

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LONGI GREEN ENERGY TECHNOLOGY CO., LTD., LONGI SOLAR
TECHNOLOGY CO., LTD.,
LONGI (H.K.) TRADING LTD.,
LONGI (KUCHING) SDN. BHD.,
LONGI SOLAR TECHNOLOGY (TAIZHOU) CO., LTD.,
LONGI SOLAR TECHNOLOGY (ZHEJIANG) CO., LTD.,
LONGI SOLAR TECHNOLOGY (HEFEI) CO., LTD., and LONGI
SOLAR TECHNOLOGY (US), INC.,
Petitioner,

v.

HANWHA Q CELLS & ADVANCED MATERIALS CORP.,
Patent Owner.

IPR2020-00353
Patent 8,933,525 B2

Before CHRISTOPHER L. CRUMBLEY, JEFFREY W. ABRAHAM, and
JASON M. REPKO, *Administrative Patent Judges*.

REPKO, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

LONGi Green Energy Technology Co., Ltd., LONGi Solar Technology Co., Ltd., LONGi (H.K.) Trading Ltd., LONGi (Kuching) Sdn. Bhd., LONGi Solar Technology (Taizhou) Co., Ltd., LONGi Solar Technology (Zhejiang) Co., Ltd., LONGi Solar Technology (Hefei) Co., Ltd., and LONGi Solar Technology (Us), Inc. (collectively, “Petitioner”) filed a petition requesting *inter partes* review of claims 1–18 of U.S. Patent No. 8,933,525 B2 (Ex. 1001, “the ’525 patent”). Paper 1 (“Pet.”). Hanwha Q Cells & Advanced Materials Corp. (“Patent Owner”) filed a Preliminary Response. Paper 10 (“Prelim. Resp.”).

On June 30, 2020, we instituted an *inter partes* review of all challenged claims based on all grounds in the Petition. Paper 11 (“Inst. Dec.”). Patent Owner filed a Response. Paper 15 (“PO Resp.”). Petitioner filed a Reply. Paper 19 (“Pet. Reply”). Patent Owner filed a Sur-reply. Paper 20 (“Sur-reply”). An oral hearing was held on March 25, 2021. A transcript of that hearing has been entered into the record. Paper 24 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued under 35 U.S.C. § 318(a). For the reasons that follow, Petitioner has shown by a preponderance of the evidence that claims 1–18 are unpatentable.

A. Related Matters

Both parties assert that the ’525 patent is not involved in any pending litigation. *See* Paper 9, 2 (Patent Owner’s Updated Mandatory Notices); Paper 14, 2 (Petitioner’s Updated Mandatory Notices).

B. The '525 Patent

The '525 patent generally relates to semiconductor fabrication for improved solar-cell efficiency. *See* Ex. 1001, 1:14–24, 2:40–46. Solar-cell efficiency is limited by the phenomenon of surface recombination. *Id.* at 1:17–20. In solar cells, recombination of charge carriers occurs at the semiconductor surface. *Id.* These recombined charge carriers are no longer available for generating current. *Id.* at 1:20–21. To reduce surface recombination, semiconductors use passivation layers. *Id.* at 1:21–24. Passivation layers can use chemical or field-effect passivation. *Id.* at 1:25–52. The '525 patent uses both types of layers for improved passivation. *Id.* at 2:19–27. According to the '525 patent, forming a layer from two passivation sublayers with different passivation mechanisms improves passivation quality “beyond a mere accumulation of the known individual effects.” *Id.* at 2:22–27.

C. Claims

Claims 1 and 15, reproduced below, are independent.

1. A semiconductor apparatus comprising:

a semiconductor layer in the form of a wafer and a passivation layer arranged on a surface of the semiconductor layer and serving for passivating the semiconductor layer surface, wherein the passivation layer comprises a chemically passivating passivation sublayer and a field-effect-passivating passivation sublayer, which are arranged one above the other on the semiconductor layer surface;

wherein the chemically passivating passivation sublayer directly adjoins the field-effect-passivating passivation sublayer without further intermediate layers being arranged therebetween and wherein:

- i) the field-effect-passivating passivation sublayer is substantially formed from a material having a negative surface charge density; and
- ii) a covering layer comprising silicon nitride applied on the passivation layer.

Ex. 1001, 10:12–29.

15. A method of fabrication for a semiconductor apparatus, wherein a semiconductor layer in the form of a wafer is provided, having a semiconductor layer surface, and wherein a chemically passivating passivation sublayer and a field-effect-passivating passivation sublayer are applied successively on the semiconductor layer surface in order jointly to form a passivation layer, wherein the chemically passivating passivation sublayer and the field-effect-passivating passivation sublayer are applied such that chemically passivating passivation sublayer directly adjoins the field-effect-passivating passivation sublayer without further intermediate layers being arranged therebetween and wherein:

- i) the field-effect-passivating passivation sublayer is substantially formed from a material having a negative surface charge density; and
- ii) a covering layer comprising silicon nitride is applied on the passivation layer.

Id. at 11:1–12:5.

D. Evidence

Name	Reference	Exhibit No.
Sun	US 2009/0165855 A1, published July 2, 2009	1005
Hoex	B. Hoex et al., <i>Ultralow surface recombination of c-Si substrates passivated by plasma-assisted atomic layer deposited Al₂O₃</i> , 89 Applied Physics Letters 042112 (2006), http://dx.doi.org/10.1063/1.2240736	1007
Schmidt	J. Schmidt et al., <i>Surface Passivation of High-</i>	1008

	<i>efficiency Silicon Solar Cells by Atomic-layer-deposited Al₂O₃</i> , 16 Progress In Photovoltaics: Research and Applications 461–66 (2008)	
Hagino	US 2004/0112426 A1, published June 17, 2004	1009

Petitioner relies on the Declaration of Dr. Sanjay Banerjee. Ex. 1003 (“Banerjee Decl.”). Patent Owner relies on the declaration of Dr. Michael Lebby. Ex. 2001 (“Lebby Decl.”).

E. Asserted Grounds

Petitioner asserts that claims 1–18 are unpatentable on the grounds in the table below. Pet. 4.

Claims Challenged	Pre-AIA¹ 35 U.S.C. §	Reference(s)
1–6, 8–11, 13–16, 18	103(a)	Sun
3, 6, 7, 12, 18	103(a)	Sun, Schmidt
5, 7, 12, 14	103(a)	Sun, Hoex
6, 17, 18	103(a)	Sun, Hagino

II. ANALYSIS

A. Level of Ordinary Skill in the Art

The Supreme Court in *Graham v. John Deere Co.*, 383 U.S. 1 (1966) set forth four factual inquiries for determining whether a claim is unpatentable as obvious under 35 U.S.C. § 103(a). *KSR International Co. v. Teleflex Inc.* reaffirmed and summarized those four factors: (1) determining the scope and content of the prior art, (2) ascertaining the differences between the prior art and the claims at issue, (3) resolving the level of ordinary skill in the pertinent art, and (4) when in evidence, considering

¹ Congress amended § 103 when it passed the Leahy-Smith America Invents Act (AIA). Pub. L. No. 112–29, § 3(c), 125 Stat. 284, 287 (2011). Here, the previous version of § 103 applies.

objective evidence indicating obviousness or nonobviousness. 550 U.S. 398, 406 (2007) (citing *Graham*, 383 U.S. at 17–18). We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of the invention. *Graham*, 383 U.S. at 17.

According to Petitioner,

A person of ordinary skill in the art in the field of the 525 Patent (semiconductor, *e.g.*, solar cell, design or manufacture) in the 2009 time frame would have been someone with an advanced degree involving the discipline of electrical engineering, applied physics, chemistry, or materials science, and at least two years of experience designing, developing, or researching in the field.

Pet. 4

Alternatively, Petitioner asserts that a person of ordinary skill in the art “would have had a bachelor’s degree in electrical engineering, applied physics, chemistry, or materials science, and at least three years designing, developing, or researching in the field.” *Id.* at 5.

In the Institution Decision, we applied Petitioner’s proposed definition, and we asked the parties to discuss the level of ordinary skill in the art in the remaining briefing should Patent Owner propose a different definition. Inst. Dec. 5–6. Patent Owner does not dispute Petitioner’s proposed level of ordinary skill in the art. (PO Resp. 3), and neither party disagreed with the level that we applied in the Institution Decision. We continue to find that the level of ordinary skill identified by Petitioner (Pet. 4) is consistent with the record. *See* Inst. Dec. 6. Thus, we use the same definition here that we used in the Institution Decision.

B. Claim Construction

In *inter partes* review proceedings, we interpret claims in the same way as a civil action under 35 U.S.C. § 282(b), “including construing the

claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b) (2019). Only terms that are in controversy need to be construed and only to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Claim 6 recites that “the passivation layer is embodied as a reflection layer or as an antireflection layer.” Ex. 1001, 10:46–48 (emphasis added). Claim 18 recites “wherein the chemically passivating passivation sublayer and the field-effect-passivating passivation sublayer are applied in such a way that the passivation layer resulting therefrom acts as a reflection layer or as an antireflection layer.” *Id.* at 12:18–21. The parties disagree on what it means for a layer to be embodied as or act as a reflection layer or an antireflection layer, as recited in claims 6 and 18. Thus, to resolve the controversy here, we must determine the proper construction of “reflection layer” and “antireflection layer” in claims 6 and 18. *Id.* at 10:46–48.

1. The Parties’ Constructions

The Petition states that the claim terms should be given their plain and ordinary meaning. Pet. 9–10. But, in analyzing claims 6 and 18, Petitioner’s mapping to the prior art contains an implicit construction for the recited reflection and antireflection layers: a layer is (1) a reflection layer if it is part of a stack of layers that collectively function to enhance reflection on the back of a solar cell relative to the incident light or (2) an antireflection layer if it is part of a stack of layers that collectively suppress reflection on the front of the solar cell relative to the incident light. *Id.* at 37–40; 53–54

(discussing improving light-trapping properties); 66–67 (discussing “suppressing reflection”).

