

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REC SOLAR PTE. LTD. and JINKOSOLAR (U.S.) INC.,
Petitioner,

v.

HANWHA Q CELLS & ADVANCED MATERIALS CORPORATION,
Patent Owner.

IPR2019-01145
Patent 9,893,215 B2

Before CHRISTOPHER L. CRUMBLEY, JEFFREY W. ABRAHAM, and
JULIA HEANEY, *Administrative Patent Judges*.

HEANEY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
37 C.F.R. § 318(a)

I. INTRODUCTION

We have jurisdiction to conduct this *inter partes* review under 35 U.S.C. § 6, and this Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that REC Solar Pte. Ltd. and JinkoSolar (U.S.) Inc. (collectively “Petitioner”) have shown by a preponderance of the evidence that claims 12–14 of U.S. Patent No. 9,893,215 (Ex. 1001, “the ’215 patent”) are unpatentable.

Petitioner filed a Petition to institute an *inter partes* review of claims 12–14 of the ’215 patent. Paper 3 (“Petition” or “Pet.”). Hanwha Q Cells & Advanced Materials Corporation (“Patent Owner”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”). Pursuant to 35 U.S.C. § 314(a), we instituted an *inter partes* review of claims 12–14 on all grounds advanced in the Petition. Paper 16 (“Dec. on Inst.” or “Institution Decision”).

After institution of trial, Patent Owner filed a Patent Owner Response (“PO Resp.,” Paper 31), Petitioner filed a Reply (“Pet. Reply,” Paper 40), and Patent Owner filed a Sur-Reply (“PO Sur-Reply,” Paper 44).

An oral hearing was held on September 9, 2020, and a transcript is included in the record. Paper 47 (“Tr.”).

A. Related Proceedings

Petitioner and Patent Owner identify the following pending litigation involving the ’215 patent: *Certain Photovoltaic Cells and Products Containing Same*, Inv. No. 337-TA-1151 (U.S.I.T.C.); *Hanwha Q CELLS & Advanced Materials Corp. v. JinkoSolar Holding Co. Ltd. et al.*, No. 1:19-cv-00450-MN (D. Del.); *Hanwha Q CELLS & Advanced Materials Corp. v. LONGi Green Energy Technology Co., Ltd. et al.*, No. 1:19-cv-00451-MN (D. Del.); and *Hanwha Q CELLS & Advanced Materials Corp. v. REC Solar*

Holdings AS et al., No. 1:19-cv-00452-MN (D. Del.). Pet. 67; Paper 5, 1. Petitioner and Patent Owner also indicate the '215 patent is the subject of another petition for *inter partes* review that was concurrently filed by a different petitioner: IPR2019-01072. Pet. 67; Paper 5, 1–2.

B. The '215 Patent

The '215 patent is titled “Method For Manufacturing a Solar Cell With a Surface-Passivating Dielectric Double Layer, And Corresponding Solar Cell.” Ex. 1001, at [54]. According to the '215 patent, “[a] key requirement for achieving high degrees of efficiencies in solar cells is very effective suppression of surface recombination losses.” *Id.* at 1:14–16. The '215 patent explains that, in order to achieve this purpose, the surface of solar cells should be passivated as effectively as possible, so that charge carrier pairs which are generated inside the solar cell by incident light and which diffuse to the surfaces of the solar cell substrate do not recombine at the solar cell surface, where they would no longer be available to help improve the efficiency of the solar cell. *Id.* at 1:16–22. Good passivating results can be achieved using aluminum¹ oxide layers which are deposited by means of atomic layer deposition (“ALD”). *Id.* at 2:19–21. However, in ALD, only a single molecular layer of the material to be deposited is generally deposited on the substrate surface within each deposition cycle. *Id.* at 2:23–25. Because a deposition cycle typically lasts about 0.5 to 4 seconds, low deposition rates are generally obtained using ALD, where the thickness of the deposition of the aluminum oxide layers may not be suitable for use as an antireflection layer or as a back reflector. *Id.* at 2:25–32.

¹ The '215 patent refers to the element as “aluminium.” We substitute the American spelling, “aluminum.”

The '215 patent describes a method for manufacturing silicon solar cells with a dielectric passivating layer for reducing surface recombination losses in light of the challenges using an ALD process described above. *Id.* at 2:57–60. The dielectric passivating layer is composed of two partial layers: a first dielectric layer (*i.e.*, very thin aluminum oxide containing layer), which is formed by ALD; and a second dielectric layer (*i.e.*, a thicker layer made of silicon oxide, silicon nitride, or silicon carbide, for example), which can be deposited on the first dielectric layer by means of plasma enhanced chemical vapor deposition (“PECVD”), for example. *Id.* at 2:61–67.

According to one embodiment, the first dielectric layer is deposited at a thickness of less than 50 nm, preferably less than 30 nm, and more preferably less than 10 nm. *Id.* at 5:40–43. According to the '215 patent, even at a very low thickness, the first dielectric layer offers very good surface-passivating properties on account of its high quality which can be achieved as a result of the ALD. *Id.* at 5:43–45. Further, according to the embodiment, the second dielectric layer is deposited at a thickness of more than 50 nm, preferably more than 100 nm, and more preferably more than 200 nm. *Id.* at 5:51–54. As described in the '215 patent, the thickness of the second dielectric layer can be adapted to its task as an antireflection layer. *Id.* at 5:54–56.

Figure 1 of the '215 patent is reproduced below:

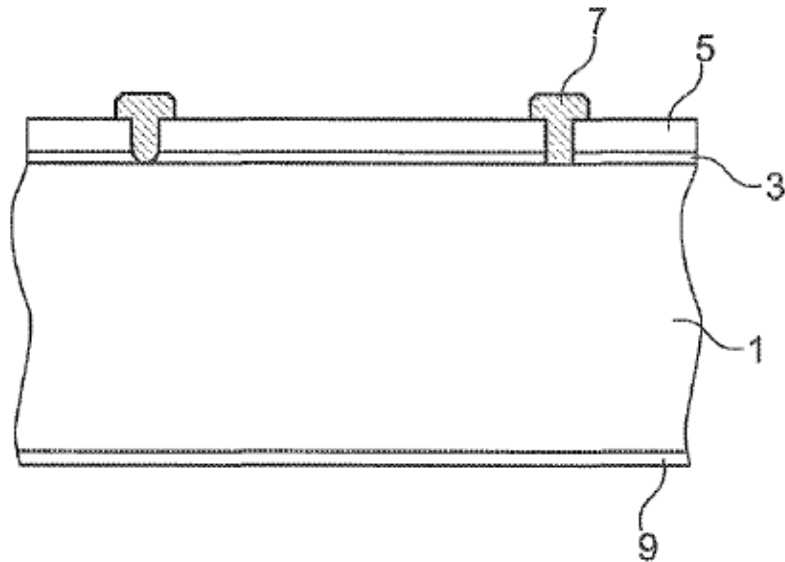


Figure 1 is “a solar cell according to one embodiment of the invention.” *Id.* at 6:44–45. The ’215 patent describes that the solar cell includes silicon wafer 1. *Id.* at 6:51–57. The solar cell further includes aluminum oxide (Al_2O_3) layer 3 that is deposited onto the silicon wafer via an ALD coating process. *Id.* at 6:63–7:11. The solar cell additionally includes silicon oxide thin layer 5 that is subsequently coated onto Al_2O_3 layer 3. *Id.* at 7:30–35. The silicon layer, which is deposited by means of PECVD, has a very high hydrogen content and therefore serves as a source of hydrogen. *Id.* at 7:65–8:3. The hydrogen diffuses through the ultrathin Al_2O_3 layer and passivates unsaturated silicon bonds (“dangling bonds”) at the $\text{Si}/\text{Al}_2\text{O}_3$ interface, leading to very good surface passivation. *Id.* at 8:3–7.

