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Paper 32
Date: October 24, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

EDEN PARK ILLUMINATION, INC.,
LARSON ELECTRONICS LLC, and FAR UV TECHNOLOGIES, INC.,
Petitioner,

v.

S. EDWARD NEISTER,
Patent Owner.

IPR2022-00682
Patent 8,975,605 B2

Before, JEFFREY W. ABRAHAM, ELIZABETH M. ROESEL, and JULIA HEANEY, *Administrative Patent Judges*.

ROESEL, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. Background and Summary

Eden Park Illumination, Inc., Larson Electronics LLC, and Far UV Technologies, Inc. (collectively, "Petitioner") filed a Petition (Paper 4, "Pet.") requesting an *inter partes* review of claims 1, 2, 5, and 6 ("the challenged claims") of U.S. Patent No. 8,975,605 B2 (Ex. 1001, "the '605 patent"). S. Edward Neister ("Patent Owner") filed a Preliminary Response. Paper 9 ("Prelim. Resp."). We instituted an *inter partes* review. Paper 10 ("Institution Decision" or "Inst. Dec.").

After institution, Patent Owner filed a Patent Owner Response (Paper 20, "PO Resp."), Petitioner filed a Reply (Paper 21, "Pet. Reply"), Patent Owner filed a Sur-reply (Paper 22, "PO Sur-reply"), and Petitioner filed a Sur-sur-reply (Paper 28, "PET Sur-sur-reply").[1] We held an oral hearing on August 9, 2023, and a transcript is in the record. Paper 31 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). We determine that Petitioner has shown by a preponderance of the evidence that the challenged claims of the '605 Patent are unpatentable.

B. Related Proceedings

The parties identify the following as related proceedings: (1) *Healthe, Inc. v. High Energy Ozone LLC*, No. 6:20-cv-02233 (M.D. Fla.); (2) *High Energy Ozone LLC v. Larson Electronics LLC*, No. 3:21-cv-01166 (N.D.

[1] Petitioner's unopposed motion for leave to file a Sur-sur-reply and Exhibit 1042 as supplemental information pursuant to 37 C.F.R. § 42.123(b) is granted for the reasons given by Petitioner. Paper 27.

Tex.); (3) *High Energy Ozone LLC v Eden Park Illumination, Inc.*, No. 1:21-cv-02753 (N.D. Ill.) (administratively closed); (4) *High Energy Ozone LLC v Eden Park Illumination, Inc.*, No. 3:22-cv-00425 (N.D. Tex.); (5) *High Energy Ozone LLC v. Far UV Technologies*, No. 4:21-cv-00345 (W.D. Miss) (administratively closed); and (6) *High Energy Ozone LLC v. Far UV Technologies*, No. 3:22-cv-00280 (N.D. Tex.). Pet. 44–45; Paper 7, 1.

The parties also identify as a related matter (because of common parties, inventor, and assignee) IPR2022-00381 (U.S. Patent No. 9,700,642). Pet. 45; Paper 7, 1.

C. The '605 patent

The '605 patent, titled "Method and Apparatus for Producing a High Level of Disinfection in Air and Surfaces," issued on March 10, 2015. Ex. 1001, codes (45), (54). The '605 patent issued from a continuation of an application filed January 29, 2009. *Id.* code (63).

The '605 patent explains that in the past, a method of "sterilizing and disinfecting air has been based predominately on using commercially available germicidal ultra-violet (GUV) lamps" and that "[t]hese lamps are either pulsed or continuously excited." Ex. 1001, 1:24–27. Lamps that are continuously excited are mercury based and emit principally at 254 nm. *Id.* at 1:27–28. According to the '605 patent, though such a treatment method "is effective for treating the room air of individual rooms, it is not practical for treating large flowing volumes of air that pass quickly down large ducts." *Id.* at 1:36–39. This is because of the long treatment time that is required. *Id.* at 1:39–40. The '605 patent also explains that "[c]laims have been made that germicidal UV-C (GUV) radiation is used to deactivate DNA [deoxyribonucleic acid]" because "the mercury lamp emission at 254 nm is close to a good DNA absorption band." *Id.* at 1:55–58. However, "[n]o claims are made that combine different wavelength UV photons to produce a higher level of deactivation of microorganisms" and "no claims are made that combine FUV [(Far UV)] photons with UV-C photons to produce a higher level of deactivation of microorganisms." *Id.* at 1:58–62. The '605 patent discloses that recently, new UV emitting lamps based on the excitation of excimers are becoming commercially available in which the emitters produce single line or narrow spectral emission at a wavelength determined by the gas composition of the lamp. *Id.* at 2:4–8. However, "[n]o patent has been found that teaches the use of FUV sources coupled with UV-C sources with supporting equipment that can effectively and efficiently disinfect and sterilize large volumes of air, large and small surfaces, and food stuffs in various stages of preparation." *Id.* at 2:11–17.