In particular, the Petition refers to multiple layers when discussing whether passivation layers act as a reflective or antireflective layer. *Id.* That is, Petitioner considers the function of multiple layers acting together. *See id.* For example, Petitioner states that “it was typical to design the back passivation *layers* to act as a reflector.” *Id.* at 38 (emphasis added). Likewise, the Petition states that “passivation *layers* deposited on the front side of the solar cell would have to act as an anti-reflection layer.” *Id.* (emphasis added); *see also id.* at 39 (“all the dielectric layers (i.e., 104a, 106a, 108a, altogether) on top of Sun’s ‘photoelectric conversion layer’ 102 should, altogether, have anti-reflection properties”); *see also* Tr. 20:4–5 (“All three layers are part of the antireflection stack and each one is considered to be an antireflection layer.”); *id.* at 21:1–13 (discussing collective function). These statements also refer to the layers’ placement, i.e., on the cell’s front surface or back surface relative to the incident light, and how the prior art’s stack of layers enhances or suppresses reflection. *See* Pet. 37–40; 53–54; 66–67.

Unlike Petitioner, Patent Owner argues that one has to look at each layer individually to determine whether it is a reflective or antireflective layer. Tr. 41:20–42:3 (“So we have to look at each piece . . . You can break it out, and you have to do that. That’s what the claims tell us.”). Patent Owner argues that an individual layer must be “specifically fashioned” to be a reflection or antireflection layer. Sur-reply 3.

Also, in Patent Owner’s view, a reflection or antireflection layer is not merely any dielectric layer. *Id.* For example, Patent Owner argues that “Dr. Lebby explained that a [person of ordinary skill in the art] would understand

an individual antireflection layer is *calibrated* to minimize the amount of light reflecting off of the front surface of a solar cell through destructive interference.” *Id.* (emphasis added); *see also id.* at 6 n.1 (discussing how the antireflection layers must be “specifically calibrated”); Tr. 29:19–21 (discussing “destructive interference”). Patent Owner similarly argues that “[a] **reflection** layer is a thick layer placed against the back metal contact of a solar cell and is used as a cavity to trap light that would otherwise scatter off of the back metal contact away from the solar cell.” Sur-reply 3 (citing Ex. 1025, 41:7–42:5; Ex. 2001). Patent Owner thus argues “the optical properties and thicknesses of a layer must be ‘**chosen**’ to enable the functions of reflection or antireflection.” *Id.* (emphasis in original).

2. Analysis

Having reviewed and considered the record, we agree with Petitioner that the proper construction of “reflective” and “antireflective” considers both the layer’s position relative to the incident light and the collective function of multiple layers. *See* Pet. 37–40; 53–54; 66–67. That is, a layer is (1) a reflection layer if it is part of a stack of layers that collectively function to enhance reflection on the back of a solar cell relative to the incident light or (2) an antireflection layer if it is part of a stack of layers that collectively suppresses reflection on the front of the solar cell relative to the incident light. *Id.* Our reasoning follows.

Under *Phillips*, we first look to the claim language. *Phillips*, 415 F.3d 1303, 1312 (Fed. Cir. 2005). The claim recites that the layer must be “embodied as” (claim 6, Ex. 1001, 10:46–48) or “act as” (claim 18, *id.* at

12:18–21) a reflection or antireflection layer.² The parties, though, do not argue that the issues here turn on the meaning of “embodied” or “act.” *See, e.g.*, PO Resp. 18; Sur-reply 11–26; Tr. 11:9–20. And we determine that the difference in claim language does not affect our analysis of the prior art. So we do not need to construe the terms “embodied” or “act.” Apart from those terms, the claims do not impose any other limitations on the recited reflection layer or antireflection layer. For example, the claims do not include any requirements on what degree of reflection or antireflection is necessary to satisfy the limitation.

Likewise, the written description of the ’525 patent does not define reflection or antireflection by a particular performance threshold or other metric. As stated in *Phillips*, “the specification is always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.” *Phillips*, 415 F.3d at 1315 (internal quotes and citation omitted). Here, the ’525 patent explains that thickness, among other “optical properties,” determines whether a layer embodies an antireflection or reflection layer. Ex. 1001, 5:34–38; *see also id.* at 7:1–10 (discussing “additional optical properties”). Yet the ’525 patent does not further specify how to make a layer reflective or anti-reflective. *See generally id.* For instance, the patent does not specify an optimal thickness. *See id.*

² We agree with Petitioner that the term “or” indicates that a passivation layer that is embodied as, or acts as, either an antireflection layer or a reflection layer satisfies claims 6 and 18. Pet. Reply 2 (citing Ex. 1025, 120:12–122:7). Patent Owner does not dispute this. *See generally* PO Resp.; Sur-reply (arguing both reflection and antireflection layer limitations in the alternative).

Instead of focusing on a performance metric or a property like thickness, Petitioner’s interpretation emphasizes the layer’s actual—as opposed to intended—role in the overall design of the solar cell, e.g., as “part of a reflection layer.” *See, e.g.*, Pet. 37–38. In this way, Petitioner’s assertions are consistent with the language of claims 6 and 18, which recite the passivation layer is embodied as “a reflection layer or as an antireflection layer.” Ex. 1001, 10:47–48 (claim 6), 12:20–21 (claim 18) (emphasis added). We emphasize “a” and “an” because those terms indicate that more than one layer can be a reflection or antireflection layer:

“As a general rule, the words ‘a’ or ‘an’ in a patent claim carry the meaning of ‘one or more.’” *TiVo, Inc. v. EchoStar Commc’ns Corp.*, 516 F.3d 1290, 1303 (Fed. Cir. 2008). “The exceptions to this rule are extremely limited: a patentee must evince a clear intent to limit ‘a’ or ‘an’ to ‘one.’” *Baldwin Graphic Sys., Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1342 (Fed. Cir. 2008) (internal quotation marks and citation omitted). “The subsequent use of definite articles ‘the’ or ‘said’ in a claim to refer back to the same claim term does not change the general plural rule, but simply reinvokes that non-singular meaning.” *Id.* An exception to the general rule arises only “where the language of the claims themselves, the specification, or the prosecution history necessitate a departure from the rule.” *Id.* at 1342–43.

01 Communique Lab., Inc. v. LogMeIn, Inc., 687 F.3d 1292, 1297 (Fed. Cir. 2012). Here, we see no exception that would necessitate a departure from the general rule. *See, e.g.*, Ex. 1001, 1:1–10:10, (the descriptive part of the specification); Ex. 1002 (file history of the patent).

Petitioner’s assertions (Pet. 38–39) also imply a construction that is consistent with the ’525 patent’s descriptions of the layers in a solar cell. The patent describes how another layer can work with a passivation layer to influence its optical properties:

In one advantageous development it is provided that an intermediate layer is arranged between the chemically passivating passivation sublayer and the field-effect-passivating passivation sublayer. The intermediate layer can serve for *influencing or optimizing* electrical, optical and/or mechanical properties of the passivation layer or the connection between the two passivation sublayers

Ex. 1001, 4:35–47 (emphasis added). In this case, a stack comprises the intermediate layer and the passivation layer. *See id.* The patent explains that the layers can have a cumulative effect on the stack’s overall properties. *Id.* at 4:48–52, *cited in* Pet. Reply 16 n.5. The patent also explains that adding another layer to the passivation layer adapts it for antireflection. *Id.* After describing this embodiment, the phrase “antireflection layer–ARC” appears in parentheses. *Id.*; *see also* Sur-reply 21 (discussing “antireflection coating ‘ARC’”). Thus, in this example, the patent treats the passivation layer as part of an antireflection layer because it contributes to the antireflective properties of the entire structure, including the ARC. *See* Ex. 1001, 4:48–52.

Petitioner’s interpretation (Pet. 38–39) is also consistent with the plain and ordinary meaning of reflection and antireflection layers as understood by a person of ordinary skill in the art, as demonstrated by Patent Owner’s own evidence and arguments. For example, Dr. Lebby describes how a solar cell’s layers work together: When dielectric reflection layers are placed between an aluminum metal sheet and the substrate, the dielectric reflection layer acts as a cavity that traps light. Lebby Decl. ¶ 45, *discussed in* PO Resp. 11–12. Dr. Lebby also refers to the collection of layers as dielectric “reflection layers,” which indicates that the layers can work together to improve overall reflection. *Id.*

Petitioner's position is also consistent with Patent Owner's characterization of Kavakli (Ex. 1030). Sur-Reply 10–11. Patent Owner notes that Kavakli teaches that “the number of layers and their relative position in the stack also impacts” antireflection. *Id.* at 11 (citing Ex. 1030, 351–352). We agree that the cited teachings support this statement: Kavakli selects the inside layer's properties based on those of the outside layer. Ex. 1030, 351–352. Thus, like Petitioner's implicit construction (Pet. 38–39), Kavakli considers how multiple layers work together.

Also, in arguing against Petitioner's simulated experiments, Patent Owner explains that “after light is already trapped in the simulated top-layer cavity of SiN, the SiO₂/Al₂O₃ layers underneath would also contribute to the light trapping,” and thus, Patent Owner contends that Petitioner should account for “any additive impact of SiO₂/Al₂O₃ to reflection when placed *underneath* the SiN top layer.” Sur-reply 24 (emphasis in original). In this way, Patent Owner acknowledges that one must account for the collective function of the stack of layers. *See id.*

Patent Owner does offer a rebuttal to Petitioner's implicit construction, arguing that Petitioner's focus on the stack as a whole renders claims 6 and 18 superfluous. *Id.* at 4; *see also* Tr. 41:20–42:3 (arguing that the layers should be considered individually). But we do not agree that considering the other layers' functions results in a boundless construction. Petitioner's implicit construction at least excludes layers that are not part of a stack that enhances or suppresses reflection. That is, under the construction that is used in Petitioner's analysis, the claims would exclude a passivation layer that does not enhance or suppress reflection by itself and is also not used with another layer to enhance or suppress reflection. *See* Pet. 37–40; 53–54; 66–67. Also, the terms “reflection” and “antireflection” limit the

placement of the layer. Specifically, Dr. Banerjee explains how a layer's placement relative to the incident light—i.e., on the front or back of the solar cell—is one indication of whether a layer is a reflective layer or antireflective layer. Banerjee Decl. ¶¶ 118–119.