C. The Challenged Claims

Petitioner challenges claims 12–14 of the ’215 patent. Pet. 1. Claims 13 and 14 depend from claim 12. Claim 12, reproduced below, is illustrative of the subject matter of the challenged claims:

12. A solar cell comprising:
- a silicon substrate;
 - a first dielectric layer comprising aluminum oxide on a surface of the silicon substrate; and
 - a second dielectric layer directly on a surface of the first dielectric layer, materials of the first dielectric layer and the second dielectric layer differing and hydrogen being embedded into the second dielectric layer;
- wherein the first dielectric layer has a thickness of less than 50 nm and is interposed between the surface of the silicon substrate and the second dielectric layer.

Ex. 1001, 9:35–10:9.

Claims 13 and 14 depend from claim 12. Claim 13 requires that the second dielectric layer comprise silicon nitride, silicon oxide, or silicon carbide. Claim 14 further limits the thickness of the first dielectric layer to less than 30 nm.

D. Prior Art and Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability:

Claims Challenged	Statutory Basis ²	Reference(s)
12–14	§ 102	Agostinelli '086 ³
12–14	§ 103	Agostinelli '086, Nakano ⁴ , Hoex 2006 ⁵
12–14	§ 103	Nakano, Hoex 2006

² The Leahy-Smith America Invents Act (“AIA”) included revisions to 35 U.S.C. §§ 102, 103 that became effective on March 16, 2013. Because the '215 patent issued from an application filed before March 16, 2013, we apply the pre-AIA versions of the statutory bases for unpatentability.

³ EP Patent Application No. 1,763,086 to Agostinelli et al. (Ex. 1005).

⁴ U.S. Patent No. 4,463,216 to Nakano et al. (Ex. 1006).

⁵ B. Hoex, et al. “Ultralow surface recombination of c-Si substrates passivated by plasma-assisted atomic layer deposited Al₂O₃,” 89 Applied Physics Letters, 042112 (2006) (Ex. 1007).

Claims Challenged	Statutory Basis ²	Reference(s)
12–14	§ 102	Narwankar ⁶
12–14	§ 103	Narwankar, Tan ⁷

Pet. 17–66. Petitioner relies on the Declaration of Bruce Clemens Ph.D. (Ex. 1003). Patent Owner relies on the Declaration of Michael S. Lebby, Ph.D., D.Eng. (Ex. 2012).

II. ANALYSIS

A. Claim Construction

For petitions such as this one, filed after November 13, 2018, we apply the same claim construction standard “used in the federal courts, in other words, the 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, 51,343 (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. Only those terms in controversy need to be construed and only to the extent necessary to resolve the controversy. See *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013,

⁶ U.S. Patent Application Publication No. 2005/0260347 to Narwankar et al. (Ex. 1008).

⁷ U.S. Patent No. 6,929,700 to Tan et al. (Ex. 1030).

1017 (Fed. Cir. 2017) (“we need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

Petitioner argues that the preamble of claim 12, which recites a “solar cell,” is not limiting because the body of claim 12 describes a structurally complete invention, and because no element of the claim refers to the “solar cell.” Pet. 8–10. Patent Owner argues that the term “solar cell” is limiting because (1) the applicant relied on the term to distinguish the invention from prior art and (2) the term breathes life and meaning into the claims. PO Resp. 2. For reasons discussed in section II.H.1 below, we determine that “solar cell” is not limiting.

B. Level of Ordinary Skill in the Art

Factors pertinent to a determination of the level of ordinary skill in the art include “(1) 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).

Dr. Clemens testifies that a person having ordinary skill in the art would have “an advanced degree involving the disciplines of electrical engineering, applied physics, chemistry, materials science, or the like, and at least two years of experience designing, developing, or researching in the field of the ’215 patent,” or alternatively, “a bachelor’s degree involving the disciplines of electrical engineering, applied physics, chemistry, materials science, or the like, and at least three years designing, developing, or researching in the field of the ’215 patent.” Ex. 1003 ¶ 13. Patent Owner does not contest this level of skill. PO Resp. 2. Because Petitioner’s proposed level of ordinary skill appears consistent with the level of ordinary skill in the art at the time of the invention as reflected in the prior art in this proceeding, we adopt Dr. Clemens’s definition of the level of ordinary skill in the art.

C. Principles of Law

Anticipation under 35 U.S.C. § 102 requires that each limitation in a claim is found in a single prior art reference, arranged as recited in the claim. *Net MoneyIn, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008). The disclosure of the element by the reference can be an express disclosure or an inherent disclosure. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987).

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 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. Overview of the Asserted References

1. Agostinelli '086 (Ex. 1005)

Agostinelli '086, entitled “Photovoltaic Cell With Thick Silicon Oxide and Silicon Nitride Passivation and Fabrication Method,” relates to “a method for producing a photovoltaic device,” such as a solar cell. Ex. 1005, at [54], ¶ 8.

Figure 1 of Agostinelli '086 is reproduced below.

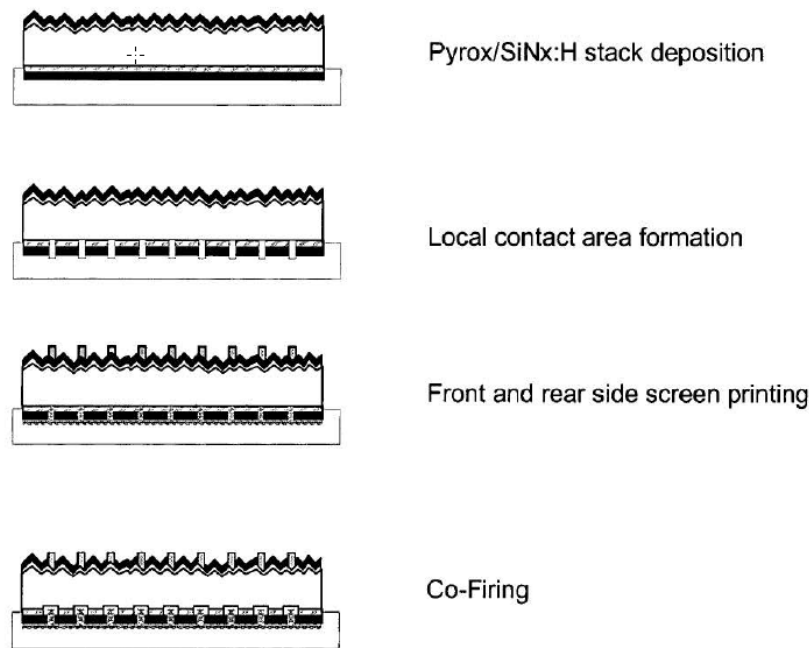


Fig. 1.

Figure 1 illustrates an “[e]xample of a photovoltaic device generated via a solar cell fabrication process according to the present invention.” *Id.* ¶ 49. Agostinelli '086 describes that the solar cell includes a silicon layer, a dielectric layer, and a passivation layer comprising hydrogenated silicon nitride (“SiN”). *Id.* ¶ 8. The silicon layer can be any silicon substrate. *Id.* ¶ 9. The dielectric layer can be a low quality amorphous oxide, such as Al₂O₃. *Id.* ¶¶ 12, 18, 56. The passivation layer improves the dielectric

layer's passivation properties due to the hydrogenated silicon nitride. *Id.* ¶¶ 56, 59.