The '605 patent discloses that researchers understand that GUV photons produce strong covalent bonds such as those in dimers. Ex. 1001, 2:33–40. According to the '605 patent, "GUV light is known to produce [t]hymine, cytosine-thymine, and cytosine dimers" and "[a]fter the formation of the dimer, further replication of the DNA stops." *Id.* at 2:40–43. The '605 patent further discloses that:

> It has been fairly well established that the peptide bonds in all proteins are responsible for the peak absorption at two different wavelength regions; namely at 200 nm and at 280 nm. The peak absorption at either 200 nm and/or near 280 nm is also exhibited by all nitrogenous bases in the DNA as well as the proteins that form the outer cellular membrane of bacteria, spores and viruses. This occurs as well for nucleoproteins, diglycine, triglycine, and bovine albumin . . . . Amino acids have a peak absorption band near 260 nm. A UV lamp emitting at 222 nm

> and/or 282 nm will produce the greatest photon absorption by the nitrogenous bases and proteins. A UV-C lamp emitting at 260 nm will produce the greatest photon absorption by the amino acids in the DNA. Consequently these three wavelengths are primary absorption bands that permit destruction of microorganisms.

Id. at 3:58–4:8.

The '605 patent describes a method that uses "a dual-single lined lamp that emits at least two narrow wavelength bands of ultra-violet photons that match closely to the maximum absorption bands for DNA chromophores of nitrogenous bases, proteins, amino acids and other component bonds of microorganisms" with a preference of "a multi-wavelength narrow line source emitting at least two different wavelengths." Ex. 1001, 4:57–64. Three tests were conducted in regard to microorganisms' exposure to certain wavelengths: (1) with a combination of 222 nm and 254 nm photons or with only 282 nm photons on *Serratia marcescens*; (2) with only 282 nm photons or with a combination of 282 nm and 254 nm photons on *Aspergillus Niger*; and (3) with a combination of 222 nm and 254 nm photons or with a combination of 282 nm and 254 nm photons on *Escherichia coli*. *Id.* at 4:15–31. The '605 patent discloses that the results of these tests "showed significant reduction in living organisms when multi-wavelength narrow line photons were used compared to single wavelength photons" and that "[t]hese tests also demonstrated that the correct combination of dual-single line photons were significant and dependant on each organism." *Id.* at 4:43–48.

D. Illustrative Claim

Petitioner challenges claims 1, 2, 5, and 6 of the ’605 patent. Independent claim 1 is the independent claim challenged and is reproduced below.

> 1. [1pre] A process for destroying or deactivating the DNA organic bonds and proteins of microorganisms comprising the steps of:
>
> [1a] generating photons of at least two single line wavelengths from a non-coherent light source selected from the group consisting of at least two wavelengths being of 222 nm, 254 nm, and 282 nm;
>
> [1b] directing the photons to a substance to be disinfected, whereby the photons destroy or deactivate the DNA organic bonds and proteins of microorganisms;
>
> [1c] exposing the surface to be disinfected to the generated photons of at least two wavelengths, wherein the exposing achieves a ninety percent kill of microorganisms in a time period of less than one second.

Ex. 1001, 9:22–10:9 (bracketed text added to correspond with Petitioner’s designation of claim elements); *see* Pet. 16–21.

E. Asserted Challenges to Patentability

Petitioner raises the following challenges to patentability:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 2	103	Brown-Skrobot,[2] Clauβ[3]

[2] Ex. 1004, US 2005/0079096 A1, published Apr. 14, 2005 (“Brown-Skrobot”).

[3] Ex. 1005, Clauβ, M., Mannesmann, R., & Kolch, A., *Photoreactivation of <u>Escherichia coli</u> and <u>Yersinia enterolytica</u> after Irradiation with a 222 nm Excimer Lamp Compared to a 254 nm Low-pressure Mercury Lamp*, 33 ACTA HYDROCHIMICA ET HYDROBIOLOGICA 579–84 (2005) (“Clauβ”). Petitioner refers to this reference as “Clauss.”

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
5, 6	103	Brown-Skrobot, Clauβ, Liang[4]

Pet. 2–3.

F. Testimonial Evidence

The record includes three declarations of Oliver R. Lawal submitted by Petitioner (Exs. 1003, 1037, and 1042) and Mr. Lawal's deposition testimony submitted by Patent Owner (Ex. 2002). The record also includes two declarations of Mark T. Hernandez, Ph.D., submitted by Patent Owner (Exs. 2001, 2017) and Dr. Hernandez' deposition testimony submitted by Petitioner (Ex. 1041).

II. ANALYSIS

A. Principles of Law

"In an IPR [(*inter partes* review)], the 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) (citing 35 U.S.C. § 312(a)(3) (2012) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review). Furthermore, a petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

[4] Ex. 1006, US 2005/0163648 A1, published July 28, 2005 ("Liang").

Obviousness is a question of law based on underlying determinations of fact. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966); *Richardson-Vicks, Inc. v. Upjohn Co.*, 122 F.3d 1476, 1479 (Fed. Cir. 1997). A claim is unpatentable as obvious, under 35 U.S.C. § 103, if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). 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) objective evidence of nonobviousness.[5] *Graham*, 383 U.S. at 17–18. Consideration of the *Graham* factors "helps inform the ultimate obviousness determination." *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1048 (Fed. Cir. 2016) (en banc), *cert. denied*, 138 S. Ct. 420 (2017). To prevail in an *inter partes* review, Petitioner must explain how the proposed combinations of prior art would have rendered the challenged claims unpatentable. Subsumed within the *Graham* factors are the requirements that all claim limitations be found, either expressly or inherently, in the prior art references and that the skilled artisan would have had a reasonable expectation of success in combining the prior art references to achieve the claimed invention. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1361 (Fed. Cir. 2007).