Consistent with the '525 patent's description, we also disagree with Patent Owner's construction to the extent that it uses a performance metric or threshold to determine whether a layer is a reflection or antireflection layer. *See, e.g.*, PO Resp. 17–20; Sur-reply 3, 7; Tr. 31:15–32:20. That is, Patent Owner argues that antireflection layers must have an “optimal thickness.” PO Resp. 17–20. Patent Owner cites a specific equation known as “the quarter wavelength equation.” *Id.* at 17 (citing Lebby Decl. ¶ 57, Ex. 2003, 1:46–60, Ex. 2002, 80–81); *see also* Sur-reply 7 (discussing the equation). In Patent Owner's view, to be an antireflection layer, the layer must be designed “to minimize the amount of light reflecting off of the front surface of a solar cell through destructive interference” or otherwise “specifically fashion[ed]” to have an optimal thickness. Sur-reply 3.

Patent Owner's claim-construction arguments, though, are undermined by Dr. Lebby's and Dr. Banerjee's testimony on how solar cells are designed. *See* PO Resp. 16–20, 24–27; Sur-reply 2–7. Specifically, Dr. Lebby was asked about a threshold value and answered:

I haven't seen anything in the prior art that relates to the solar cells that indicates that there is a threshold for reflective to antireflective. So I certainly haven't seen those metrics discussed, and I am certainly not aware of those metrics.

Ex. 1025, 19:16–25. Dr. Lebby emphasizes throughout his testimony that no single parameter determines whether a layer is reflective or antireflective. *Id.* at 19:16–25, 43:18–19, 138:8–14. Dr. Lebby stated, “That

is what I have been indicating all day in this deposition[:] It's not just the thickness issue." *Id.* at 138:8–14.

Likewise, in the cited deposition from an ITC case³ not involving the '525 patent, Dr. Banerjee was asked about the "ideal lambda" to use in the quarter-wavelength formula when designing a solar cell. Ex. 2004, 248:13–249:3. Dr. Banerjee replied,

I mean, unfortunately, the solar spectrum is a broadband spectrum. So you look at the solar spectrum, and I think that's shown in Nakano,⁴ if I remember right. So you pick something sort of in the middle. The visible part of the spectrum is between 400 to 800 nanometers. But then you have to couple that with the band gap of silicon, which is 1.1 EV. So something on the order of 500 nanometers will be a reasonable choice.

Id., discussed in Sur-reply 7–8. Also, Dr. Banerjee was asked about whether 30 nm of aluminum oxide will have good antireflective properties at a particular wavelength. *Id.* at 250:13–19. Dr. Banerjee replied that anti-reflection is not defined by a particular wavelength:

Well, the choice of 500 nanometers was somewhat arbitrary. So it would be -- you know, it's not as if it's anti-reflective at precisely one wavelength. It's a range, you know. At that specific wavelength it will be more or less perfect cancellation. But around that wavelength also there would be partial cancellation.

Id., cited in Sur-reply 8.

We do not view Dr. Banerjee's testimony in the ITC deposition as contradicting Petitioner's position or the Banerjee Declaration in this case. Sur-reply 5–8. Rather, like Dr. Lebby's testimony, Dr. Banerjee's

³ Patent Owner filed the transcript of Dr. Banerjee's testimony, conducted on September 4, 2019, from a matter before the United States International Trade Commission (ITC): *Certain Photovoltaic Cells and Products Containing Same*, Inv. No. 337-TA-1151. Ex. 2004.

⁴ U.S. Patent No. 4,463,216 to Nakano et al. is Exhibit 2003.

description of “something sort of in the middle” (*id.* at 248:18–19) and “around that wavelength” (*id.* at 250:18) supports the proposition that one specific parameter does not define whether an individual layer is reflective or antireflective.

Indeed, because Petitioner does not rely on performance metrics or optimization of individual layers in the Petition, Petitioner’s assertions align with Dr. Lebby’s and Dr. Banerjee’s testimony discussed above. *See* Pet. 38–39. The grounds in the Petition address how a layer functions within a collection or stack of layers placed in a specific location, not the degree of enhancement or suppression of reflection that an individual layer provides.

Likewise, we disagree with Patent Owner’s argument that we should consider the designer’s intended purpose for the layer. *See* PO Resp. 17–30; Sur-reply 3, 7. First, such a construction would turn on one’s subjective intent, which is not a proper basis for construing claim terms. *See, e.g., Geneva Pharms., Inc. v. Glaxo-SmithKline PLC*, 349 F.3d 1373, 1384 (Fed. Cir. 2003).

Second, the record shows that, to determine a designer’s intended purpose for a layer, one would have to account for numerous possible parameters and functions. *See, e.g.,* Ex. 1025, 19:16–25 (Dr. Lebby’s testimony about thresholds); Ex. 2004, 250:13–19; Ex. 2004, 248:13–259:3 (Dr. Banerjee’s testimony about “ideal” parameters). Dr. Lebby testified that “it is not just the thickness” that determines antireflection, but “the composition, the refractive index, what its performance is over wavelengths . . . come into play, too.” Ex. 1025, 147:7–11; *see also id.* at 138:8–14. Even Patent Owner acknowledges that “a POSITA would not conclude that a passivation layer is an antireflection layer merely based on its thickness.” Sur-reply 16–17 (citing Ex. 2001 ¶¶ 60–64).

One may design a layer to perform well for multiple purposes. For example, the '525 patent explains that passivation layers may perform functional tasks during solar-cell fabrication, serving as etching, texture, or diffusion barriers. Ex. 1001, 6:56–59. Yet the record provides little guidance on how to use a particular equation or metric, for example, to determine the designer's intent. Thus, in construing the claims, we do not consider what the designer may have intended when choosing a specific layer. *See* Sur-reply 3, 7, 14.

In sum, we disagree with Patent Owner's argument that the claims require an intentional choice to embody the passivation layer as a reflection or antireflection layer. Sur-reply 3; *see also* Tr. 31:15–32:20 (arguing for particular values used to classify layers). Nor do we consider the claims to require evaluating the reflective or antireflective properties of the layers in isolation. Sur-reply 4; Tr. 41:20–42:3.

For claims 6 and 18, we adopt the construction applied in Petitioner's analysis in the Petition: A layer is (1) a reflection layer if it is part of a stack of layers that collectively function to enhance reflection on the back of a solar cell relative to the incident light or (2) an antireflection layer if it is part of a stack of layers that collectively suppress reflection on the front of the solar cell relative to the incident light. Pet. 37–40; 53–54; 66–67. Because nothing more specific is needed to resolve the issue in this Decision, we do not further construe "reflection layer" or "antireflection layer."

C. Uncontested Grounds: Claims 1–5 and 7–17

In our Institution Decision, we concluded that Petitioner's argument and evidence demonstrated a reasonable likelihood that claims 1–18 were unpatentable as obvious based on the challenges identified in the table in section I.E. Inst. Dec. 2. We must now determine whether Petitioner has

established by a preponderance of the evidence that the specified claims are unpatentable over the cited prior art. 35 U.S.C. § 316(e); 37 C.F.R.

§ 42.1(d). Petitioner “has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016). This burden never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

We previously instructed Patent Owner that “any arguments for patentability not raised in the [Patent Owner Response] may be deemed waived.” Paper 12, 8; *see also In re Nuvasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016) (holding that patent owner’s failure to make arguments at trial as instructed in the scheduling order constitutes waiver). Also, the Board’s Trial Practice Guide states that the Patent Owner Response “should identify all the involved claims that are believed to be patentable and state the basis for that belief.” Patent Trial and Appeal Board Consolidated Trial Practice Guide 66 (Nov. 20, 2019), *available at* <http://www.uspto.gov/TrialPracticeGuideConsolidated>.

In the Response, Patent Owner only argued for the patentability of claims 6 and 18, which depend from claims 1 and 15. Before considering the patentability of claims 6 and 18, we first analyze the Petitioner’s challenges to claims 1–5 and 7–17.

1. Obviousness over Sun

Petitioner asserts that claims 1–5, 8–11, and 13–16 are unpatentable as having been obvious over Sun alone. Pet. 17–50.

a) Sun

Sun generally relates to passivation layers for solar cells. Ex. 1005, Abstract. Sun uses two passivation layers. *Id.* The first passivation layer is

disposed on the substrate. *Id.* The second passivation layer is between the substrate and first passivation layer, and the material for the second layer is the oxide of the substrate material. *Id.* According to Sun, this arrangement enhances the surface-passivation effect and carrier lifetime, which improves the solar cell's photoelectric-conversion efficiency. *Id.*

b) Claim 1

The Petition contains an analysis of how Sun allegedly teaches or suggests each limitation of claim 1. Pet. 17–32. Petitioner supports its assertions with Dr. Banerjee's testimony. Banerjee Decl. Patent Owner does not substantively address these assertions or otherwise contend that the art lacks any of the features recited in claim 1. *See* PO Resp. 14–29.

(1) The Semiconductor Layer

Claim 1 recites, in part, “a semiconductor layer in the form of a wafer.” Ex. 1001, 10:13. Petitioner asserts that photoelectric-conversion layer 102 corresponds to the claimed semiconductor layer. *Id.* Petitioner's assertion is adequately supported by Dr. Banerjee's undisputed testimony, which we credit. *See* Banerjee Decl. ¶ 80. And in the paragraph cited in the Petition, Sun states that the photoelectric-conversion layer 102 is a p-type poly-silicon wafer. Ex. 1005 ¶ 39. Thus, we find that Sun teaches a semiconductor apparatus comprising “a semiconductor layer in the form of a wafer,” as recited in claim 1. Pet. 18–19.

(2) The Chemically Passivating Sublayer

Claim 1 recites, in part, “a passivation layer arranged on a surface of the semiconductor layer and serving for passivating the semiconductor layer surface, wherein the passivation layer comprises a chemically passivating passivation sublayer.” Ex. 1001, 10:13–16.