2. Nakano (*Ex. 1006*)

Nakano relates to a solar cell having a semiconductor substrate and a thin alumina coating on the major surface of the substrate. *Ex. 1006*, at [57]. Nakano's Figure 4 is reproduced below:

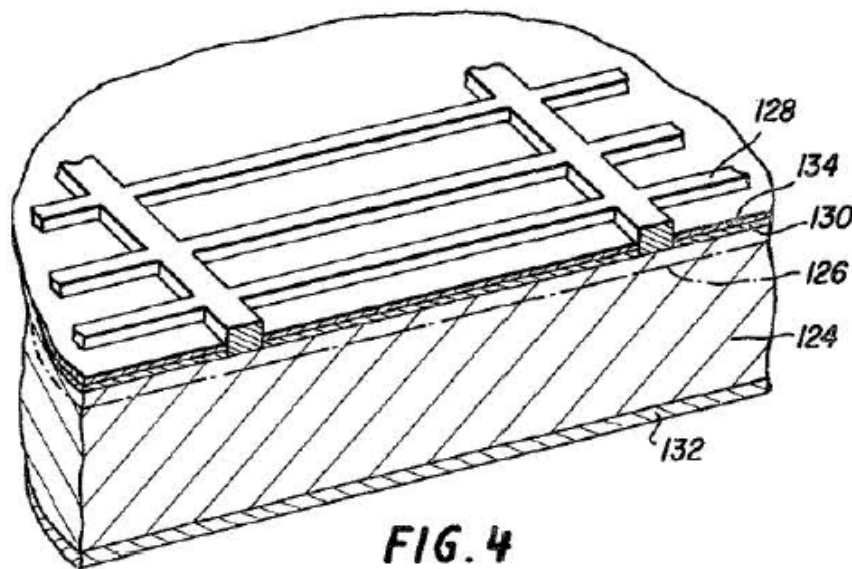


Figure 4 illustrates a partially cut-off perspective view of an embodiment of the invention. *Id.* at 2:63–64. An n⁺ type layer (122 – not labeled) is provided by diffusion in a major surface region of p-type conductive semiconductor substrate (124) to form p-n junction (126). *Id.* at 3:16–18. On the surface of n⁺ type conductive layer (122), grid-like metallic surface electrode (128) is provided. *Id.* at 3:19–21. The portion of the principal surface other than that occupied by the metallic grid is covered first with aluminum oxide layer (130), and then with tantalum pentoxide layer (134). *Id.* at 3:22–25. Further, on the other principal surface of the substrate, rear side electrode (132) is provided. *Id.* at 3:25–27.

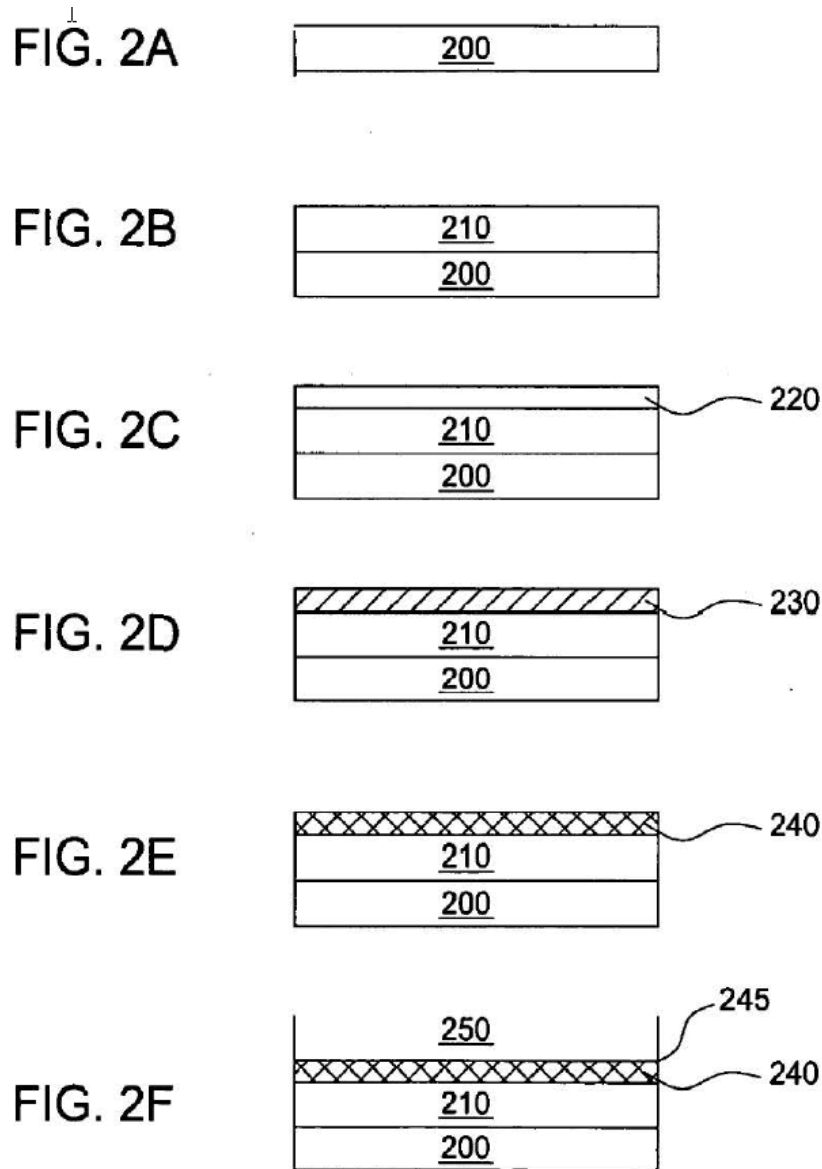
3. *Hoex 2006 (Ex. 1007)*

Hoex 2006, entitled “Ultralow Surface Recombination of *c*-Si Substrates Passivated By Plasma-Assisted Atomic Layer Deposited Al₂O₃,” relates to “surface passivation of crystalline silicon (*c*-Si)” that improves “performance of high efficiency industrial solar cells.” Ex. 1007, 042112–1. Hoex 2006 describes using a high band-gap dielectric Al₂O₃ as a surface passivation layer. *Id.* More specifically, Hoex 2006 describes preparing ultrathin films of Al₂O₃ via plasma-assisted atomic layer deposition (“PA-ALD”) with a thickness of 7–30 nm that provide a “good level of surface passivation on *p*-type *c*-Si.” *Id.*

4. *Narwankar (Ex. 1008)*

Narwankar, entitled “Formation of a Silicon Oxynitride Layer on a High-K Dielectric Material,” relates to “methods for depositing capping layers, such as silicon oxides or silicon oxynitrides, to dielectric materials.” Ex. 1008, at [54], ¶ 2. Narwankar further discloses the method for depositing a capping layer on a dielectric layer includes depositing the dielectric layer on a substrate, and depositing a silicon-containing layer on the dielectric layer by an ALD process. *Id.* ¶ 9.

Narwankar’s Figures 2A–2F are reproduced below.



Figures 2A–2F illustrate a process sequence for depositing multiple layers on a substrate surface. *Id.* ¶ 15. As depicted in Figs. 2A–2B, dielectric layer 210 is deposited on substrate 200 by conventional deposition techniques, such as ALD. *Id.* ¶ 22. Dielectric layer 210 is deposited on the substrate surface and may have a variety of compositions, including aluminum oxide (“Al₂O₃” or “AlO_x”). *Id.* ¶ 24. As depicted in Fig. 2C, silicon oxide layer 220 is deposited on dielectric layer 210 by an ALD process. *Id.* ¶ 25. As depicted in Fig. 2D, silicon oxide layer 220 is exposed to a nitridation

process, where the nitridation process physically incorporates nitrogen atoms into the silicon oxide material to form nitrogen-containing silicon oxide layer 230. *Id.* ¶ 38. As depicted in Fig. 2E, the substrate is annealed converting nitrogen-containing silicon oxide layer 230 to capping layer 240, such as silicon oxynitride (“SiO_xN_y”). *Id.* ¶ 41. As shown in Fig. 2F, once capping layer 240 is formed, additional materials are deposited thereon, such as polysilicon layer 250. *Id.* ¶ 42.

