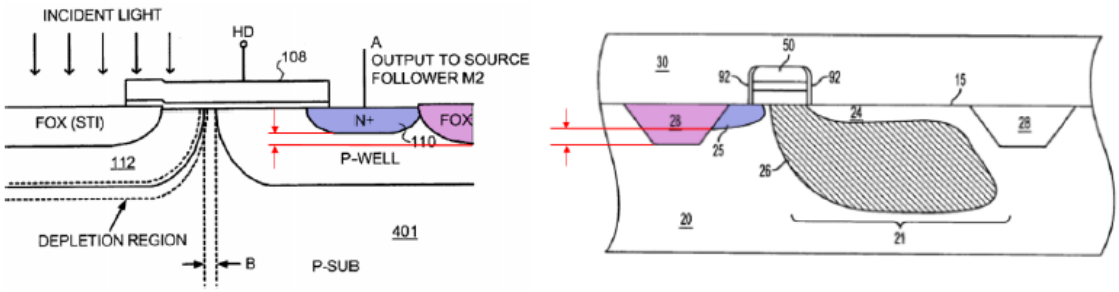
FIG. 1B
(PRIOR ART)

Figure 1B of Hong depicts a cross-sectional view of a conventional CMOS image sensor 10 having photodiode 21 and floating diffusion node 25 bounded by trench isolation region 28. *Id*. at 1:44–56.

Petitioner contends that, even if KR '197 and Lee '767 do not disclose a device isolation region that abuts a detection section (or floating diffusion node), both He and Hong depict such abutment. Opp. Amend 3–5. Patent Owner does not seriously contest this point, and we agree with Petitioner that both He and Hong show device isolation regions of dielectric material that abut a detection section. In addition, in the context of proposed claim 51, which requires "dielectric material spanning at least the sidewalls of the floating diffusion node," we find that Figure 1B of Hong establishes this element of the claim, in that it shows an isolation region extending across the entire sidewall of the floating diffusion node.

With regard to the proposed substitute claim requirement that the dielectric material "extends into the semiconductor substrate at a depth that is greater than that of the detection section," Petitioner relies on the

testimony of Mr. Guidash, who reviews the figures of He and Hong and provides the following annotated figures:



Annotated Figure 4 of He (left) and annotated Figure 1B of Hong (right), as annotated by Mr. Guidash, show with red lines the difference in depth between the dielectric material (shaded purple) and the detection section (shaded blue). Ex. 1028 ¶¶ 13, 17. Petitioner argues that these annotations by Mr. Guidash establish that the dielectric material extends further into the substrate than the detection section in both references. Opp. Amend 3–5.

Patent Owner responds that Petitioner's evidence, relying solely on Mr. Guidash's annotations and visual observation of the figures of He and Hong, is not credible evidence that is sufficient to support a conclusion of obviousness. Amend Reply 11–12. Quoting *Hockerson-Halberstadt*, discussed above in the context of the Lee obviousness ground, Patent Owner again argues that "[p]atent drawings do not define the precise portions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue." *Id*. at 11 (quoting 222 F.3d 956). But again, this argument is misplaced, as the claims do not require any "particular sizes" and Petitioner is not relying of the figures of the prior art to show such sizes with particularity. Rather, the claims simply require a relative relationship between the depth of the isolation region and the depth of the detection section; namely, that the former is greater than the latter. And, as discussed above, we do not consider reliance on the figures to show

relative sizes to be prohibited by *Hockerson-Halberstadt* or any of the other cases cited by Patent Owner. Indeed, as Petitioner points out, Patent Owner relies on a similar visual comparison of the depth of the two regions in Figure 7A of the '122 patent to establish that there is written description support for the proposed substitute claims. Amend Sur-Reply 3–4. Patent Owner cannot argue both that such visual observation of a figure is sufficient to establish written description support, but is simultaneously too unreliable to be sufficient to establish obviousness.

For these reasons, we find that He and Hong disclose the limitations of the proposed amended claims that are not present in KR '197 or Lee '767.