Petitioner asserts that Sun's second passivation layer performs the same chemical passivation that is disclosed in the '525 patent. Pet. 20. Specifically, Petitioner asserts that the patent's chemical passivation relies on chemical saturation of free-surface (dangling) bonds. *Id.* at 21. For its silicon semiconductor solar cells, the '525 patent uses thermal growth of a silicon-oxide (SiO_2) layer. *Id.* (citing Ex. 1001, 1:31–39, 3:16–20). Likewise, Petitioner asserts that Sun uses thermal oxidation of the silicon-oxide layer. *Id.* at 22 (citing Ex. 1005 ¶ 19; Banerjee Decl. ¶ 86). Relying on Dr. Banerjee's testimony, Petitioner asserts that one skilled in the art would understand that a silicon-oxide layer formed in this way would chemically passivate the silicon wafer by reducing the density of surface states. *Id.* (citing Ex. 1022, H388–390; Banerjee Decl. ¶ 86). Although Petitioner points out other ways that Sun's second passivation layer meets the claimed chemical passivation layer (*see id.* at 21–25), based on Petitioner's assertions discussed here we find that the limitation is met by Sun.

(3) The Field-Effect Passivating Sublayer

In addition to the chemically passivating layer, the recited passivation layer also comprises “a field-effect-passivating passivation sublayer.” Ex. 1001, 10:17–18.

As for this field-effect passivating layer, Petitioner asserts that Sun's first passivation layer performs the same field-effect passivation that is disclosed in the '525 patent. Pet. 25 (citing Ex. 1005 ¶¶ 26, 43, Fig. 2; Banerjee Decl. ¶ 91). For example, Petitioner points out that the '525 patent describes aluminum oxide as an example of a negatively-charged sublayer for field-effect passivation. *Id.* at 26 (citing Ex. 1001, 1:40–52; Banerjee Decl. ¶ 91). Likewise, Sun's first passivation layer is aluminum oxide. Ex. 1005 ¶ 26, *cited in* Pet. 26. Sun explains that this layer enhances

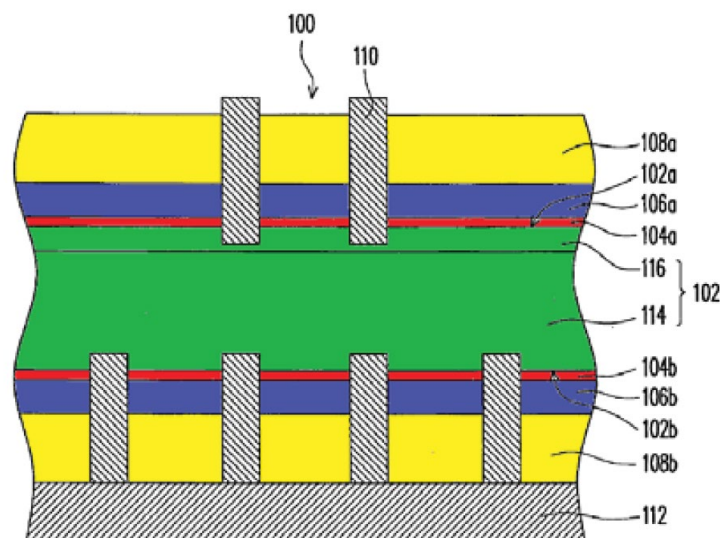
the surface-passivation effect by pushing away electrons from the surface by fixed negative charges. *Id.* For at least this reason, we find that Sun teaches the recited “field-effect-passivating passivation sublayer is substantially formed from a material having a negative surface charge density,” as recited in claim 1.

Thus, Petitioner shows that Sun’s passivation layer comprises (1) a chemically passivating passivation sublayer and (2) a field-effect passivating passivation sublayer, as recited in claim 1. Pet. 20–29.

(4) The Arrangement of Passivating Sublayers

Claim 1 further limits the arrangement of the sublayers: “one above the other,” “on the semiconductor layer surface,” and “the chemically passivating passivation sublayer directly adjoins the field-effect-passivating passivation sublayer without further intermediate layers being arranged therebetween.” Ex. 1001, 10:14–24.

Figure 2 of Sun with Petitioner’s annotations is reproduced below. Pet. 19.



Sun’s Figure 2, above, shows a cross-sectional view of the solar cell’s structure with colored layers. *Id.*

Petitioner asserts that Sun’s passivation layer is formed by layers 104a or 104b in red and 106a or 106b in blue. *Id.* According to Petitioner, layers 104a or 104b (red) are chemically passivating sublayers, layers 106a and 106b (blue) are field-effect passivating sublayers, and the photoelectric-conversion layer 102 (green) is a semiconductor layer. *Id.* at 19, 20, 30. Indeed, Sun’s Figure 2 shows passivation layers 106a and 104a (blue, red) on the semiconductor layer surface 102 (green), and there are no intermediate layers between those passivation layers. Ex. 1005, Fig. 2.

Thus, we find that Sun’s sublayers are “one above the other,” “on the semiconductor layer surface,” and “the chemically passivating passivation sublayer directly adjoins the field-effect-passivating passivation sublayer without further intermediate layers being arranged therebetween.” Pet. 19, 20, 30.

(5) The Covering Layer

Claim 1 further recites, in part, “a covering layer comprising silicon nitride applied on the passivation layer.” Ex. 1001, 10:28–29. We find that Sun’s layer 108a meets this limitation. Pet. 31. In particular, Sun’s silicon-nitride layer 108a is applied on and covers passivation layer 106a (or 108b and 106b). Ex. 1005 ¶¶ 23, 28, *cited in* Pet. 31; *see also* Banerjee Decl. ¶ 101

In summary, we find that for the reasons given, Petitioner has shown by a preponderance of the evidence that Sun teaches each limitation of claim 1 and that the claim is unpatentable. We adopt Petitioner’s analysis, which Patent Owner does not contest.

c) Claim 15

The Petition contains an analysis of how Sun allegedly teaches or suggests each limitation of claim 15. Pet. 46–49. Petitioner supports this

analysis with undisputed testimony of Dr. Banerjee. *See* Banerjee Decl.

¶¶ 141–147. Patent Owner does not contest these grounds. We have reviewed Petitioner’s uncontested assertions. For reasons similar to those discussed in connection with claim 1, we determine that these assertions are sufficiently supported by the evidence of record. *See supra* § II.C.1.b).

d) Claims 2–4, 8–11, 13, 14, and 16

For dependent claims 2–4, 8–11, 13, 14, and 16, Petitioner provides a detailed analysis identifying where Sun teaches or suggests each limitation. Pet. 32–50. Patent Owner does not contest these grounds. Upon review of the entirety of the record, we credit the testimony of Dr. Banerjee and adopt Petitioner’s uncontested analysis. Thus, we determine that Petitioner has shown by a preponderance of the evidence that the subject matter recited in claims 2–4, 8–11, 13, 14, and 16 would have been obvious.

e) Claim 5

Claim 5 recites, “The semiconductor apparatus as claimed in claim 1, wherein the field-effect-passivating passivation sublayer has a thickness in a range of between 0.1 and 10 nm.” Ex. 1001, 10:43–45.

Petitioner asserts that Sun’s aluminum-oxide layer is a field-effect passivation layer with a thickness of 15 nm. Pet. 35. Petitioner acknowledges that 15 nm falls outside the claimed range. *Id.* at 36. According to Petitioner, reducing the thickness of Sun’s aluminum-oxide layer would save time and money. *Id.* (citing Ex. 1008, 465).

Petitioner cites Hoex to show that one skilled in the art would have understood that an aluminum-oxide layer with a thickness below 10 nm can effectively provide field-effect passivation. Pet. 59 (citing Ex. 1007, Abstract; Banerjee Decl. ¶ 173). Petitioner asserts that both Sun and Hoex use ALD, and thinner layers would have been less expensive to produce with

that method. Pet. 61 (citing Ex. 1008, 465; Banerjee Decl. ¶ 175). According to Petitioner, a thinner passivation would perform equally as well as Sun's 15 nm layer. Pet. 60. In this way, the device provides the same performance at a lower cost. *See id.*

In its Preliminary Response, Patent Owner argued that Sun does not teach or suggest the subject matter of claim 5. Prelim. Resp. 6–8. In the Institution Decision, we explained why Petitioner's evidence and arguments were persuasive on the preliminary record. Inst. Dec. 11–14. Patent Owner did not present arguments in connection with claim 5 in its Response. *See* PO Resp.

After considering the full record developed during the trial, we maintain our conclusions from the Institution Decision. Inst. Dec. 11–14. The evidence of record supports Petitioner's position that reducing the number of deposition cycles reduces costs. Pet. 61 (citing Ex. 1008, 465; Banerjee Decl. ¶ 175). We credit Dr. Banerjee's undisputed testimony that reducing the deposition cycles would, in turn, reduce the amount of time and materials used for the atomic layer deposition (ALD) of aluminum oxide. Banerjee Decl. ¶ 175. Dr. Banerjee's testimony and the assertions in the Petition are consistent with the objective evidence provided, including Hoex's discussion of the cost benefits of thin films. *See* Ex. 1007, 042112-3 (discussing process optimization). Thus, we adopt Petitioner's analysis, which Patent Owner has not contested.

From the entirety of the record, including our previous analysis in the Institution Decision, we determine that Petitioner has shown by a preponderance of the evidence that the subject matter of claim 5 would have been obvious.

2. *Obviousness over Sun and Schmidt*

Petitioner asserts that subject matter of claims 7 and 12 would have been obvious over the combined disclosures of Sun and Schmidt. Pet. 54–58.

a) *Schmidt*

Schmidt assesses the performance of atomic-layer deposited aluminum oxide as a rear-surface passivating dielectric layer for solar cells. Ex. 1008, Abstract. Schmidt discloses the rear-surface recombination velocity for a stack consisting of a 30 nm aluminum-oxide film covered by a 200 nm plasma-enhanced-chemical-vapor-deposited silicon oxide (SiO_x) layer, among other test results. *Id.*

b) *Claims 7 and 12*

Petitioner provides a detailed analysis identifying where Sun and Schmidt teach or suggest each limitation of claims 7 and 12. Pet. 54–58. Petitioner also provided articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have made the Sun-Schmidt combination. *See KSR*, 550 U.S. at 418. Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have combined Sun and Schmidt, and this combination would have been within the level of ordinary skill in the art. *Id.* Patent Owner does not contest these grounds. Upon review of the entirety of the record, we credit the undisputed testimony of Dr. Banerjee and adopt Petitioner’s uncontested analysis. Thus, we determine that Petitioner has shown by a preponderance of the evidence that the subject matter recited in claims 7 and 12 would have been obvious.