5. *Tan (Ex. 1030)*

Tan, entitled “Hydrogen Assisted Undoped Silicon Oxide Deposition Process For HDP-CVD,” relates to a “method of depositing silicon oxide layers for use as insulation layers in integrated circuits.” Ex. 1030, at [54], 1:19–20. Tan describes forming an undoped silicon oxide layer over a substrate disposed in a high density plasma substrate processing chamber. *Id.* at 2:43–45. The silicon oxide layer is formed by flowing a process gas into the substrate processing chamber and forming a high density plasma from the process gas to deposit the silicon oxide layer over the substrate. *Id.* at 2:45–50. The process gas includes a silane gas, an oxygen-containing source, an inert gas, and a hydrogen-containing source, or a hydride gas that does not include silicon, boron, or phosphorus. *Id.* at 2:50–54.

Tan’s Figure 2 is reproduced below:

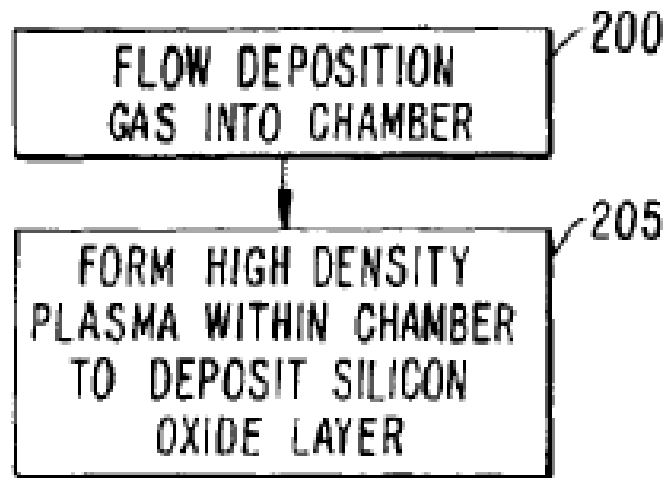


FIG. 2.

Figure 2 illustrates a “particular embodiment of the invention as used to deposit a silicon oxide film over a semiconductor substrate.” *Id.* at 11:9–11. At step 200, a process gas is flowed into a chamber. *Id.* at 11:21–23. At step 205, a plasma is formed from the process gas. *Id.* at 11:23.

E. Alleged Anticipation Based on Agostinelli '086

Petitioner argues that claims 12–14 are anticipated by the disclosure of Agostinelli '086. Pet. 17–28.

1. Claim 12

Petitioner asserts Agostinelli '086 discloses each element of claim 12, and supports its analysis with the testimony of Dr. Clemens. Petitioner asserts Agostinelli '086 discloses a silicon substrate (*id.* at 18 (citing Ex. 1005 ¶ 38)) and each of the first and second dielectric layers as recited in claim 12. *Id.* at 19–22. Patent Owner does not dispute that Agostinelli '086 discloses these elements. As discussed below, Patent Owner argues that Petitioner fails to show that Agostinelli '086 discloses a first dielectric layer

comprising aluminum oxide and having a thickness as recited in the following limitation:

wherein the first dielectric layer has a thickness of less than 50 nm and is interposed between the surface of the silicon substrate and the second dielectric layer

Ex. 1001, 10:7–9.

Petitioner asserts that Agostinelli '086 discloses this limitation because it describes that a dielectric layer comprising “low quality amorphous oxide, for instance $\text{Al}_2\text{O}_3/\text{TiO}_2$ pseudobinary alloys (PBAs)” (Pet. 19 (citing Ex. 1005 ¶¶ 41, 44)), having a thickness between 40 and 1500 nm. *Id.* at 23 (citing Ex. 1005 ¶¶ 44, 53). The specific portions of Agostinelli '086 relating to the thickness of the dielectric layer are set forth below:

[0019] In advantageous embodiments a dielectric layer is deposited which has a thickness between 40 and 1500 nm. In certain embodiments, the minimal thickness depends on the material which is employed and is determined by the amount of material which is necessary to act simultaneously as a diffusion mask during emitter diffusion, and be still of use for surface passivation and contact formation.

[0020] For pyrox SiO_x this is typically about 300nm, For TiO_2 deposited by solgel this is about 50 nm, for $\text{Al}_2\text{O}_3/\text{TiO}_2$ pseudobinary alloys (PBAs) deposited by solgel this is about 150 nm. Those thickness values are only indicative and a deviation of 10%, 20% or more from the given values is possible. Also a combination, or a stack of layers, of different materials are possible and would lead to a certain threshold thickness for the combined diffusion mask, surface passivation and contact formation process.

[0041] In certain embodiments the dielectric layer comprises a low quality amorphous oxide.

[0044] The low-quality amorphous oxide can for instance be a Spin-on oxide or APCVD (Atmospheric pressure)

pyrolithic oxide, spin-on, spray-on or dip oxide It can be for instance a silicon oxide, TiO₂ (e.g. deposited by solgel), or Al₂O₃/TiO₂ pseudobinary alloys (PBAs). In advantageous embodiments the dielectric layer has a thickness between 40 and 1500 nm. In certain embodiments, the minimal thickness depends on the material which is employed and is determined by the amount of material which is necessary to act simultaneously as a diffusion mask during emitter diffusion, and be still of use for surface passivation and contact formation. For pyrox SiO_x this is typically about 300nm, For TiO₂ deposited by solgel this is about 50 nm, for Al₂O₃/TiO₂ pseudobinary alloys (PBAs) deposited by solgel this is about 150 nm. Those thickness values are only indicative and a deviation of 10%, 20% or more from the given values is possible. . . .

[0053] In the embodiments of the present invention, for instance more than 10 nm, 40 nm, 100 nm, 200 nm, 800 nm of Oxide are deposited on the silicon surface. On top of it a layer of SiN_x:H optimized for hydrogen release is deposited. The silicon surface passivation is improved by means of hydrogenation.

[0056] A generic low quality amorphous Oxide was deposited (e.g. SiO₂, SiO_x, SOG, TiO₂, Al₂O₃ . . . or their pseudo-alloys, SiON_x,) on the solar cell's rear side silicon surface (e.g.by APCVD, or spin coating) and its surface passivation properties were improved by depositing an optimized hydrogenated dielectric layer (namely: SiN_x:H)....

Ex. 1005 ¶¶ 19, 20, 40, 44, 53, 56.

Patent Owner argues that Agostinelli '086 does not disclose an aluminum oxide layer having a thickness less than 50 nm, but rather expressly discloses an aluminum oxide thickness of about 150 nm. PO Resp. 22. Patent Owner relies on the two statements in Agostinelli '086 that thickness “for Al₂O₃/TiO₂ pseudobinary alloys (PBAs) deposited by solgel . . . is about 150 nm.” *Id.* (citing Ex. 1005 ¶¶ 20, 44) (emphasis omitted). *See also id.* at 23 (citing Ex. 2011, 170:18–22).