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[5] In this case, the parties have not asserted or otherwise directed our attention to any objective evidence of nonobviousness.

B. Level of Ordinary Skill in the Art

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art ("POSITA") at the time of the invention. *Graham*, 383 U.S. at 17.

Petitioner contends that a POSITA "would have had at least a bachelor's degree in an engineering discipline, such as biological, chemical, environmental, electrical, mechanical, and/or systems engineering, or an equivalent degree such as one in physics or similar subject matter." Pet. 9 (citing Ex. 1003 ¶ 20). "Such a person would also have had two to three years of work or research experience with UV disinfection technology and/or systems and would be familiar with the fundamentals of UV excimer lamps," but "less education could be compensated by more experience and vice versa." *Id.* Patent Owner does not dispute Petitioner's proposed definition. *See* PO Resp. 8.

We determine that Petitioner's proposed definition is consistent with the prior art of record, and apply it for this Decision. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that specific findings on ordinary skill level are not required "where the prior art itself reflects an appropriate level and a need for testimony is not shown" (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985))).

C. Claim Construction

We construe claim terms according to the standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc); 37 C.F.R. § 42.100(b) (2023). Under *Phillips*, we give claim terms "their ordinary and customary meaning." *Phillips*, 415 F.3d at 1312. "[T]he ordinary and customary meaning of a claim term 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." *Id.* at 1313. "Importantly, the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification." *Id.*

"The Board is required to construe 'only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.'" *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (quoting *Vivid Techs., Inc. v. Am. Sci. Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Except for the claim term discussed below, we determine that no other claim terms require express construction for purposes of resolving the controversy.

1. "a . . . light source"

Claim element [1a] recites "generating photons of at least two single line wavelengths from a non-coherent light source selected from the group consisting of at least two wavelengths being of 222 nm, 254 nm, and 282 nm." Ex. 1001, 9:25–10:2.

Patent Owner contends that "a . . . light source" means a single light source, such that claim 1 requires a single light source that emits two or more single line wavelengths. PO Resp. 8–11; PO Sur-reply 3–5. More particularly, Patent Owner argues that "a 'source' . . . is defined as . . . a single lamp." PO Resp. 10.[6] Petitioner disagrees, arguing that "'a non-

[6] At the hearing, Patent Owner changed its position, conceding that a single source may include multiple lamps, so long as they are in the same location and connected to the same power source. Tr. 22:12–14, 23:11–12,

coherent light source' should be construed to mean 'one or more non-coherent light sources'" and, at a minimum, the limitation encompasses a "source" comprising one or more lamps. Pet. Reply 2. We agree with Petitioner.

It is a well-settled principle of claim construction that "an indefinite article 'a' or 'an' in patent parlance carries the meaning of 'one or more' in an open-ended claim containing the transitional phrase 'comprising.'" *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F.3d 1351, 1356 (Fed. Cir. 2000). "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) (quoting *KCJ*, 223 F.3d at 1356)). "An exception to the general rule that 'a' . . . means more than one only arises where the language of the claims themselves, the specification, or the prosecution history necessitate a departure from the rule." *Id.* at 1342–43; *see also ABS Glob., Inc. v. Cytonome/St, LLC*, No. 2022-1761, 2023 WL 6885009, at *4 (Fed. Cir. Oct. 19, 2023) (discussing and applying the general rule).

Patent Owner argues that the specification requires a single light source that emits two or more wavelengths. PO Resp. 9–10 (citing Ex. 1001, 1:20–23, 2:62–67, 4:62–64,[7] 7:35–36, Fig. 7); PO Sur-reply 3–5 (additionally citing Ex. 1001, 7:47–8:15). We disagree. As discussed below, none of the cited specification passages show a clear intent to depart

25:19–26. Patent Owner's concession undermines the construction Patent Owner proposed in the briefs, which is what we address here.

[7] Patent Owner mistakenly cites Ex. 1001, 6:62–64 when quoting column 4, lines 62–64. PO Resp. 10.

from the general rule for the indefinite article "a" in the phrase, "a non-coherent light source."

Patent Owner relies on the specification's description of an "apparatus [that] consists of two separate chambers that produce the different wavelengths during the same excitation process." PO Resp. 9; Ex. 1001, 1:20–23. In contrast, claim 1 recites a "process for destroying or deactivating the DNA organic bonds and proteins of microorganisms" including the step of "generating photons of at least two single line wavelengths from a non-coherent light source." *Id.* at 9:22–26. Claim 1 is not limited to an apparatus having two separate chambers that produce different wavelengths during the same excitation process. The specification passage relied upon by Patent Owner describes a preferred embodiment having "two separate chambers," which is "merely illustrative" and should not be read into the claims. *Id.* at 1:20–23, 7:32–46, 9:15–17; *In re Am. Acad. Of Sci. Tech Ctr.*, 367 F.3d 1359, 1369 (Fed. Cir. 2004) ("We have cautioned against reading limitations into a claim from the preferred embodiment described in the specification, even if it is the only embodiment described, absent clear disclaimer in the specification."); *see also ABS Glob*., 2023 WL 6885009, at *5 ("[T]he singular-only meaning is not demanded by the specification's embodiments, described as nothing more than examples.").