3. *Obviousness over Sun and Hagino*

Petitioner asserts that the subject matter of claim 17 would have been obvious over the combined disclosures of Sun and Hagino. Pet. 68–71.

a) Hagino

Hagino generally relates to solar-cell manufacturing. Ex. 1009, Abstract. In Hagino’s solar cell, the light-receiving surface passivation film entirely covers the light-receiving region. *Id.* ¶ 32. Hagino explains that the passivation film acts as an antireflection film. *Id.*

b) Claim 17

The Petition contains an analysis of how Sun and Hagino allegedly teach or suggest each limitation of claim 17. Pet. 68–71. Petitioner supports this analysis with Dr. Banerjee’s testimony. Banerjee Decl. ¶¶ 190–195. Petitioner also provided articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have made the Sun-Hagino combination. *See KSR*, 550 U.S. at 418. Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have combined Sun and Hagino, and this combination would have been within the level of ordinary skill in the art. *Id.* Patent Owner does not contest these grounds. Upon review of the entirety of the record, we credit the undisputed testimony of Dr. Banerjee and adopt Petitioner’s uncontested analysis. Thus, we determine that Petitioner has shown by a preponderance of the evidence that the subject matter recited in claim 17 would have been obvious.

D. Contested Grounds: Claims 6 and 18

Claim 1 recites a passivation layer comprising (1) a field-effect passivation sublayer and (2) a chemical passivation sublayer. As discussed above, Petitioner has shown that Sun teaches both layers. *Supra* § II.C.1.b). Claim 6 further recites that the passivation layers be “embodied as a reflection layer *or* as an antireflection layer.” Ex. 1001, 10:46–48 (emphasis added). Claim 18 recites a similar limitation in a method claim: “the chemically passivating passivation sublayer and the field-effect-passivating

passivation sublayer are applied in such a way that the passivation layer resulting therefrom acts as a reflection layer *or* as an antireflection layer.” *Id.* at 12:17–21 (emphasis added). Because it uses the term “or,” claims 6 and 18 require only one of a reflection or antireflection layer. In the sections that follow, we explain why we determine Petitioner has shown that it would have been obvious to embody a passivation layer as either a reflection layer or an antireflection layer.

Petitioner has shown by a preponderance of the evidence that the subject matter of claims 6 and 18 would have been obvious based on four alternative theories: Petitioner asserts that Sun’s passivation layers are embodied as or act as reflection layers, or in the alternative, it would have been obvious to combine Sun and Schmidt to arrive at the claimed reflection layers. Pet. 37–38, 53–54. We discuss the recited reflection layer in section II.D.1. Petitioner also asserts Sun’s passivation layers are embodied as or act as antireflection layers, or in the alternative, it would have been obvious to combine Sun and Hagino to arrive at the claimed antireflection layers. *Id.* at 38–40, 65–67. We discuss the recited antireflection layer in section II.D.2. As noted above, Petitioner need only prevail on one of these four alternative theories; we determine below that it has sufficiently established all four.

1. The Reflection Layer

As discussed in the claim-construction section above, we agree with Petitioner that, in claims 6 and 18, a layer can be a reflection layer if it is part of a stack of layers that collectively enhances reflection on the back side of a solar cell relative to the incident light. *Supra* § II.B. Because nothing more specific is needed to resolve the issue in this Decision, we do not further construe “reflection layer.”

a) The Petition: Claim 6, Sun alone

Petitioner asserts that “[o]ne skilled in the art would have expected (and certainly have found it obvious) that the silicon oxide/aluminum oxide passivation layers in Sun that are deposited on the back side of the solar cell (104b and 106b) would act *as part of* a reflection layer.” Pet. 38 (emphasis added). As discussed above, Sun discloses the same three layer stack on the back of the solar cell as claim 1. *Supra* § II.C.1.b). Petitioner asserts that “it was typical to design the back passivation layers to act as a reflector.” *Id.* (citing Ex. 1008, 461, 464–465; Ex. 1003 ¶ 120). To support this assertion, Petitioner cites Schmidt. Pet. 37–38.

According to Petitioner, Schmidt teaches that a silicon-oxide/aluminum-oxide stack acts as a reflection layer on a cell’s rear surface. *Id.* at 38. Petitioner asserts that Schmidt teaches that a rear passivation layer that uses aluminum oxide (Al_2O_3) should be an effective reflector of near-bandgap photons. *Id.* (citing Ex. 1008, 464–465, Table II)

b) Analysis: Claim 6, Sun alone

The Petition shows that Sun’s passivation layers are (1) positioned on the solar cell’s rear surface relative to the incident light and (2) used together with the silicon-nitride layer. Pet. 37–38. Patent Owner does not dispute that Sun’s silicon-nitride layer is a reflection layer, stating that “[a] POSITA would have readily understood that Sun includes silicon nitride layer 108b on the back of its solar cell as a reflection layer.” PO Resp. 24 (citing Lebby Decl. ¶ 75). Thus, Sun’s passivation layer is part of a stack of layers that collectively enhances reflection on the back surface of a solar cell relative to the incident light. For this reason, which is discussed in more detail below, Petitioner has shown that Sun’s silicon oxide/aluminum oxide passivation layer deposited on the back side of the solar cell, without further

modification, “is embodied as a reflection layer” as recited in claim 6.
Pet. 38.

Schmidt supports Petitioner’s assertion that the reflective effect of all the layers on the rear surface of Sun’s cell should be considered together. *Id.* (citing Ex. 1008, 461, 464–465; Ex. 1003 ¶ 120). Specifically, Schmidt explains that it is desirable for a cell’s rear stack to improve light trapping: “the SiO₂/Al stack at the cell rear acts as an excellent reflector for near-bandgap photons, significantly improving the light trapping properties and hence the short-circuit current of the cell.” Ex. 1008, 461, *quoted in* Pet. 38. This shows that the position of the layer—i.e., whether it is part of the “rear stack”—is relevant to its function. *See id.*

Schmidt refers to the performance of an Al₂O₃/SiO_x stack, not just the performance of individual layers. *Id.* at 464. For example, Schmidt states that “[a]ll three *rear structures* are equally effective reflectors for near-bandgap photons ($R_r = 91\%$).” *Id.* (emphasis added), *quoted in* Pet. 38, 54. Here, Schmidt’s “rear structures” include an Al₂O₃/SiO_x stack, comprising 30 nm of Al₂O₃ and 200 nm of SiO_x. *Id.* at 465 (Table II). Like Schmidt, Petitioner considers Sun’s passivation layer, which is part of the stack that includes a silicon-nitride layer, to be embodied as a reflection layer. Pet. 38.

Patent Owner argues that Schmidt uses a silicon-oxide/aluminum metal (SiO₂/Al) stack, instead of a silicon-oxide/aluminum-oxide stack, like Sun. PO Resp. 25 (citing Ex. 1007, 461, Lebby Decl. ¶ 77). We disagree. Although Schmidt discusses SiO₂/Al stacks in the introduction, Schmidt largely examines the efficiency of using thin films of aluminum oxide (Al₂O₃) grown by ALD, like Sun. *See, e.g.*, Ex. 1008, Title, Abstract, 462. Petitioner cites Schmidt’s introduction only for the general teaching that

back passivation layers typically act as reflectors. Pet. 37–38 (citing Ex. 1008, 461, 464–65; Banerjee Decl. ¶ 120).

In Patent Owner’s view, Schmidt’s layers are much thicker than Sun’s: Schmidt teaches a 220 nm-thick layer of thermal SiO₂, and a 230 nm-thick aluminum-oxide/silicon-oxide stack, and by contrast, Sun’s passivation layers, combined, are only 17 nm thick. PO Resp. 26. According to Patent Owner, Sun’s passivation layers are “far too thin to perform effective reflection” alone, and so Sun uses another layer—silicon-nitride layer 108b—as the reflection layer. *Id.* at 24 (citing Lebby Decl. ¶ 75), 26 (citing Lebby Decl. ¶ 79).

But Dr. Lebby explained that a 100 nm-thick dielectric layer placed against a back-metal contact acts as a light-trapping cavity. Lebby Decl. ¶¶ 45–46. And Sun teaches that the first passivation layer has a thickness of 2 nm to 100 nm. Sun ¶ 18. So we disagree with Patent Owner’s argument for at least the reason that it does not address the full range of thicknesses contemplated by Sun. *See* PO Resp. 24, 26.

Even so, the record does not support the argument that thickness alone determines whether a layer is embodied as the recited reflection layer: Dr. Lebby explained that he had not seen, nor was he aware of, metrics for determining whether a layer is reflective. Ex. 1025, 19:16–25; *see also* Ex. 2004, 248:13–259:3 (Dr. Banerjee’s testimony about “ideal” parameters). Dr. Lebby testified that “it is not just the thickness” that determines reflective properties, but “the composition, the refractive index, what its performance is over wavelengths . . . come into play, too.” Ex. 1025, 147:7–11; *see also supra* § II.B (explaining that the recited reflection layer is not defined by specific parameters). And Schmidt teaches that an aluminum oxide layer that is 30 nm thick can be part of a stack that reflects light, when

used in combination with another layer. *See* Ex. 1008, 464. So, for this additional reason, we disagree with Patent Owner’s argument that Sun’s passivation layers are too thin to be reflection layers. PO Resp. 24. Apart from those passages discussed here and in section II.B *supra*, we give little weight to the testimony of Dr. Lebby to the extent that his opinion relies on Patent Owner’s overly narrow interpretation of the claim. Ex. 2001, 30–33.

In its Reply, Petitioner presents experimental data to purportedly show how Sun’s passivation layers would perform as a reflector. Pet. Reply 20–23. Under the construction of “reflection layer” adopted in this Decision, we need not assess the performance of Sun’s layers individually, in isolation. *See supra* § II.B. Therefore, we do not consider these experiments in reaching our conclusion. So Patent Owner’s arguments about these experiments are moot. Sur-reply 22–26.

In sum, Petitioner has shown that Sun’s passivation layers are part of a stack that collectively enhances reflection at the back surface of the solar cell relative to the incident light. Pet. 37–38. For this reason, Petitioner has shown that Sun’s passivation layers are embodied as reflection layers under the construction adopted in this Decision. *See supra* § II.B.