Patent Owner further argues that Agostinelli '086's description of a dielectric layer having a thickness between 40 and 1500 nm (Ex. 1005 ¶ 44) does not disclose an aluminum oxide layer having a thickness of less than 50 nm. PO Resp. 26–27. Rather, Patent Owner argues, a person of ordinary skill would understand from the entirety of Agostinelli '086 that the range of 40–1500 nm refers to three different materials of varying thickness in the oxide layer, i.e. titanium dioxide (about 50 nm), aluminum oxide (about 150 nm), and silicon oxide (about 300 nm). *Id.* at 26–27 (citing Ex. 1005 ¶¶ 20, 44; Ex. 2012 ¶ 110). Patent Owner argues a person of ordinary skill would understand that the low end of the 40–1500 nm range “would address the titanium dioxide layer expressly listed in the sentence” later in paragraph 44 of Agostinelli '086. *Id.* at 27 (citing Ex. 2012 ¶ 110).

As to the disclosure in paragraph 53 of Agostinelli '086 of “more than 10 nm, 40 nm, 100 nm, 200 nm, 800 nm of Oxide are deposited on the silicon surface,” Patent Owner argues that this passage does not disclose that aluminum oxide can be less than 50 nm, but rather acknowledges that the oxide layer of Agostinelli '086 may vary in thickness depending on the material used. PO Resp. 24 (citing Ex. 1005 ¶¶ 20, 44; Ex. 2012 ¶¶ 105–106). Patent Owner further argues that a person of ordinary skill would recognize the thickness of 10 or 40 nm as the titanium dioxide layer because a 20% deviation from the titanium dioxide thickness of 50 nm expressly disclosed in paragraph 44 is around 40 nm, and thicknesses of 30 nm for titanium dioxide are not uncommon. *Id.* at 25 (citing Ex. 2012 ¶¶ 105–107).

We agree with Patent Owner that Agostinelli '086 does not disclose an aluminum oxide layer having thickness less than 50 nm. Petitioner does not cite any disclosure in Agostinelli '086 of an aluminum oxide layer having thickness less than 50 nm. Rather, Petitioner relies on the general

disclosure of a dielectric layer having a thickness between 40 and 1500 nm. Pet. 23 (citing Ex. 1005 ¶¶ 44). Each of the statements where Agostinelli '086 discloses this range is followed by the sentence

In certain embodiments, the minimal thickness depends on the material which is employed and is determined by the amount of material which is necessary to act simultaneously as a diffusion mask during emitter diffusion, and be still of use for surface passivation and contact formation.

Id. Agostinelli '086 then lists the minimal thicknesses of several materials, including Al₂O₃/TiO₂ PBAs at 150 nm. Ex. 1005 ¶¶ 20, 44. Thus, a person of ordinary skill in the art would understand from Agostinelli '086 that different thicknesses are appropriate for different materials, and that the minimum thickness of a dielectric layer comprising aluminum oxide is about 150 nm. *See* Ex. 2012 ¶ 106. Petitioners' expert, Dr. Clemens, also supports this by explaining that different materials have "vastly different" atomic properties, and will function differently depending on their thickness. Ex. 2011, 191:25-192:21.

As to the disclosure of oxide thicknesses of "10 nm, 40 nm . . ." in paragraph 53 of Agostinelli '086, we find that in the context of the earlier disclosures of about 150 nm thickness of aluminum oxide, a person of ordinary skill in the art would not understand paragraph 53 as a disclosure that each oxide disclosed in the reference may be used at any of the thicknesses listed in paragraph 53, especially given Agostinelli's repeated statement that the minimal thickness that may be used depends on the material of the layer. Agostinelli does not contain any express disclosure of aluminum oxide in the range of 40 nm thickness; rather, the only layer thickness disclosed for aluminum oxide is about 150 nm, three times the thickness of claim 12. Further, Agostinelli '086 does not correlate the

generic list of oxides in paragraph 56 to the thickness ranges in paragraph 53, and thus lacks the specificity required to show anticipation. *See Atofina v. Great Lakes Chem. Corp.*, 441 F.3d 991, 999 (Fed. Cir. 2006) (where a prior art reference and challenged claims have an overlapping range, the reference only anticipates if it teaches the anticipatory value with sufficient specificity).

For the foregoing reasons, we find that Petitioner has not shown by a preponderance of the evidence that Agostinelli '086 anticipates claim 12.

2. Claims 13 and 14

Dependent claim 13 specifies that the second dielectric layer comprises a material selected from the group consisting of silicon nitride, silicon oxide and silicon carbide. Petitioner asserts that Agostinelli '086's disclosure of a second dielectric layer comprising hydrogenated silicon nitride satisfies this limitation. Pet. 21, 27 (citing Ex. 1005 ¶ 53).

Dependent claim 14 requires the first dielectric layer of claim 12 to have a thickness of less than 30 nm. Petitioner's analysis relies on Agostinelli '086's disclosure of dielectric layers with thicknesses of "more than 10 nm, 40 nm" as expressly disclosing the "less than 30 nm" limitation. *Id.* at 27–28 (citing Ex. 1003 ¶ 78; Ex. 1005 ¶¶ 18, 53). Because each of these claims depends from claim 12, and Petitioner's analysis does not remedy the deficiencies described above, we likewise conclude that Petitioner has not demonstrated by a preponderance of the evidence that claims 13 and 14 are anticipated by Agostinelli '086, for the reasons stated above with regard to Petitioner's challenge of claim 12.

F. Alleged Obviousness Based on Agostinelli '086, Nakano, and Hoex 2006

Petitioner argues that claims 12–14 would have been obvious over the combined teachings of Agostinelli '086, Nakano, and Hoex 2006. Pet. 28–37. Specifically, Petitioner contends that Hoex 2006 and Nakano would have motivated a person of ordinary skill in the art with a reasonable expectation of success to modify Agostinelli '086 to have thinner Al_2O_3 , because “Agostinelli teaches dip-coating Al_2O_3 , Nakano teaches controlling the thickness of dip-coated Al_2O_3 for a structurally similar cell, and both Nakano and Hoex 2006 teach Al_2O_3 of less than 30 nm successfully passivates.” Pet. Reply 10–11 (citing Ex. 1003 ¶¶ 87–96; Ex. 1006, 7:34–50, Table 1; Ex. 2011, 217:16–18).

Patent Owner challenges the sufficiency of Petitioner’s rationale for modifying Agostinelli '086 to have thinner Al_2O_3 based on Nakano’s and Hoex 2006’s teachings. Patent Owner argues several reasons that Petitioner’s rationale is inadequate, including the following: (1) Nakano’s dip method results in poor passivation (PO Resp. 37–40); (2) Hoex 2006 teaches a high-cost ALD technique which is incompatible with the low-cost goals of Agostinelli '086 (*id.* at 33–37); (3) a person of ordinary skill in the art would not have been motivated to keep two layers in Agostinelli '086 in view of Hoex 2006 or Nakano (*id.* at 41–43); and (4) Hoex 2006’s negative charge is incompatible with the additional silicon nitride layer of Agostinelli '086 which a person of ordinary skill in the art would understand to have a high positive charge (*id.* at 43–44).

We agree with Patent Owner that Petitioner fails to explain sufficiently why a person of ordinary skill would have modified Agostinelli '086 to have thinner Al_2O_3 based on the teachings of Hoex 2006 and

Nakano. As to Nakano's passivation teaching, Patent Owner relies on Nakano Figure 8 and the testimony of Dr. Lebby, who explains that a person of ordinary skill in the art would not have looked to deposit thinner Al_2O_3 by Nakano's dip method, because of the poor passivation of Nakano's structure. PO Sur-Reply 11 (citing Ex. 2012 ¶¶ 140–42; Ex. 1050, 52:2–23).