Moreover, the preceding sentence of the specification is more pertinent to claim 1. Ex. 1001, 1:17–20 ("The method utilizes multi-wavelength UV photons that combine the effects of Far UV photons with UV-C photons to produce a higher level of disinfection than possible with either source separately."). Like claim 1, this sentence describes a method.

Notably, it describes the method as combining a source of Far UV photons with a source of UV-C photons. *Id.* In other words, the invention combines ***two sources*** of photons having two different wavelengths. *Id*.

Elsewhere the specification similarly describes the improvement as resulting from the combination of sources of photons having different wavelengths. For example, when describing the prior art's shortcomings, the '605 patent states: "No claims are made that combine different wavelength UV photons to produce a higher level of deactivation of microorganisms. Furthermore, no claims are made that combine FUV photons with UV-C photons to produce a higher level of deactivation of microorganisms." Ex. 1001, 1:58–62. Immediately following this description of the prior art's shortcomings, the '605 patent discloses that the invention improves upon the prior art by combining a source of far UV photons with a source of UV-C photons. "***A source*** of Far UV photons targets a nitrogenous base absorption band . . . while ***a source*** of UV-C photons target[s] other nitrogenous base absorption peaks . . . . The application of multi-wavelength but narrow line UV photons produces an improvement . . . compared to using ***either source*** of photons separately." *Id.* at 1:62–2:3. The foregoing characterization of the invention provides strong support for Petitioner's position that "a source" means one or more sources.

The '605 patent includes additional descriptions suggesting that the invention improves upon the prior art by combining multiple sources of UV radiation at different wavelengths. For example, the '605 patent states, "While FUV photons have shown to be effective in breaking bonds, it is possible that the correct dual wavelength combination of FUV and UV-C could be just as or more effective." Ex. 1001, 3:3–6. In another description of the prior art's shortcomings, the '605 patent states, "No one has done a detailed study of the effectiveness of inactivation for the different single line UV emitters working in combination." *Id.* at 3:16–19. This statement suggests that "different single line UV emitters working in combination" is within the scope of what the inventor contemplated as his invention.

The '605 patent reinforces this suggestion when describing tests conducted to "test the concept" of the invention. Ex. 1001, 4:8–53. For example, the '605 patent states, "Petrie dishes were inoculated with each organism and exposed to different combinations of UV photons." *Id.* at 4:11–13. "The left side of the dish was exposed with a combination of 222 nm plus 254 nm photons. The right side of the dish was exposed with only 282 nm photons. The multi-wavelength side produced a significant improvement." *Id.* at 4:16–20. The '605 patent summarizes by stating, "All tests were done using single line photon ***sources*** that emitted near the peak absorption of the two absorption bands of the DNA nitrogenous bases and the single absorption band of the DNA amino acids." *Id.* at 4:36–39 (emphasis added). This statement provides strong evidence that the invention encompasses generating photons of at least two single line wavelengths from multiple sources.

Patent Owner relies on the following passage from the specification:

> [C]ritical to this patent is that the multi-wavelength source produces two different narrow spectral width (commonly referred to as single line) emissions that correspond to at least two peak absorption chromophores of the microorganism's DNA. This source is now referred to in the rest of the patent as a dual-single line lamp.

Ex. 1001, 2:62–67; PO Resp. 9–10; PO Sur-reply 3. According to Patent Owner, this passage provides a "clear and unambiguous definition" and shows that the "dual-single line lamp" is "critical" and "not merely one embodiment." PO Sur-reply 1, 3. Patent Owner argues that "[t]he description of the 'source' as 'multi-wavelength' would make no sense if the claimed 'source' could in fact be two separate single-wavelength sources." *Id.*

We disagree with Patent Owner's interpretation. The quoted passage provides a definition of "a dual-single line lamp," not the claim term "a non-coherent light source." Although the '605 patent frequently refers to "a dual-single line lamp" (*e.g.,* Ex. 1001, 7:35–36), that term is not used in the claims. The quoted passage discusses criticality of a source's emissions, including their narrow spectral width and correspondence with the wavelengths absorbed by the target microorganism. *Id.* at 2:62–66. The passage does not show criticality of the physical configuration of the emissions' source.

Patent Owner also relies on Figure 7 and the description of "a multi-wavelength narrow line source emitting at least two different wavelengths." Ex. 1001, 4:62–64, Fig. 7; PO Resp. 10; *see* page 11 n.7, *supra*. These portions of the specification describe and illustrate a preferred embodiment and do not justify departing from the general rule that the indefinite article "a" means "one or more." *ABS Glob.*, 2023 WL 6885009, at *4–5. Nor do they define a "source" as a single lamp, as argued by Patent Owner. PO Resp. 10.

Patent Owner argues that claim 1 distinguishes between the singular and the plural by reciting "at least *two* single line wavelengths from *a* non-coherent light source." PO Sur-reply 4 (citing *Harari v. Lee*, 656 F.3d 1331, 1341 (Fed. Cir. 2011)). In *Harari*, the Court determined that "[t]he plain language of the claim clearly indicates that only a single bit line is used when accessing a number of cells." *Id.*, 656 F.3d at 1341. The Court cited three separate claim recitations, each of which "expressly distinguishes between the singular and plural." *Id.* Following an extensive discussion of the specification, the Court concluded that "the correct and only reasonable construction of the claim terms 'a bit line' and 'said bit line' . . . is that [the claim] requires that a single bit line activates multiple memory cells." *Id.*

We disagree with Patent Owner that the facts of this case justify a departure from the general rule that, in a patent claim, the indefinite article "a" means "one or more." In contrast to *Harari*, the '605 patent does not emphasize that two or more wavelengths must be generated by a single light source or lamp. Instead, the '605 patent describes a method of combining a source of Far UV photons with a source of UV-C photons. Ex. 1001, 1:17–20, 1:62–2:3, 4:36–39. Although the preferred embodiment uses a "dual-single line lamp" (*id.* at 2:62–66, 7:4–6, Fig. 7), we do not read claim 1 as limited to this embodiment.