2. Obviousness Grounds – Reason to Combine

Although we conclude that the combined prior art cited by Petitioner discloses all elements of the proposed substitute claims, "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *KSR*, 550 U.S. at 418. We must also analyze whether Petitioner has proven that a person of ordinary skill in the art *would* have combined the disclosures of the references in the manner Petitioner suggests. *See Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("obviousness concerns whether a skilled artisan not only *could have* made [the combination] but *would have*."). Petitioner must provide "some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *Id*. This requires Petitioner to demonstrate by a preponderance of evidence that "a skilled artisan would have had reason to combine the teaching of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success from doing so." *PAR*

Pharm., Inc. v. TWI Pharm., *Inc.*, 773 F.3d 1186, 1193 (Fed. Cir. 2014). "[I]dentify[ing] a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does" can help protect against the pitfall of hindsight reasoning. *See KSR*, 550 U.S. at 418.

Petitioner contends that a person of ordinary skill in the art would have had reason to combine either KR '197 or Lee '767 with He or Hong. Opp. Amend 20–22. According to Petitioner, the two primary references of KR '197 and Lee '767 are directed to CMOS image sensors and disclose the "basic layout" of components such as a photodiode, transfer gate, floating diffusion node, and device isolation region. *Id*. at 20. The references allegedly lack some disclosure of "very basic characteristics of an image sensor," however, and Petitioner contends that a person of ordinary skill in the art would have looked to references such as He or Hong to provide these basic details. *Id*. For example, Petitioner contends that a person of ordinary skill in the art would have looked to He or Hong "to determine that the device isolation region could be deeper than and abutting the" floating diffusion node. *Id*. Petitioner characterizes these "very basic characteristics" as "mere design choices." Amend Sur-Reply 6. Mr. Guidash testifies similarly, that a person of skill in the art "would understand that abutting (or not abutting) are design choices," and that "[i]n general, the idea of abutting a device isolation region to an [floating diffusion node] is so well-known, it is simply a design choice in the image sensor art." Ex. 1028 ¶ 53. Mr. Guidash also directs us to He and Hong as evidence of this design choice. *Id*.

Patent Owner contends that, at best, Petitioner addresses only the question of whether a person of ordinary skill *could* have combined the

references, not whether they *would* have done so. Amend Reply 2. According to Patent Owner, it is insufficient for Mr. Guidash to have simply identified abutment and dielectric depth as design choices without considering the drawbacks of making those choices, and why a person of ordinary skill in the art would have made those particular design choices given those drawbacks. *Id*. at 3–4 (citing Ex. 1028 ¶¶ 51–60; Ex. 2025, 176:12–16, 178:8–188:25). Patent Owner also argues that Petitioner's analysis is flawed to the extent that it fails to take into account the art-recognized drawbacks of placing a device isolation region in direct, abutting contact with a floating diffusion node. *Id*. at 4–5. He and Lee '666, both references cited by Petitioner, as well as the Miyagawa reference cited by the Examiner during prosecution, discuss that contact between a floating diffusion node and a device isolation region is possible, but that such abutment has considerable drawbacks of "significant crystalline defects and undesired leakage currents." *Id*. (citing Ex. 1003, 3:35–42; Ex. 1007, 3:32–34; Ex. 1006 ¶¶ 21–23, 25). As such, Patent Owner contends, abutting the device isolation region and the floating diffusion node was not simply a "design choice," as Petitioner contends.

After reviewing the entirety of the record, we are led to the conclusion that Petitioner has not provided a satisfactory reason that a person of ordinary skill in the art would have combined the references in the manner proposed. At base, Petitioner's argument is that a person of skill would have begun with the image sensor layouts disclosed in KR '197 or Lee '767, but would have needed to look to He or Hong to "fill in" certain basic design characteristics not disclosed in the primary references. We accepted a similar reason to combine with respect to the original claims, concluding for example that because KR '197 did not discuss the material for its device

isolation region, the skilled artisan would have turned to a reference such as He to identify potential materials such as STI or Locos.