Petitioner does not dispute that Nakano results in poor passivation,⁸ but rather argues that Nakano's passivation is irrelevant because Patent Owner relies on Agostinelli '086 as the base reference in this ground (*see* Tr. 54:22–55:19) and Agostinelli '086 teaches that passivation is attributable to hydrogenation of its second dielectric layer. Tr. 58:6–19. We are not persuaded by Petitioner's reply argument because it is inconsistent with the Petition, which in fact relied on Nakano's Figure 8 as a reason that a person of ordinary skill in the art would have been motivated to produce a thinner Al_2O_3 layer. Pet. 33–34. Further, Petitioner's new argument is untimely; "Petitioner may not submit new evidence or argument in reply that it could have presented earlier, e.g. to make out a *prima facie* case of unpatentability." Consolidated Trial Practice Guide ("TPG") 73 (Nov. 2019), *available at* <https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf>. In view of the argument and evidence Petitioner presented in the Petition, and the undisputed evidence of Nakano's poor passivation, we determine that Petitioner has not met its burden to show that a person of ordinary skill in the art would have modified Agostinelli '086 by applying Nakano's teaching of a thinner Al_2O_3 layer using dip coating.

⁸ The record citations following the statement in Petitioner's Reply Brief that "both Nakano and Hoex teach Al_2O_3 of less than 30nm successfully passivates" do not support that statement as to Nakano. *See* Pet. Reply 11.

As to Hoex 2006, Patent Owner persuasively argues that Petitioner's proposed combination is premised on an incorrect interpretation of Hoex 2006, in that the Petition asserted and Dr. Clemens testified that Hoex 2006 deposits two dielectric layers. Pet. 37 ("Both [Nakano and Hoex 2006] disclose depositing two dielectric layers on the surface of the silicon substrate to achieve a reduced recombination velocity at the silicon substrate"; Ex. 1003 ¶ 104). Dr. Clemens admits this was incorrect. Ex. 2011, 95:11–96:6. Although Petitioner argues that its incorrect reading of Hoex 2006 as a two-layer structure is immaterial (Reply 13), we find more persuasive Patent Owner's explanation that a person of ordinary skill in the art would not have applied Hoex 2006's single-layer teaching to Agostinelli '086's two-layer structure because Hoex 2006 achieves excellent passivation with its monolayer and there would have been no need to retain Agostinelli '086's second layer. *See* PO Sur-Reply 13–14 (citing Ex. 2012 ¶ 148; Ex. 1007). To the extent that Petitioner claims to rely on Hoex solely for the thickness of its aluminum oxide layer, not the use of that layer as a monolayer (Reply 10–11), Petitioner has not explained why a person of ordinary skill would have considered the thickness of a monolayer to be indicative of the thickness of aluminum oxide that should be used in a two-layer structure.

Accordingly, Petitioner has not met its burden to establish a reason or motivation for modifying Agostinelli '086 to have thinner Al₂O₃ based on the teachings of Hoex 2006 and Nakano. After considering the parties' arguments and evidence and the record as a whole, we are not persuaded Petitioner has established by a preponderance of the evidence that claims 12–14 of the '215 patent are unpatentable over the combination of Agostinelli '086, Hoex 2006, and Nakano.

G. Alleged Obviousness Based on Nakano and Hoex 2006

Petitioner argues that claims 12–14 would have been obvious over the combined teachings of Nakano and Hoex 2006. Pet. 37–46. Specifically, Petitioner contends Nakano discloses each element of claim 12, except Petitioner acknowledges Nakano does not expressly disclose hydrogen being embedded into its second dielectric layer. Pet. 37–45. Petitioner argues that a person of ordinary skill in the art would have been motivated to replace Nakano’s tantalum pentoxide dielectric layer with the hydrogenated amorphous silicon nitride layer of Hoex 2006, because it would have involved simple substitution of a known element for another element (i.e., hydrogenated amorphous silicon nitride) which was known to improve the performance of solar cells. Pet. 42–43 (citing Ex. 1003 ¶¶ 117–20). Petitioner asserts that Hoex 2006 teaches hydrogenated amorphous silicon nitride had become the industry standard at the time of its publication because of its desirable antireflective properties. *Id.* (citing Ex. 1007, 042112-1).

Patent Owner argues that Hoex 2006 teaches a single layer of silicon nitride deposited on a silicon substrate, and that Petitioner fails to explain why a person of ordinary skill would have been motivated to substitute Nakano’s tantalum pentoxide antireflection layer with Hoex 2006’s silicon nitride layer, because Hoex 2006’s single layer achieves both the goals of Nakano’s dielectric and antireflection layers. PO Resp. 47–48 (citing Ex. 1007, 75; Ex. 1012, 705; Ex. 2010, 1659; Ex. 2012 ¶¶ 161–62). Similar to its argument against the combination of Agostinelli ’086 and Hoex 2006 in the preceding ground, Patent Owner argues that the combination of Hoex 2006 and Nakano is not a mere simple substitution of a silicon nitride layer for a tantalum pentoxide layer, because a person of ordinary skill would

have understood that Hoex 2006's single silicon nitride layer was more efficient than Nakano's two layer dielectric system. *Id.* at 48–49 (citing Ex. 1006, Table 1; Ex. 1012, 708, Figs 3, 4(a); Ex. 2012 ¶ 165). Patent Owner also argues that Petitioner fails to show that Nakano's tantalum pentoxide layer is embedded with hydrogen, and that Nakano's mere use of reactants containing hydrogen to form the tantalum pentoxide layers does not satisfy the limitation of "hydrogen being embedded into the second layer." *Id.* at 45–46 (citing Ex. 1007, 12).

Our analysis above as to the reasons Petitioner fails to show sufficiently why a person of ordinary skill would have used the teachings of Nakano and Hoex 2006 to modify Agostinelli '086 also supports our determination here that Petitioner has not met its burden to establish a reason or motivation for combining the teachings of Nakano and Hoex 2006 to arrive at the structure recited in claims 12–14. Further, Petitioner's arguments as to the substitution of Hoex 2006's material for Nakano's (Pet. Reply 14–19) are not persuasive. For example, Nakano's teaching that "other highly refractive materials such as titanium dioxide can be used [as the antireflective layer]" (Ex. 1006, 5:64–68) does not "invite substitution" with hydrogenated silicon nitride, particularly where Nakano's embodiments consistently use tantalum pentoxide as an antireflection coating. *See* Pet. Reply 14–15 (citing Ex. 1003 ¶¶ 116–18). And Petitioner does not persuasively explain why a person of ordinary skill would have been motivated to include hydrogen in an antireflection layer in Nakano's structure; the excerpt from Hoex 2006 upon which Petitioner relies as teaching hydrogenated amorphous silicon nitride as an antireflection coating (*see* Pet. Reply 14–15 (citing Ex. 1007, 1)) is in the context of using

hydrogenated amorphous silicon nitride in a layer that provides *both* passivation and antireflection.

Accordingly, Petitioner has not met its burden to establish a person of ordinary skill in the art would have had reason to modify Nakano by replacing its tantalum pentoxide dielectric layer with the hydrogenated amorphous silicon nitride layer of Hoex 2006. After considering the parties' arguments and evidence and the record as a whole, we are not persuaded Petitioner has established by a preponderance of the evidence that claims 12–14 of the '215 patent are unpatentable over the combination of Nakano and Hoex 2006.

H. Alleged Anticipation Based on Narwankar

Petitioner argues that Narwankar anticipates claims 12–14. Pet. 46–59.