Furthermore, we agree with Petitioner that the '605 patent's "dual-single line lamp" could be considered as including two "sources." Pet. Reply 4. The lamp is described as having two chambers, which contain different gas mixtures to produce different wavelength photons when the lamp is electrically excited. Ex. 1001, 7:37–67, Fig. 7. Consistent with the '605 patent's description of combining a source of Far UV photons with a source of UV-C photons, the Figure 7 embodiment could be considered a combination of two sources of UV light generated by different gas mixtures. Ex. 1001, 1:17–20, 1:62–2:3, 4:36–39.

For these reasons, we do not construe "a . . . light source" in claim 1 as limited to a single light source, as argued by Patent Owner.

D. Petitioner's Challenge based on Brown-Skrobot and Clauβ

Petitioner contends that claims 1 and 2 are unpatentable as obvious based on Brown-Skrobot and Clauβ. Pet. 10–26. Patent Owner opposes. PO Resp. 12–29. We provide an overview of the references before turning to the parties' contentions.

1. Brown-Skrobot (Ex. 1004)

Brown-Skrobot is titled "Method and Apparatus of Sterilization Using Monochromatic UV Radiation Source" and describes an apparatus for delivering UV radiation to a medical device for sterilization. Ex. 1004, code (54), ¶ 22. Brown-Skrobot defines "monochromatic ultraviolet radiation" as "radiation having a wavelength or wavelengths between from 160 to 400 nm, and the majority of the radiation is concentrated within a bandwidth of 3 nm." *Id.* ¶ 33. Preferably, "the majority of radiation is within a bandwidth of 2 nm, more preferably within 1 nm." *Id.* According to Brown-Skrobot, "[t]he preferred monochromatic UV radiation has the majority wavelength or wavelengths within about 220 to 320 nm, more preferably within 240 to 280 mm." *Id.*

Brown-Skrobot discloses various sources of monochromatic UV radiation, including excimer lamps. Ex. 1004 ¶ 34. Brown-Skrobot provides examples of gas mixtures used in excimer lamps that produce monochromatic UV radiation, including krypton and chlorine (KrCl), xenon and iodine (XeI), and xenon and bromine (XeBr). *Id.* ¶ 38. Brown-Skrobot discloses that multiple monochromatic UV radiation sources can be used together to provide the same or different amounts of energy at different wavelengths. *Id.* ¶ 42. According to Brown-Skrobot, "[t]he different wavelengths may provide increased levels of sterility." *Id.* The monochromatic UV radiation sources may be used in conjunction with other structural and optical elements, such as reflectors, to direct the radiation at the target. *Id.* ¶ 40.

Brown-Skrobot also discloses that "[n]on-ionizing radiation such as monochromatic ultraviolet (UV) light is known to damage the DNA of exposed cells. The UV radiation causes thymine to dimerize which inhibits replication of DNA during cell reproduction." Ex. 1004 ¶ 6.

2. Clauβ (Ex. 1005)

Clauβ is titled "Photoreactivation of *Escherichia coli* and *Yersinia enterolytica* after Irradiation with a 222 nm Excimer Lamp Compared to a 254 nm Low-pressure Mercury Lamp." Ex. 1005, 579. Clauβ explains that "monochromatic emission of 254 nm almost corresponds with the maximum of DNA absorption at approx. 260 nm" and that "[t]his absorption causes damage to DNA by altering nucleotide base pa[i]ring, especially 6-4 photoproducts and thymine dimers formation," which can lead to cell death.[8] *Id.* at 580. Clauβ further explains that UV radiation can also damage proteins and their constituent amino acids and that "proteins show absorption maxima at 220 nm and 280 nm." *Id.* Clauβ discusses photoreactivation as a repair mechanism for DNA damage and observes that

[8] We understand that 6-4 photoproducts and thymine dimers are both structural alterations of DNA formed in a photochemical reaction induced by UV radiation that results in the coupling of consecutive nucleotide bases on a strand of DNA. *See https://en.wikipedia.org/wiki/Pyrimidine_dimer.*

"[d]ue to the fact that the photoreactivation only repairs DNA damage[,] it would be interesting to investigate the photoreactivation of bacteria after irradiation with wavelengths in the range of the absorption maxima of proteins." *Id.*

Clauβ describes experiments comparing photoreactivation of bacteria after irradiation with a KrCl excimer lamp at a wavelength of 222 nm (near protein absorption maximum) and a low-pressure mercury lamp at a wavelength of 254 nm (near DNA absorption maximum). Ex. 1005, 580–582, Figs. 2, 3 (inactivation curves for *E. coli* ATCC 11229 and *Y. enterolytica* ATCC 4780 at 222 nm and 254 nm with and without photoreactivation). Based on these experiments, Clauβ observes, "When the photoreactivation after irradiation is excluded, the mercury lamp with 254 nm clearly shows better results regarding inactivation. Whereas, on the other hand with photoreactivation afterwards the excimer lamp with 222 nm wavelength obviously shows better results." *Id.* at 582.