Because Petitioner has shown that Sun’s layers are at least one of the two recited types of layers, Petitioner has shown by a preponderance of the evidence that the subject matter of claim 6 would have been obvious over Sun alone.

c) The Petition: Claim 6, Sun in view of Schmidt

The Petition characterizes the first challenge as “obvious in view of Sun” (Pet. 40) and the second as “obvious in view of Sun and Schmidt” (*id.* at 54). The citations to Sun and Schmidt are mostly the same. But,

unlike the rationale based on “Sun alone,” the Sun-Schmidt obviousness rationale refers to the analysis of claim 3 and also cites a third reference, Cook, for an “additional motivation to combine Sun and Schmidt.” *Id.* (citing Ex. 1020, 55).

In particular, Petitioner’s analysis for claim 3 explains that it would have been “obvious to use the ALD of Schmidt . . . in the [s]cheme of Sun to form the aluminum oxide passivation layer.” *Id.* at 51 (citing Ex. 1005 ¶ 39, Ex. 1003 ¶ 154). As for the third reference, Petitioner asserts that Cook provides another reason to combine Sun and Schmidt: maximizing light trapping. *Id.* at 54 (citing Ex. 1020, 55).

d) Analysis: Claim 6, Sun in view of Schmidt

As discussed above, we need not consider the performance of Sun’s layers individually to determine whether the layer is embodied as a reflection layer. *Supra* § II.B. Nevertheless, Petitioner’s obviousness rationale is based on modifying Sun’s layer to maximize the cell’s light-trapping properties. Pet. 54. That is, although not required by the claim interpretation adopted in section II.B, Petitioner’s obviousness ground is based on the reasoning that enhancing reflection of an individual passivation layer can be desirable. *Id.*

In particular, we agree with Petitioner that Schmidt teaches designing the cell’s rear stack to improve light trapping. Ex. 1008, 461, 464–465. Schmidt shows that a rear passivation layer of aluminum oxide and silicon oxide ($\text{Al}_2\text{O}_3/\text{SiO}_x$) can be part of a reflection layer. *Id.* at 464–465. Schmidt’s Table II, for example, shows results for an $\text{Al}_2\text{O}_3/\text{SiO}_x$ stack. *Id.* at 464. Schmidt refers to Table II’s entries as “rear structures.” *Id.* Schmidt states that “[a]ll three rear structures are equally effective reflectors for near-bandgap photons ($R_r = 91\%$).” *Id.*, *quoted in* Pet. 38, 54. More generally,

Schmidt also shows that a solar cell's rear structure is typically designed to trap light. *Id.* at 461 (providing an overview of the prior approaches).

Cook also supports Petitioner's rationale because Cook teaches using a reflective surface for light trapping. Ex. 1020, 55. Cook explains that a highly reflective back surface can reflect unabsorbed photons back into the cell's interior. *Id.* On this record, Petitioner adequately explains why one of ordinary skill in the art would have been motivated to enhance reflection by using Schmidt's teachings to form Sun's passivation layer. Pet. 53–54.

To the extent that Patent Owner's arguments about the ground based on Sun alone are relevant to the Sun-Schmidt combination, we find those arguments unpersuasive for the same reasons discussed in section II.D.1.b). Additionally, the argument that Sun's layers are too thin to trap light (*see, e.g.*, PO Resp. 24, 28) is unpersuasive for the additional reason that the argument is moot in light of Petitioner's proposed modification to Sun to enhance light trapping (Pet. 51, 54).

As for Cook's teachings, Patent Owner argues that Cook's back surface lacks dielectric layers because it relies solely on a metal-contact sheet for reflection. PO Resp. 27; *see also* Sur-reply 28–29 (arguing that Cook teaches a cell can achieve maximum light trapping with only a rear metal contact). According to Patent Owner, "Cook provides no motivation to interpret Sun's passivation layers as reflection layers." PO Resp. 28 (citing Ex. 2001 ¶ 82). Patent Owner argues that Petitioner has not shown a reasonable expectation of success that Sun's layers could function in a way that meets the claim language. *Id.*⁵

⁵ Here, Patent Owner refers to an "antireflection layer." PO Resp. 28. We interpret this to mean a reflection layer because the title of the section is "Sun and Schmidt Do Not Render Obvious a Reflection Layer." *Id.* at 27. To

Yet Petitioner is not proposing to substitute Cook’s teachings into Sun. Rather, Petitioner is proposing to modify Sun with Schmidt. Pet. 51, 54. Petitioner relies on Cook for the teaching that it would have been desirable to design a structure to reflect unabsorbed photons back into the cell’s interior—not for modifying Sun’s cell with Cook’s reflection layer. *Id.* (citing Ex. 1020, 55).

Patent Owner argues that it would not have been obvious to “lift layers out of one design, and throw them into another design” and that modifying Sun’s layers would have unpredictable results. Sur-reply 28 (citing Ex. 1025, 95:1–14, 91:25–92:20; Ex. 2004, 288:14–21). But bodily incorporation is not the test for obviousness. Even so, Patent Owner provides little support for the assertion about unpredictability. *See id.* For example, Dr. Lebby provides no evidence or analysis to support this statement. Ex. 1025, 91–95. Thus, we assign little weight to the testimony of Dr. Lebby on this point about unpredictability. *See Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 294 (Fed. Cir. 1985) (“Lack of factual support for expert opinion going to factual determinations, however, may render the testimony of little probative value in a validity determination.”).

For similar reasons, we disagree with Patent Owner’s argument about textured layers and give little weight to Dr. Lebby’s testimony on this point. Sur-reply 26–27; Ex. 2001, 33–34. In particular, Patent Owner argues that Schmidt and Cook cannot be relied upon for the motivation to modify Sun because both use textured layers. Sur-reply 27, 29. According to Patent Owner, Petitioner asserts that a cell’s performance is largely attributed to

the extent that Patent Owner intended to state “antireflection layer,” we find that argument unpersuasive for similar reasons and those discussed in section II.D.2.

texturing and, thus, teachings about textured cells are “irrelevant” to Sun’s flat structures. *Id.* at 27.

We disagree with Patent Owner because Schmidt states that “[a]ll three rear structures are equally effective reflectors for near-bandgap photons ($R_r = 91\%$)”—referring to the structures in Table II. Ex. 1008, 464, *quoted in* Pet. 38, 54. The three rear structures are “(i) one batch of cells keeps the thermally grown SiO_2 , (ii) the second one is coated by a 130 nm Al_2O_3 film and (iii) the third batch is passivated by a stack consisting of a 30 nm Al_2O_3 layer and a 200 nm thick.” *Id.* at 462. Schmidt’s silicon nitride (SiN_x) layer, however, is the layer that is textured. *See id.*, Fig. 1. Patent Owner’s argument (Sur-reply 26–29) does not explain how texturing affects the reflective performance of these structures, which are not textured but relied upon by Petitioner in the combination.

As for the structures in Table II, Patent Owner argues that Schmidt does not teach that the range of thicknesses from 30 nm to 220 nm provide reflection. *Id.* at 28. In Patent Owner’s view, “Schmidt teaches that a single layer of thermal SiO_2 should be 220 nm thick, a single layer of aluminum oxide should be 130 nm thick, and a stack of aluminum oxide/silicon oxide should be 230 nm thick.” *Id.* We disagree.

Although Schmidt’s aluminum-oxide/silicon-oxide stack is 230 nm thick overall, Table II shows that the aluminum-oxide layer is 30 nm thick. Ex. 1008, 465 (showing “ Al_2O_3 (30 nm)/ SiO_x (200 nm)”). Because the aluminum-oxide layer is part of Schmidt’s reflective stack, it is a reflection layer as understood in the context of the ’525 patent. *See supra* § II.B.

In Patent Owner’s view, Sun already teaches using a reflection layer of a- $\text{SiN}_x\text{:H}$ as a light trapping cavity, but Schmidt does not include a reflection layer made of the same material. Sur-reply 27 (citing

Ex. 2001 ¶ 80). Patent Owner argues that “Schmidt does not teach or suggest that a structure like Sun’s—which already has a reflection layer—would require *another* reflection layer.” *Id.* at 27–28 (emphasis in original).

Petitioner, though, need not prove how Schmidt can be incorporated into Sun to show that one of ordinary skill in the art would reasonably expect success. *See In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012). And as discussed above, the record does not show that an ordinarily skilled artisan would have viewed individual layers in a stack as reflective or not. *See supra* § II.B. Rather, the relevant inquiry in the context of the ’525 patent is how the stack as a whole performs. *See id.*

In sum, Petitioner has shown that it would have been obvious to use Schmidt’s teaching to modify Sun’s passivation layers to embody them as reflection layers that maximize light trapping—although maximizing performance in this way is not required by the claim. *See* Pet. 54.

Thus, weighing the evidence of record, we find that a person of ordinary skill in the art would have combined Sun and Schmidt. This combination would have been within the level of ordinary skill in the art.

Because Petitioner has shown that at least one of the two recited types of layers would have been obvious, Petitioner has shown that the subject matter of claim 6 would have been obvious over Sun and Schmidt.

2. The Antireflection Layer

Petitioner also presents theories of unpatentability of claims 6 and 18 based on the presence of an antireflection layer. As discussed in the claim-construction section above, we agree with Petitioner that, in claims 6 and 18, a layer can be a reflection layer if it is “part of” a stack of layers that suppresses reflection on the front of the solar cell relative to the incident

light. *Supra* § II.B. Because nothing more specific is needed to resolve the issue in this Decision, we do not further construe “antireflection layer.”

a) The Petition: Claim 6, Obviousness over Sun Alone

As discussed above, Petitioner has shown that claim 6 is obvious over Sun alone for at least the reason that Sun teaches “the passivation layer is embodied as a reflection layer.” *Supra* § II.D.1.b). Alternatively, Petitioner shows that Sun alone teaches that the passivation layer is embodied as an antireflection layer.