1. Claim 12

Petitioner asserts Narwankar discloses each element of claim 12, and supports its analysis with the testimony of Dr. Clemens. For example, Petitioner asserts that Narwankar discloses a substrate including silicon (*id.* at 47 (citing Ex. 1007 ¶ 19)) and each of the first and second dielectric layers as recited in claim 12. *Id.* at 47–51. Patent Owner disputes that Narwankar discloses a first dielectric layer comprising aluminum oxide having a thickness of less than 50 nm, and a second dielectric layer embedded with hydrogen. PO Resp. 53. In addition, Patent Owner contends that Narwankar is directed to semiconductor processing techniques and not a solar cell, and therefore does not anticipate because the preamble recitation “solar cell” limits the claim to solar cells. We first address the parties'

dispute as to whether the term “solar cell” is limiting.

solar cell

Petitioner argues that the recitation of “solar cell” in the preamble of claim 12 is not limiting on the claim’s scope, because the body of the claim describes a structurally complete invention, and because no element of the claim refers to the “solar cell.” Pet. 8–10. Petitioner further argues that a person of ordinary skill in the art would have understood that “solar cell” merely states one intended use of the dielectric stack of claim 12, because “the claim recites a semiconductor structure that *may* be used as a solar cell but may also have other uses.” *Id.* at 9 (citing Ex. 1003 ¶ 33); *see also* Pet. Reply 4 (citing Ex. 1003 ¶ 33; Ex. 1048, 34:20–35:2).

Patent Owner argues that “solar cell” is limiting because (1) the applicant relied explicitly on the term “solar cell” during prosecution to distinguish the invention from non-solar cell prior art, Fujisaki⁹ (PO Resp. 2–7); and (2) the preamble breathes life and meaning into the claim such that a person of ordinary skill would read the claims as meaningful only in the context of a solar cell (*id.* at 7–10).

We are not persuaded by Patent Owner’s argument as to the prosecution history of the ’215 patent. During prosecution, the Examiner expressly rejected the argument that “solar cell” in the preamble was limiting and found that Fujisaki anticipated the claim’s layer structure. Ex. 1002, 535 (“Applicant’s arguments in that the ‘solar cell’ in the present invention is different from the teaching of Fujisaki are not persuasive. The preamble of ‘solar cell’ merely states the purpose or intended use of

⁹ Fujisaki et al., “Al₂O₃/Si₃N₄ Stacked Insulators for 0.1 um Gate-metal-oxide-semiconductor Transistors Realized by High-density Si₃N₄ Buffer Layers,” 82 Applied Physics Letters 3931–3933 (June 2003).

invention which is of no significance to claim construction. Therefore, the preamble of ‘solar cell’ is not given patentable weight in the claim.”); *see also id.* at 502 (“Examiner pointed out the “solar cell” in the preamble is not given patentable weight and ... is anticipated by Fujisaki et al.’s structure based on the broadest reasonable interpretation.”). In response, rather than relying on the preamble, the applicant chose to amend the claim body in order to distinguish Fujisaki by adding limitations that recite structure unrelated to the device’s functioning as a solar cell. *Id.* at 493. Because the prosecution history does not demonstrate a clear reliance on the preamble to distinguish prior art, it does not support construing “solar cell” as limiting. *See Catalina Mktg. Int’l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 810 (Fed. Cir. 2002) (holding preamble non-limiting because there was not “clear reliance on the preamble to distinguish the prior art, especially where the examiner’s initial rejection considered terminal location insignificant for patentability.”).

As to Patent Owner’s argument that “solar cell” “is a fundamental characteristic of the invention” (PO Resp. 7–9 (citing Ex. 1001, [54], 1:8–10, 14–16, 2:36–43, 5:58–6:34, 6:44)), we have considered the evidence and Patent Owner’s arguments and do not agree that the structure recited in the body of claim 12 is only meaningful in the context of a solar cell. The body of claim 12 provides a structurally complete invention; deleting “solar cell” from the preamble would have no impact on the claimed structure and the preamble does not provide antecedent basis for any of the limitations in the body of the claim, such as “silicon substrate,” “first dielectric layer,” and “second dielectric layer.”

The Federal Circuit has recognized “as a general rule preamble language is not treated as limiting.” *Aspex Eyewear, Inc. v. Marchon*

Eyewear, Inc., 672 F.3d 1335, 1347 (Fed. Cir. 2012); *see also Catalina*, 289 F.3d at 809 (“[a] preamble generally is not limiting when the claim body describes a structurally complete invention such that deletion of the preamble phrase does not affect the structure or steps of the claimed invention.”). *Poly-America, LP v. GSE Lining Tech., Inc.*, 383 F.3d 1303, 1310 (Fed. Cir. 2004), upon which Patent Owner relies, is distinguishable because in that case “analysis show[ed] that the inventor considered that the ‘blown-film’ preamble language represented an important characteristic of the claimed invention.” *Id.* Here, although Patent Owner points to language throughout the ’215 patent specification referring to a “solar cell,” the claim language itself does not support that a person of ordinary skill would read claim 12 as meaningful only in the context of a solar cell. Further, Dr. Lebby’s testimony that “the body of the claims recite a complete structure which is only meaningful in the context of a solar cell” (Ex. 2012 ¶ 50) is conclusory, and does not rebut Dr. Clemens’s testimony that the elements of claim 12, i.e., a silicon substrate, first dielectric layer, and second dielectric layer, “have utility on their own and could be used for a variety of purposes including photodectors.” Ex.1003 ¶ 33. Accordingly, Patent Owner does not persuade us that “solar cell” is such an important characteristic of the claimed invention that the preamble of claim 12 should be construed as limiting.¹⁰

¹⁰ We note that our determination is consistent with the Order construing certain terms of the ’215 patent issued by ALJ McNamara in the parallel proceeding at the International Trade Commission (“ITC”). Ex. 1045, 20–21.

hydrogen embedded into the second dielectric layer

Petitioner does not contend that Narwankar expressly discloses this limitation, but rather asserts that Narwankar satisfies this limitation because its process for forming the silicon oxide layer (i.e., second dielectric layer 220) describes the use of hydrogen as an oxidizing gas and a purge gas, and further describes using silane as a silicon precursor. Pet. 52–55 (citing Ex. 1008, Fig. 3, ¶¶ 27, 36). Petitioner asserts that the presence of hydrogen in the processing chamber during the formation of the silicon oxide layer results in reactions that cause hydrogen to be embedded in the silicon oxide layer. *Id.* at 53 (citing Ex. 1003 ¶¶ 157–160; Ex. 1030, 2:45–56). Petitioner asserts that Narwankar’s process of using hydrogen-containing compounds to form second dielectric layer 220 is similar to the process described in the ’215 patent, because both processes describe the use of silane, ammonia, and methane as reactants. *Id.* at 54 (citing Ex. 1001, 5:6–14, 7:61–64; Ex. 1008 ¶¶ 27, 36). Petitioner further asserts that the presence of hydrogen-containing compounds in the processing chamber during the formation of Narwankar’s capping layer 240 also results in hydrogen being embedded in the resulting dielectric layer. *Id.* at 54–55 (citing Ex. 1003 ¶ 139; Ex. 1008 ¶¶ 38–40).

Patent Owner disputes that hydrogen would necessarily be present in the second dielectric layer due to Narwankar’s process, and argues that Petitioner and its expert do not provide sufficient evidence to support the assertion that hydrogen would necessarily be present. PO Resp. 55–56. Patent Owner argues that a person of ordinary skill would have understood that the amount of bonded hydrogen resulting from the use of silicon nitride in the processing chamber would depend on the deposition temperature and ratio of reactants. *Id.* at 56. Patent Owner further argues that Narwankar

discloses using hydrogen for removing halogen atoms which form a “volatile and removable byproduct” with hydrogen (*id.* (citing Ex. 1008 ¶ 35)), and that a person of ordinary skill in the art would understand Narwankar as teaching a hydrogen removal process. PO Sur-reply 23–24 (citing Ex. 1008 ¶ 35; Ex. 2012, 185; Ex. 1050, 69:14–19).