Clauβ concludes that "without photoreactivation the inactivation with UV radiation with 254 nm wavelength near the absorption maxima of DNA is most effective" and "[t]o get the same inactivation results with 222 nm wavelength the necessary irradiation has to be 50% higher." Ex. 1005, 583. Clauβ further concludes,

> But when the bacteria get the chance to photoreactivate, the ratios change. With photoreactivation and irradiation with 254 nm the bacteria has to be irradiated 300% more to obtain the same reduction as without photoreactivation. At 222 nm a higher irradiation of only 25% for *E. coli* and 50% for *Y. enterolytica* are necessary to get the same inactivation as without photoreactivation.

Id. According to Clauβ, these results indicate that irradiation at 222 nm damages molecules other than DNA, and photoreactivation is a DNA repair process only and not able to repair damage to other molecules. *Id.*

3. *Combining Teachings*

Petitioner contends that it would have been obvious to combine the teachings of Brown-Skrobot and Clauβ, wherein "Brown-Skrobot's method of sterilizing with '[t]wo or more monochromatic uv radiation sources' 'having a wavelength or wavelengths between from 160 to 400 nm' is performed using the 222 nm KrCl excimer lamp and 254 nm low-pressure mercury lamp of Clauss." Pet. 12 (citing Ex. 1003 ¶ 67; Ex. 1004 ¶¶ 33, 42; Ex. 1005, 580). Petitioner contends that a POSITA would have been motivated to combine the teachings of Brown-Skrobot and Clauβ for several reasons. Pet. 13–15 (citing Ex. 1003 ¶¶ 68–73). For example, Petitioner contends that using "different wavelengths may provide increased levels of sterility" and "the synergistic effect of using multiple light sources of different wavelengths for germicidal use, including specifically sources emitting monochromatic 222 nm and 254 nm wavelengths, was known." Pet. 13, 15 (citing, among others, Ex. 1008, 1529).

Patent Owner argues that "Brown-Skrobot discourages the use of both 222 nm and 282 nm wavelengths from light sources other than lasers," that "Clauβ is a study of two separate excimer lamps and the effect of photoreactivation on the produced wavelengths," and that the "POSITA would not have been motivated to combine Brown-Skrobot with Clauβ to arrive at the claimed invention with a reasonable expectation of success." PO Resp. 12, 19, 21.

After considering the parties' submissions, we determine that the preponderance of the evidence favors Petitioner. The evidence shows that a POSITA would have had reasons to combine (1) Brown-Skrobot's teaching of using two or more monochromatic UV radiation sources having different wavelengths between 160 to 400 nm for sterilization (Ex. 1004 ¶¶ 33, 42) with (2) Clauβ's teaching of a 222 nm KrCl excimer lamp and 254 nm low-pressure mercury lamp for disinfection (Ex. 1005, 579).

Petitioner shows persuasively that a POSITA would have wanted to obtain the benefits of combining two or more monochromatic UV radiation sources that emit different wavelengths, as taught by Brown-Skrobot (Ex. 1004 ¶ 42) and would have selected 222 nm and 254 nm in order to obtain the advantages of irradiating bacteria with these wavelengths, as taught by Clauβ (Ex. 1005, 579, 582, 583). Petitioner's combination of teachings fits comfortably within the obviousness scenarios discussed in *KSR*. *See, e.g.*, 550 U.S. at 417 (stating that "when a patent 'simply arranges old elements with each performing the same function it had been known to perform' and yields no more than one would expect from such an arrangement, the combination is obvious," quoting *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, 282 (1976)).

Petitioner's combination is supported by the teachings of both Brown-Skrobot and Clauβ. Brown-Skrobot teaches a process of sterilizing a medical device by irradiating the device with monochromatic UV radiation to kill microorganisms. Ex. 1004, code (57), claim 1. Significantly, Brown-Skrobot teaches that "[t]wo or more monochromatic uv radiation sources can be used together to . . . provide the same or different amounts of energy at different wavelengths of monochromatic uv radiation." *Id.* ¶ 42. Regarding the wavelengths of monochromatic UV radiation, Brown-Skrobot teaches a preferred range of 220 to 320 nm. *Id.* ¶ 33, claim 13. Brown-Skrobot teaches various sources of monochromatic UV radiation, including a KrCl excimer lamp. *Id.* ¶¶ 34, 38, claims 10, 12. According to Brown-Skrobot, "[t]hese are only examples, other monochromatic UV radiation sources can be used." *Id.* ¶ 38.

Petitioner's combination is also supported by Clauβ, which describes two monochromatic UV radiation sources, a 222 nm KrCl excimer lamp and a 254 nm low-pressure mercury lamp, for disinfection and deactivating bacteria. Ex. 1005, 579 (title and abstract).

Petitioner shows persuasively that a POSITA would have found it obvious to implement the sterilization method disclosed in Brown-Skrobot by combining the monochromatic UV sources disclosed in Clauβ. Pet. 13–15; Pet. Reply 7–16. Our finding is supported by Brown-Skrobot's teaching concerning the benefits of using two or more monochromatic UV radiation sources having different wavelengths.