Petitioner's argument here, however, is different. The modification being proposed is not a *KSR*-type "simple substitution" of one element for another; nor is it as straightforward as the reason to combine applied to the original claims, involving choosing a material for a region when the primary references are silent as to that detail. Although Petitioner characterizes the elements that it identifies in He and Hong are "very basic characteristics" of an image sensor (Opp. Amend 20; Amend Sur-Reply 6), the record does not support this conclusion. Rather, what Petitioner proposes is a modification of an existing structure to an alternative structure disclosed in the prior art. For example, KR '197 already discloses a device that has a region in between the floating diffusion node and the isolation region (*see* Ex. 1004, Figure 7A), and Petitioner is proposing that a skilled artisan would have modified that structure to one having abutment, as disclosed in He or Hong. But Petitioner provides no reason for making that design alteration rather than indicating that those other references have shown that it is possible. *See* Amend Sur-Reply 10 ("Petitioner has never stated that those choices are 'equally viable.' Petitioner and its expert have only stated that there are two choices – abutting or not abutting."). Although *KSR* instructs us that "if a technique has been used to *improve* one device, and a person of ordinary skill in the art would recognize that it would *improve* similar devices in the same way, using the technique is obvious" (*KSR*, 550 U.S. at 417 (emphasis added)), neither Petitioner nor Mr. Guidash provide a satisfactory explanation why making a device isolation region abut a floating diffusion node is, in fact, an improvement. Indeed, Patent Owner provides evidence

that the prior art recognized significant drawbacks to making the modification proposed by Petitioner, such as increasing dark current.

Petitioner argues that the drawbacks identified by Patent Owner must not be insurmountable, because He recognizes those drawbacks and still abuts its device isolation region and floating diffusion node. Amend Sur-Reply 8. To be sure, recognition of the drawbacks of a particular feature does not foreclose incorporation of that feature in an obviousness analysis, short of a teaching away. But He addresses the issue of increased dark current by covering the surface of the photodiode with an overlying structure to protect against surface damage. Ex. 1007, Abstract. Petitioner does not recognize this feature of He, discuss whether a person of ordinary skill would have thought it necessary to have incorporated it into KR '197 to compensate for increased dark current, or address if its incorporation would have been compatible with KR '197's image sensor design at all. For all of these reasons, Petitioner has not established that the modification proposed to KR '197 would have led to any reasonable expectation of success, as opposed to an unacceptable increase in dark current. A "simple substitution" or "design choice" rationale does not relieve a Petitioner from addressing expectation of success, or whether the result a person of ordinary skill in the art would have expected from the modification would have been merely predictable. *See KSR*, 550 U.S. at 416 ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.").

In sum, while Petitioner has demonstrated that the prior art reflects that some image sensors used a structure in which a device isolation region abuts a floating diffusion node, Petitioner has not provided us with a sufficient reason why the skilled artisan *would* have modified the designs of

KR ’197 or Lee ’767 in such a manner, especially given the art-recognized drawbacks. *See Belden*, 805 F.3d at 1073. Petitioner’s evidence is not sufficient to support a rationale that abutment would have been a “design choice” or “simple substitution” of one element for another. As such, we find that Petitioner has not established a sufficient reason why a person of ordinary skill in the art would have made the modifications to KR ’197 or Lee ’767 to incorporate the designs of He or Hong, namely that the dielectric region abuts (or spans the sidewall of) the detection section.

3. Indefiniteness Ground

Finally, Petitioner raises an indefiniteness challenge to claims 51–60, arguing that the claim’s requirement that the dielectric region “spanning the sidewalls . . . to reduce a depletion region” does not provide any measure of the degree of reduction required. Opp. Amend 24–25. And Petitioner also argues that the term “spanning” is undefined in the ’122 patent, rendering the term vague, as it could encompass both “abutting” and “not abutting.” *Id*. On this latter point, Mr. Guidash testifies that “spanning” had no art-recognized meaning and therefore could refer to abutting or something altogether different. Ex. 1028 ¶¶ 5–6. Mr. Guidash recognizes, however, that the Patent Owner relies on Figures 7A and 7B of the ’122 patent as indicating “spanning.” *Id*.