Having evaluated the evidence, we find that Narwankar’s process would result in the presence of hydrogen. Dr. Clemens credibly testifies, based on several prior art references describing deposition processes using hydrogen containing precursors, that a person of ordinary skill in the art would have understood that Narwankar’s process would necessarily result in the presence of hydrogen in the dielectric layer. Ex. 1003 ¶¶ 159–160 (citing Exs. 1030, 1033–1036, 1039, 1040–1042). Contrary to Patent Owner’s argument, the references upon which Dr. Clemens relies do consider specific parameters of the deposition processes. *Id.* Further, although Patent Owner argues that deposition temperature and reactant ratio would affect the *amount* of bonded hydrogen, claims 12–14 do not require a minimum amount of embedded hydrogen, and Patent Owner does not identify any evidence that the hydrogen that would be introduced in Narwankar’s process can be completely removed.

Further, we disagree that Narwankar as a whole teaches a hydrogen removal process. Although Patent Owner relies on paragraph 35 of Narwankar to support its argument, we find that Narwankar ¶ 35 addresses one specific embodiment, and teaches the use of hydrogen for removing halogen atoms which form a “volatile and removable byproduct” with hydrogen. Narwankar, however, also describes using hydrogen as a carrier gas or purge gas as part of its ALD process (*id.* ¶ 27), and describes a nitridation process that bombards SiO_x layer 220 with gases that include

hydrogen, such as NH_3 . *Id.* ¶¶ 39–40. Dr. Clemens explains that a person of ordinary skill in the art would have understood that a nitridation process using NH_3 inevitably would cause incorporation of hydrogen. Ex. 1003 ¶¶ 39, 163. We find that Petitioner’s evidence outweighs Patent Owner’s evidence, which focuses on the embodiment of Narwankar ¶ 35.

Accordingly, we find that Narwankar satisfies claim 12’s limitation that hydrogen is embedded into the first dielectric layer.

wherein the first dielectric layer has a thickness of less than 50 nm and is interposed between the surface of the silicon substrate and the second dielectric layer

Petitioner asserts that Narwankar’s disclosure of dielectric layer 210 with thickness preferably ranging from 2 nm to 50 nm and more preferably from about 5 nm to 20 nm satisfies this claim limitation. Pet. 56 (citing Ex. 1003 ¶ 141; Ex. 1008 ¶ 22); *see also id.* at 48 (arguing that dielectric layer 210 corresponds to the first dielectric layer comprising aluminum oxide because Narwankar “discloses that the dielectric layer ‘may have a variety of compositions’ and ‘may include combinations of hafnium, . . . **aluminum**, silicon, **oxygen** and/or nitrogen.’” (citing Ex. 1008 ¶ 24)).

Patent Owner argues that Narwankar does not expressly disclose that dielectric layer 210 comprises aluminum oxide. PO Resp. 53–55. Specifically, Patent Owner argues that Narwankar’s statement concerning dielectric layer thickness relates to a list of possible layer materials representing “an incredibly large number of possible materials” as well as aluminum oxides. *Id.* at 54–55 (citing Ex. 1008 ¶ 24; Ex. 2012 ¶¶ 179, 293–95). Patent Owner relies on *NetMoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1370 (Fed. Cir. 2008) to support its argument that Narwankar’s disclosure of aluminum oxide among a list of materials does not disclose

aluminum oxide having the recited thickness “arranged or combined in the same way as in the claim. PO Resp. 54; PO Sur-Reply 23.

We agree with Petitioner that *NetMoney* is distinguishable because the asserted anticipatory disclosure in that case was disclosed in separate embodiments. Reply 20–21. By contrast, as Petitioner points out, Narwankar first discloses that dielectric layer 210 has a thickness ranging from 5 to 20 nm, and also discloses that dielectric layer 210 may have a composition that includes aluminum oxides. *Id.* at 20. Thus, unlike the disclosure in *NetMoney*, Narwankar’s disclosure relied upon by Petitioner expressly involves a single dielectric layer (layer 210), not separate embodiments. We find that a person of ordinary skill in the art would understand Narwankar’s dielectric layer 210 to include aluminum oxide and have a thickness within the range recited in claim 12, and that Petitioner sufficiently shows that Narwankar discloses this limitation.

Conclusion as to Claim 12

We have reviewed Petitioner’s evidence and arguments on the limitations of claim 12 not discussed above, and for which Patent Owner does not provide a substantive response. We find that a preponderance of the evidence supports the conclusion that these uncontested limitations are disclosed by Narwankar.

For the foregoing reasons, we find that Petitioner has shown by a preponderance of the evidence that Narwankar anticipates claim 12.

2. Claims 13 and 14

Dependent claim 13 specifies that the second dielectric layer comprises a material selected from the group consisting of silicon nitride, silicon oxide and silicon carbide. Petitioner asserts, with supporting evidence in Dr. Clemens’s testimony, that Narwankar’s disclosure of silicon

oxide second dielectric layer 220 satisfies this limitation, and additionally that capping layer 240 also meets this limitation because it comprises silicon oxide and silicon nitride. Pet. 58 (citing Ex. 1003 ¶¶ 133–134, 143; Ex. 1008, Figs. 1, 2C, ¶¶ 25–27, 40, and 41). Patent Owner does not separately address this dependent claim.

Dependent claim 14 requires the first dielectric layer of claim 12 to have a thickness of less than 30 nm. Petitioner asserts that Narwankar’s disclosure of dielectric layer 210 with thickness preferably ranging from 5 nm to 20 nm expressly discloses the “less than 30 nm” limitation, and Dr. Clemens supports this assertion. *Id.* at 58 (citing Ex. 1003 ¶ 141, 144; Ex. 1008 ¶¶ 22). Patent Owner also does not separately address this limitation.

Having considered the parties’ arguments and evidence and the record as a whole, we are persuaded by Petitioner’s arguments and evidence, and find that Petitioner has established by a preponderance of the evidence that Narwankar anticipates claims 13 and 14 of the ’215 patent.

I. Alleged Obviousness Based on Narwankar and/or Tan

Petitioner argues that claims 12–14 would have been obvious over the teaching of Narwankar alone or the combined teachings of Narwankar and Tan. Pet. 59–66.

As discussed above, we find that Petitioner has shown Narwankar anticipates claims 12–14. A disclosure that anticipates under §102 also renders the claim invalid under § 103, for “anticipation is the epitome of obviousness.” *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019) (citing *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed.

Cir. 1983) (internal citations omitted)).¹¹ Accordingly, based on Petitioner's showing that Narwankar anticipates claims 12–14, we find that the record also sufficiently supports Petitioner's contention that the teachings of Narwankar alone, or the combined teachings of Narwankar and Tan, render claims 12–14 obvious.

III. CONCLUSION

Based on the evidence and arguments, Petitioner has shown by a preponderance of the evidence that the challenged claims of the '215 patent are unpatentable.¹²

In summary:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
12–14	§ 102	Agostinelli '086		12–14
12–14	§ 103	Agostinelli '086, Nakano, and Hoex 2006		12–14
12–14	§ 103	Nakano and Hoex 2006		12–14
12–14	§ 102	Narwankar	12–14	

¹¹ Patent Owner has not presented any evidence regarding objective indicia of nonobviousness.

¹² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
12–14	§ 103	Narwankar and/or Tan	12–14	
Overall Outcome			12–14	

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has shown by a preponderance of the evidence that claims 12–14 are unpatentable; and

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

IPR2019-01145
Patent 9,893,215 B2

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