> The different wavelengths may provide increased levels of sterility, because different microorganisms that have to be sterilized on a medical device may have greater or lesser sensitivities to uv radiation at different wavelengths; therefore, multiple monochromatic uv radiation sources can be used which produce monochromatic uv radiation at different wavelengths which when used together will successfully sterilize all the microorganisms, that might not otherwise be sterilized, or would require greater levels of energy if only one monochromatic uv radiation source is used.

Ex. 1004 ¶ 42. In our view, the above-quoted passage in Brown-Skrobot provides strong evidence that a POSITA would have had a reason to combine two or more monochromatic UV radiation sources having different wavelengths. Particularly persuasive is Brown-Skrobot's teaching that different microorganisms have different sensitivities to different wavelengths of radiation such that combining sources that emit different wavelengths will provide more effective sterilization. *Id.* Brown-Skrobot also teaches that combining two or more monochromatic UV radiation sources having different wavelengths may require less energy than using a single monochromatic UV radiation source to provide the same level of sterilization. *Id.*

We find that Brown-Skrobot would have led a POSITA to consider a combination of two or more monochromatic UV radiation sources that emit wavelengths of 222 nm and 253 nm. Brown-Skrobot discloses various monochromatic UV radiation sources, including a KrCl excimer lamp, which emits a wavelength of 222 nm, and a xenon-iodine (XeI) excimer lamp, which emits a wavelength of 253 nm. Ex. 1004 ¶¶ 38, 39, claims 10, 12; *see also* Ex. 1003 ¶ 40 (listing characteristic wavelengths of various gas mixtures used in excimer lamps); *id.* ¶ 61 (summarizing Brown-Skrobot). Krypton-chlorine and xenon-iodine are among just ten gas mixtures listed in paragraph 38 and claim 12 of Brown-Skrobot. *Id.* ¶ 38, claim 12. Petitioner shows persuasively that "using a KrCl excimer lamp at 222 nm was disclosed by Brown-Skrobot, and the low-pressure mercury lamp at 254 nm taught by Clauss falls within the 'preferred' wavelength range of monochromatic UV light expressly suggested by Brown-Skrobot." Pet. 14; Ex. 1003 ¶ 71; Ex. 1004 ¶ 33.

Petitioner also shows persuasively that 222 nm and 254 nm wavelengths were "known to be effective for disinfecting substances and surfaces: light of wavelength 254 nm because it destroys DNA through dimer production and of wavelength 222 nm due to the absorption maxima of protein." Pet. 14 (citing Ex. 1003 ¶ 72; Ex. 1005, 580; Ex. 1009[9]). Petitioner's contention is supported by Brown-Skrobot, which discloses that monochromatic UV radiation is known to damage the DNA of exposed cells by causing dimerization of thymine,[10] which inhibits replication of DNA during cell reproduction. Ex. 1004 ¶ 6 (cited at Pet. 16). Petitioner's contention is also supported by Clauβ, which discloses that a low-pressure mercury lamp's "nearly monochromatic emission of 254 almost corresponds to the maximum DNA absorption at approx. 260 nm" and that "proteins . . . show absorption maxima at 220 nm and 280 nm." Ex. 1005, 580. Petitioner's evidence concerning target molecules provides a persuasive reason why a POSITA would have selected 222 nm and 254 nm wavelengths for use in Brown-Skrobot's sterilization method.

Our finding regarding a reason for combining prior art teachings is further supported by Clauβ, which compares a 222 nm KrCl excimer lamp with a 254 nm low-pressure mercury lamp as sources of UV radiation for deactivating bacteria and disinfection. Ex. 1005, 579. Clauβ teaches that these two radiation sources provide complementary benefits. Clauβ addresses the problem of photoreactivation, whereby microorganisms that have been inactivated by exposure to UV radiation are reactivated when they are exposed to visible light. Ex. 1005, 579–580; *see also* Ex. 1003 ¶ 65 (discussing Clauβ); Ex. 1037 ¶ 12 (explaining photoreactivation). Clauβ's

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[9] Exhibit 1009 (US 9,700,642 B2, issued July 11, 2017 to Neister) is not shown to be prior art to the '605 patent, so we do not rely on it.

[10] Thymine is one of the nucleotide bases that make up DNA. *See* page 18 n.8, *supra*.

Figures 2 and 3 are inactivation curves for particular bacteria[11] after irradiation with a 222 nm KrCl excimer lamp and a 254 nm low-pressure mercury lamp, with and without subsequent photoreactivation. Ex. 1005, 582. Based on these curves, Clauβ concludes:

> When the photoreactivation after irradiation is excluded, the mercury lamp with 254 nm clearly shows better results regarding inactivation. Whereas, on the other hand with photoreactivation afterwards the excimer lamp with 222 nm wavelength obviously shows better results.

Id.; *see also id.* at 579, 583 (similar disclosures in Clauβ's abstract and discussion section). In other words, the 254 nm low-pressure mercury lamp provides better results when photoreactivation is excluded, whereas the 222 nm KrCl excimer lamp provides better results when photoreactivation occurs. *Id.* at 579, 582, 583. Other evidence confirms that a 254 nm mercury lamp has "greater bactericidal power" than a 222 nm excimer lamp. Ex. 1008, 1531, Table 1.