Patent Owner notes that Mr. Guidash on cross-examination accepted that a dictionary meaning of “spanning” would be an appropriate ordinary and plain meaning of the term as used in the ’122 patent. Amend Reply 9. And furthermore, Patent Owner argues that the claim phrase is not rendered indefinite by the inclusion of “to reduce a depletion region,” citing Dr. Theuwissen’s testimony that the language signifies contact between the

floating diffusion node and the dielectric material, which would necessarily result in a reduction of the depletion region. *Id*. at 10 (citing Ex. 2026 ¶ 10; Ex. 2017, 49:14–17).

We find that neither the claim term "spanning," nor the inclusion of "to reduce a depletion region," renders claim 51 indefinite. We disagree with Petitioner's argument that "it is unclear whether 'spanning' requires abutment, or not." Amend Sur-Reply 13. Patent Owner indicates Figures 7A and 7B of the '122 patent as exemplifying "spanning," and those figures clearly show that the dielectric material abuts the floating diffusion node. As we have construed the term, "spanning" means that the device isolation region extends along the entire sidewall of the floating diffusion node. The term is not so vague that it rises to the level of indefinite.

Similarly, we are not convinced that "to reduce a depletion region" injects indefiniteness into claim 51. Dr. Theuwissen sufficiently explains why contact between the regions necessarily reduces a depletion region, and we do not read the claim to require any particular degree of reduction.

V. CONCLUSION

Based on the evidence and arguments, we find that Petitioner has met its burden as to original claims 1, 2, 4–12, 14–22, and 24–30, but has not met its burden as to original claims 3, 13, and 23. Patent Owner has met its burden to show that the Revised Motion to Amend meets all statutory and regulatory requirements, and Petitioner has not met its burden of proving that proposed substitute claims 31, 32, 34–42, 44–52, and 54–60 are unpatentable. We do not reach the Motion to Amend to the extent it seeks entry of proposed substitute claims 33, 43, or 53.

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Patent Owner's Motion to Exclude is *denied*;

FURTHER ORDERED that claims 1, 2, 4–12, 14–22, and 24–30 of U.S. Patent No. 7,145,122 B2 are *unpatentable*;

FURTHER ORDERED that claims 3, 13, and 23 have not been shown to be unpatentable;

FURTHER ORDERED that Patent Owner's Revised Motion to Amend is *granted*, and claims 31, 32, 34–42, 44–52, and 54–60 shall be added to U.S. Patent No. 7,145,122 B2; and

FURTHER ORDERED that, because this Decision is final, a party to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

In summary:

Claims	35 U.S.C.	Reference(s)	Claims Shown Unpatentable	Claims Not shown Unpatentable
1, 2, 4–7, 10–12, 14–17, 20–22, 24–27, 30	§ 102(a)	KR '197	1, 2, 4–7, 10–12, 14–17, 20–22, 24–27, 30	
3, 13, 23	§ 103(a)	KR '197 "in view of the knowledge of a person having ordinary skill in the art"		3, 13, 23
8, 9, 18, 19, 28, 29	§ 103(a)	KR '197, He	8, 9, 18, 19, 28, 29	
1, 2, 4–7, 9–12, 14–17,	§ 103(a)	Lee '767, Lee '666	1, 2, 4–7, 9–12, 14–17,	

Claims	35 U.S.C.	Reference(s)	Claims Shown Unpatentable	Claims Not shown Unpatentable
19–22, 24–27, 29–30			19–22, 24–27, 29–30	
3, 13, 23	§ 103(a)	Lee ’767, Lee ’666, “in view of the knowledge of a person having ordinary skill in the art”		3, 13, 23
8, 9, 18, 19, 28, 29	§ 103(a)	Lee ’767, Lee ’666, He	8, 9, 18, 19, 28, 29	
Overall Outcome			1, 2, 4–12, 14–22, 24–30	3, 13, 23

Motion to Amend Outcome	Claim(s)
Substitute Claims Proposed in the Amendment	31–60
Substitute Claims: Motion to Amend Granted	31, 32, 34–42, 44–52, 54–60
Substitute Claims: Motion to Amend Denied	
Substitute Claims: Not Reached	33, 43, 53

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