Petitioner asserts that Sun’s “passivation *layers*” deposited on the front side of the solar cell would “act as an anti-reflection *layer*.” Pet. 38 (emphasis added). In particular, Petitioner argues that “[o]ne skilled in the art would have understood that all the dielectric layers (i.e., 104a, 106a, 108a, *altogether*) on top of Sun’s ‘photoelectric conversion layer’ 102 should, *altogether*, have anti-reflection properties to allow light to get into the ‘photoelectric conversion layer’ (which is the layer that converts incident light into electricity).” *Id.* at 39 (citing Ex. 1020, 21; Ex. 1005, Fig. 2; Ex. 1009, ¶ 32; Ex. 1003 ¶ 199) (emphasis added); *id.* at 40 (discussing “the overall reflection properties of the entire dielectric stack”). As with the reflection layer, we emphasize “part of” and “altogether” here because it shows how Petitioner’s rationale focuses on the collective function of the stack, not any one layer in isolation. That is, Petitioner considers all three layers to be part of the antireflection stack and each one to be an antireflection layer. Tr. 20:4–5.

b) Analysis: Claim 6, Obviousness over Sun Alone

By contrast, Patent Owner essentially argues that the layers should be considered individually. *See* PO Resp. 14–28; Sur-reply 2–5; 16–26; Tr. 41:20–42:3. In particular, Patent Owner argues that a deposition reactor’s

precise conditions affect a material's optical properties. PO Resp. 19. Patent Owner argues that "Sun does not disclose calibrating the deposition process used to deposit its passivation layers to simultaneously accommodate antireflection." *Id.* Patent Owner argues that the optical properties and thicknesses of a layer must be "chosen" or "specifically fashioned" for antireflection. Sur-reply 3 (citing Ex. 100, 5:27–38); Sur-reply 14. For the reasons discussed above in section II.B *supra*, we disagree that an individual layer must be "specifically fashioned", "chosen," "calibrated," or "optimized" to be an antireflection layer. PO Resp. 14–28, Sur-reply 2–5, 14; 16–26; Tr. 41:20–42:3. Also, we give little weight to the testimony of Dr. Lebby to the extent that his opinion relies on Patent Owner's overly narrow interpretation of the claim. Ex. 2001, 19–26.

In Patent Owner's view, Sun has chosen "a distinct anti-reflection layer on top of the passivation layers (108a)." separate and apart from the passivation layers. PO Resp. 6, 19. In particular,

Sun's silicon oxide/aluminum oxide passivation layers with Patent Owner's annotations are shown below. *Id.* at 14.

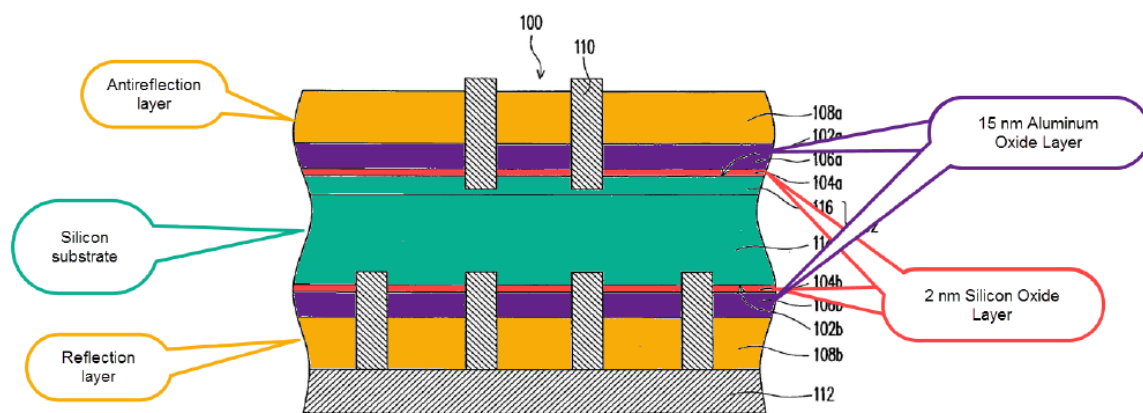


FIG. 2

Figure 2, above, shows an aluminum oxide layer (purple), a silicon oxide layer 104a (red), and a silicon substrate (green). *Id.* Patent Owner argues that

“Sun relies on a separate layer of silicon nitride 108a (orange) for antireflection.” *Id.* at 15.

Petitioner asserts that all dielectric layers on top of Sun’s photoelectric conversion layer 102 are embodied and act as antireflection layers. Pet. 39. Like the reflection layer, the ’525 patent supports Petitioner’s position that a layer is antireflective if it is part of an antireflective stack. *Id.* at 38–39. And we agree with Petitioner that the presence of a separate layer of silicon nitride does not preclude other layers from being antireflection layers. *Id.* at 39. Indeed, the fact that Sun’s passivation layers are placed alongside the layer of silicon nitride only further indicates that the passivation layers are antireflection layers.

The Banerjee Declaration supports Petitioner’s assertion: Dr. Banerjee states that “[o]ne skilled in the art would have understood that passivation layers deposited on the front of the solar cell would have to act as an anti-reflection layer for proper operation as a solar cell.” Banerjee Decl. ¶ 118 (citing Ex. 1020, 21). According to Dr. Banerjee, the purpose of the other antireflective layers would be defeated if the passivation layers on the front side of the solar cell reflected light. Banerjee Decl. ¶ 119.

Patent Owner argues that Petitioner’s argument is based on impermissible hindsight and the ’525 patent itself. Sur-reply 21. We disagree. Petitioner’s assertion about the layers above Sun’s photoelectric conversion layer 102 is supported by Cook’s and Hagino’s discussion of how the top layer of a solar cell should minimize reflection. Pet. 39 (citing Ex. 1020, 21). Cook explains that “the top surface through which light passes must be treated to minimize reflection.” Ex. 1020, 21, *quoted in* Pet. 39. According to Cook, the untreated photovoltaic cell reflects light. *Id.* at 21–22. Likewise, Hagino’s passivation film on the light-receiving

surface is antireflective. Ex. 1009 ¶ 33. Here, both teachings align with Dr. Banerjee’s comments about how a person of ordinary skill in the art would have understood Sun’s passivation layers must work for the solar cell to operate effectively. Banerjee Decl. ¶ 118. Thus, we credit the Banerjee Declaration on this point. *See id.* ¶¶ 118–119.

Patent Owner argues that Dr. Lebby explains that not all layers in a solar cell perform antireflection. PO Resp. 20 (citing Lebby Decl. ¶ 64). According to Patent Owner, “one antireflection layer of a-SiNx:H will sufficiently reduce reflection such that the other layers in a solar cell may be designed to address different problems, like passivation.” PO Resp. 20 (citing Lebby Decl. ¶¶ 64–65, Ex. 2002, 81).

But, as discussed above, the record does not indicate that there is a particular thickness or performance metric that determines whether a layer was designed to address a problem. *See, e.g.*, Ex. 1025, 19:16–25 (Dr. Lebby’s testimony about thresholds); Ex. 2004, 250:13–19; Ex. 2004, 248:13–259:3 (Dr. Banerjee’s testimony about “ideal” parameters). Nor does the patent provide guidance about how to fashion such a layer for a particular purpose, apart from general statements about thickness and optical properties. *See* Ex. 1001, 5:34–38 (discussing thickness), 7:1–10 (discussing “additional optical properties”). Instead, Petitioner’s reasoning that considers the layer’s placement relative to the incident light (Pet. 39) has ample support from Dr. Banerjee, Cook, and Hagino, as discussed above.

In its Reply, Petitioner presents simulation data to purportedly show how Sun’s passivation layers would perform. Pet. Reply 9–11. As discussed above, under the construction of “antireflection layer” adopted in this Decision, we need not assess the performance of Sun’s layers individually, in isolation. *See supra* § II.B. Thus, we do not consider these experiments in

reaching our conclusion, and Patent Owner's arguments about these experiments are moot. Sur-reply 17–20.

We find Patent Owner's arguments about the quarter wave equation (*id.* at 9–11) unpersuasive and give less weight to Dr. Lebby's testimony about the equation (Ex. 2001, 19–26) because Patent Owner and Dr. Lebby rely on a narrow interpretation of the claim, as discussed in section II.B.2 *supra*.

In sum, Petitioner has that shown Sun's passivation layers are part of a stack that collectively suppresses reflection at the front surface of the solar cell relative to the incident light. Pet. 38–39. Thus, Petitioner has shown that Sun's passivation layers are embodied as antireflection layers. *Id.* Because Petitioner has shown that Sun's layers are at least one of the two recited types of layers, Petitioner has shown that the subject matter of claim 6 would have been obvious over Sun alone.

c) The Petition: Claim 6, Obviousness over Sun and Hagino

Petitioner asserts that claim 6 would have been obvious in view of Sun and Hagino for the same reasons discussed in connection with Sun alone. Pet. 66. Petitioner also asserts that “one skilled in the art would have understood that the silicon oxide/aluminum oxide passivation layers that are deposited on the front side of the solar cell (104b and 106b) would act as an antireflection layer, given that Hagino's ‘passivation film 3A’ on the front side of the solar cell also [functions] as an antireflection film.” *Id.* (citing Ex. 1005, Fig. 2, ¶¶ 23, 39; Ex. 1009 ¶ 32; Ex. 1003 ¶ 187). Petitioner asserts that Hagino confirms that the additional silicon-nitride antireflection film on top of the passivation film “does not eliminate the need for the passivation film to function as an antireflection film.” Pet. 66 (citing Ex. 1009 ¶ 32, Ex. 1003 ¶ 187).

Petitioner explains that “[o]ne skilled in the art would have been motivated to combine Sun and Hagino to maximize solar cell efficiency by suppressing reflection of incident light at the front side of the solar cell and also by suppressing recombination by passivation.” Pet. 67 (citing Ex. 1005 ¶¶ 7, 39; Ex. 1009 ¶¶ 2, 26–39, 65–72, Fig. 2, Fig. 5H; Ex. 1009, 43–57; Fig. 1; Figs. 3A–3F; Ex. 1003 ¶ 188). Petitioner asserts that Sun and Hagino are analogous art because each is in the solar-cell field. Pet. 67. Petitioner also asserts that both are reasonably pertinent to the problem of reducing surface recombination using silicon-oxide or aluminum-oxide passivation layers. *Id.* In Petitioner’s view, this is also the problem that the inventors of the ’525 patent were trying to solve. *Id.* Petitioner also asserts that, like Sun, Hagino’s light-receiving silicon-oxide film acts as a chemical passivation layer. *Id.* (citing Ex. 1009 ¶ 31; Ex. 1003 ¶ 188).

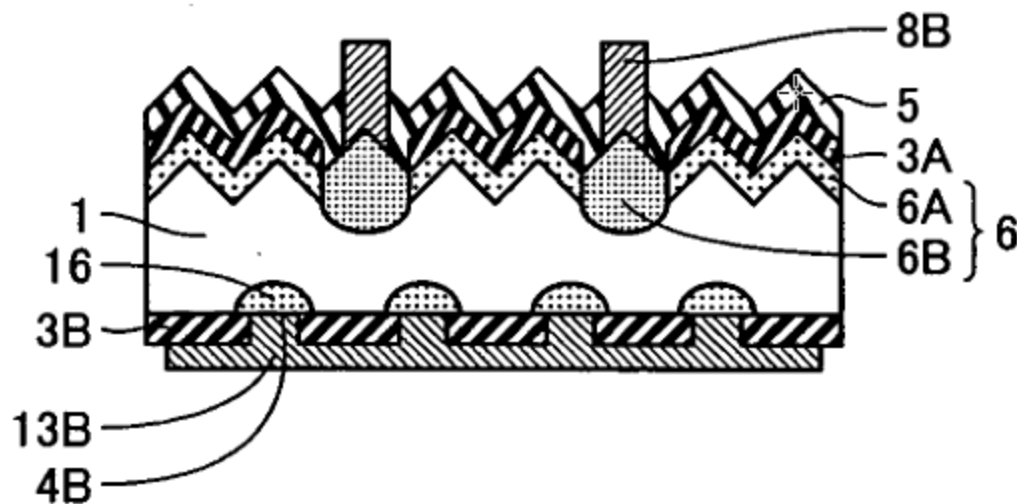
d) Analysis: Claim 6, Obviousness over Sun and Hagino

Patent Owner argues that Hagino is inapplicable to Sun because Hagino uses “a fundamentally different structure with different design constraints.” PO Resp. 21. In particular, Patent Owner argues that Hagino uses only one passivation layer, which would not “inform” one of ordinary skill about the properties of Sun’s two-layer passivation stack. *Id.* at 21–23. Patent Owner argues that Hagino and Sun use different ALD processes. *Id.* at 23 (citing Ex. 1007, 042112-1; Ex. 1008, 465; Ex. 2001 ¶ 71). According to Patent Owner, Sun designed its passivation layer to have a specific thickness to passivate the substrate, but Hagino does not specify a thickness for its layer. PO Resp. 22–23. Patent Owner argues that, in fact, Sun performs better than Hagino: Sun’s flat solar cell has 19.09% efficiency, and Hagino’s cell efficiency is 19% at best, with texturing. Sur-reply 13 (citing Ex. 1005, Table II, Ex. 1009 ¶ 72).

Petitioner, though, does not propose substituting Hagino's layers in Sun. Pet. 66. Rather, Petitioner relies on Hagino to show that a passivation layer can also function as an antireflection layer, even in the presence of another layer that also performs that function. *See id.*; *see also* Pet. Reply 17 (citing Ex. 1003 ¶ 187). Patent Owner's arguments about the relative performance of the devices (Sur-reply 13) do not squarely address the reason that Petitioner relies on Hagino: maximizing a solar cell's efficiency by using the passivation layer in two ways.

Hagino supports Petitioner's assertion that passivation layers can have a dual function. Pet. 66; *see also* Pet. Reply 17. In particular, Hagino's solar cell has a two-layer dielectric stack: a first passivation layer acts as an antireflective film, and a second antireflection layer. Ex. 1009 ¶ 39, *cited in* Pet. 66, Pet. Reply 17. Hagino's Figure 2 is reproduced below.

FIG.2



Hagino's Figure 2, above, shows a solar cell with passivation film 3A under antireflection film 5. *Id.* Like Sun, Hagino teaches a silicon-nitride layer on top of a passivation film. *See id.* ¶ 55 ("The antireflection film includes . . .

silicon nitride.”); Banerjee Decl. ¶ 187. Hagino states that “the light-receiving surface passivation film also functions as an antireflection film.” Ex. 1009 ¶ 32.

We agree with Petitioner that Hagino teaches that the presence of a silicon-nitride layer does not preclude a passivation layer from embodying an antireflection layer. *See id.* Considering Hagino’s teachings about its passivation layer’s dual role (*id.*), we agree with Petitioner that one of ordinary skill in the art would have been motivated to combine Sun and Hagino “to maximize solar cell efficiency by suppressing reflection of incident light at the front side of the solar cell and also by suppressing recombination by passivation.” Pet. 67.

Patent Owner argues that “Hagino does not teach that using one antireflection layer is insufficient in general.” PO Resp. 21. In Patent Owner’s view, “the cited portion of Hagino merely states that in some embodiments its passivation layer 3A can be formed to act as an antireflection layer.” *Id.* (citing Ex. 1009 ¶¶ 27, 37). According to Patent Owner, Sun’s silicon-nitride layer “alone would nearly eliminate all reflection, resulting in a high efficiency cell.” PO Resp. 21 (citing Ex. 2002, 81).

We agree with Petitioner’s response to these arguments. Pet. Reply 19 n.6. To support the assertions about Sun’s performance, Patent Owner cites Duttagupta’s teachings. PO Resp. 21 (citing Ex. 2002, 81); *see also* Lebby Decl. ¶ 67. Duttagupta applies the 70 nm silicon-nitride layer to a substrate that is textured. Ex. 2002, 81. Yet Sun does not discuss texturing. *Accord* Sur-reply 11 (characterizing Sun’s surface as “flat”). Duttagupta teaches that the texture reduces average reflection from 36.5% to 11.67%. Ex. 2002, Fig. 2, *cited in* Pet. Reply 18–19. Because Dr. Lebby has not sufficiently

accounted for Duttagupta's texturing in concluding that Sun would have a comparable performance, we give little weight to Dr. Lebby's testimony on this point. Ex. 2001 ¶¶ 66–72. That does not mean that Duttagupta or Hagino, which also uses texturing, are “irrelevant” to Sun. Sur-reply 11–12. Rather, we agree with Petitioner that, because texturing affects antireflection (Ex. 2002, Fig. 2), more explanation is needed to support a conclusion that Duttagupta's results apply to Sun's device, which says nothing about texturing. *See* Pet. Reply 18–19.

Even so, Petitioner proposes modifying Sun's layer to “maximize solar cell efficiency by suppressing reflection” using Hagino's teachings about using the passivation layer for antireflection. Pet. 67. The record supports Petitioner's assertion that one of ordinary skill in the art would have chosen the appropriate thickness for a cell's layers based on how the layers would function in combination. Pet. Reply 18. Contrary to Patent Owner's argument (Sur-reply 11–13, 21–22), Petitioner does not introduce a new rationale by stating that “it would have been obvious and well within the knowledge of a Skilled Artisan to select the thickness of that layer based on the existing antireflection qualities of passivation layers 106a and 104a to work in conjunction to eliminate reflection.” Pet. Reply 18. Rather, we understand Petitioner to be making a general point about the law of obviousness: one need not prove how Hagino can be bodily incorporated into Sun to show that one of ordinary skill in the art would reasonably expect success. And, on this point, the case law supports Petitioner. “It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements.” *Mouttet*, 686 F.3d at 1332.

Thus, Petitioner has shown that it would have been obvious to embody Sun's passivation layers as antireflection layers in view of Hagino's teachings. Because Petitioner has shown that Sun's layers are at least one of the two recited types of layers, Petitioner has shown that the subject matter of claim 6 would have been obvious over the Sun-Hagino combination.

3. *Claim 18*

Claim 18 recites "wherein the chemically passivating passivation sublayer and the field-effect-passivating passivation sublayer are applied in such a way that the passivation layer resulting therefrom *acts as* a reflection layer or as an antireflection layer." Ex. 1001, 12:18–21. That is, claim 18 recites limitations similar to those of claim 6, except that claim 18 is a method reciting that the passivation "acts as" a reflection or antireflection layer.

But the parties do not argue that the issues in this case turn on the meaning of "embodied" or "act." *See* Pet. 50, 59, 17 (relying on the same analysis); PO Resp. 18 (stating that the challenges to claim 18 fails for the same reasons as claim 6); Sur-reply 11–26 (arguing the claims together); Tr. 11:9–20. Petitioner relies on the same analysis for claim 18 as claim 6. Pet. 50, 59, 71. And these differences between claims 6 and 18 not affect the claim construction above. *Supra* § II.B. Thus, for the reasons discussed in connection with claim 6, Petitioner has shown that the subject matter of claim 18 would have been obvious in view of the Sun alone, Sun and Schmidt, and Sun and Hagino. *Supra* §§ II.D.1–2.

E. Cumulative Challenges to Claims 3, 5, 7, 12, and 14

As noted above in section I.E, Petitioner presents multiple, cumulative challenges to claims 3, 5, 7, 12, and 14. Because we determine that these claims are unpatentable in light of Sun (claims 3, 5, and 14) and the Sun-

Schmidt combination (claims 7 and 12) for the reasons discussed above, we do not separately assess the patentability of these claims based on the remaining grounds in this proceeding. 35 U.S.C. § 318(a) (“If an inter partes review is instituted and not dismissed under this chapter, the Patent Trial and Appeal Board shall issue a final written decision with respect to the patentability of any patent claim challenged by the petitioner and any new claim added under section 316(d).”); *see also Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984) (finding that an administrative agency is at liberty to reach a decision based on a single dispositive issue).

III. CONCLUSION

Petitioner has met its burden to show that claims 1–18 are unpatentable.

In summary, we find as follows:

Claims Challenged	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–6, 8–11, 13–16, 18	103(a)	Sun	1–6, 8–11, 13–16, 18	
3, 6, 7, 12, 18	103(a)	Sun, Schmidt	6, 7, 12, 18	
5, 7, 12, 14	103(a)	Sun, Hoex		
6, 17, 18	103(a)	Sun, Hagino	6, 17, 18	
Overall Outcome			1–18	

IV. ORDER

It is

ORDERED that claims 1–18 of the ’525 patent are unpatentable; and

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

IPR2020-00353
Patent 8,933,525 B2

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