Based on Clauβ's teachings, a POSITA would have recognized that combining a 222 nm KrCl excimer lamp with a 254 nm low-pressure mercury lamp would provide complementary benefits—improved resistance to photoreactivation and improved inactivation, respectively. As Clauβ teaches, these complementary benefits are attributable to the different mechanisms by which these wavelengths cause disinfection. Whereas 254 nm photons damage a microorganism's DNA, 222 nm photons damage its proteins and their constituent amino acids. Ex. 1005, 580; *see also* Ex. 1003 ¶ 49. As Clauβ explains, DNA damage can be repaired when the

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[11] The bacteria used in Clauβ's experiments were *E. coli* ATCC 11229 (Fig. 2) and *Y. enterolytica* ATCC 4780 (Fig. 3). Ex. 1005, 582.

microorganism is subsequently exposed to light, but protein damage cannot be repaired. Ex. 1005, 580, 583. Based on these teachings, Petitioner presents persuasive argument, supported by Mr. Lawal's testimony, that a POSITA would have sought to avoid or mitigate photoreactivation that occurs after irradiation with 254 nm photons by irradiating with 222 nm photons. Pet. 31; Ex. 1003 ¶ 83 (discussing reasons to use 254 nm and 222 nm wavelengths in the context of combining Brown-Skrobot, Clauβ, and Liang).

We also find support for Petitioner's contention that "the synergistic effect of using multiple light sources of different wavelengths for germicidal use, including specifically sources emitting monochromatic 222 nm and 254 nm wavelengths, was known." Pet. 15 (citing Ex. 1003 ¶ 73; Ex. 1004 ¶ 42; Ex. 1008, 1529, 1532; Ex. 1030, 1:23–26.) Petitioner's contention is supported by Ramsay,[12] which discloses that, under certain conditions, "synergy between 222- and 254-nm radiations was indeed observed in the disinfection" of some bacteria, e.g., *E. coli*. Ex. 1008, 1529, 1531, Table 2, 1532. Although no synergy was shown when the mercury lamp was operated at full power and the flow rate was at an industrially useful level (*id.* at 1531, Table 1, 1532), this does not negate that synergy was shown at reduced mercury lamp power and flow rate (*id.* at 1531, Table 2, 1532). Petitioner's contention is also supported by Sauska,[13] which discloses that "[i]t is often desirable to produce a germicidal lamp that has the capability of

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[12] Ex. 1008, Ramsay, I. et al., *The Synergistic Effect of Excimer and Low-Pressure Mercury Lamps on the Disinfection of Flowing Water*, 63 J. FOOD PROT. 1529 (2000) ("Ramsay").

[13] Ex. 1030, US 7,173,254 B2, issued February 6, 2007 ("Sauska").

emitting multiple bands of ultraviolet radiation or a broadband of ultraviolet radiation suitable for germicidal purposes." Ex. 1030, 1:23–26.

Our findings regarding a reason for combining prior art teachings are also supported by Mr. Lawal's testimony, which provides effective support for Petitioner's contentions. Ex. 1003 ¶¶ 67–73, 83.

Patent Owner argues that "Brown-Skrobot discourages the use of both 222 nm and 282 nm wavelengths from light sources other than lasers." PO Resp. 12. Patent Owner's argument is based on an unduly narrow view of Brown-Skrobot's teachings. According to Patent Owner, Brown-Skrobot's preferred embodiment is a contact lens manufacturing and packaging process in which lenses are exposed to monochromatic UV radiation and the process takes place in a light-tight chamber to prevent photoreactivation. *Id.* at 13; Ex. 1004 ¶¶ 47, 58, Fig. 1. Contrary to Patent Owner's characterization, Brown-Skrobot's sterilization process applies to any medical device, not just contact lenses. Ex. 1004, code (57), ¶ 2 ("This invention relates broadly to sterilization of medical devices."); *id.* ¶¶ 21–23, 45 ("Examples of medical devices which may be used in the process of this invention include, for example, catheters, surgical equipment, implants, stents, sutures, packing, staples, and bandages."). Although Brown-Skrobot's preferred embodiment relates to sterilization of contact lenses, its teachings are not so limited. *In re Mouttet*, 686 F.3d 1322, 1331 (Fed. Cir. 2012) ("A reference may be read for all that it teaches, including uses beyond its primary purpose.").

According to Patent Owner, "Brown-Skrobot focuses almost exclusively on the use of lasers" and "there is no teaching or disclosure of anything other than a single UV laser to sterilize the contact lenses." PO

Resp. 14, 22. We disagree. Brown-Skrobot discloses excimer lamps as a source of monochromatic UV radiation, including for sterilizing contact lenses. Ex. 1004 ¶¶ 22, 34, 36, 38–40, 54 ("[T]he high intensity monochromatic ultraviolet radiation can be generated and directed to the [contact lens] container by one or more monochromatic UV radiation sources, e.g. lasers or excimer lasers or lamps."); *id.* at claims 10, 12 (claiming a process of sterilizing a medical device with radiation from an excimer lamp).

Patent Owner additionally argues that Brown-Skrobot's wavelength ranges encompass "the entirety of the Far-UV spectrum [and] would not point a POSITA to the wavelengths of the claims." PO Resp. 14. Patent Owner's argument fails to take into account Brown-Skrobot's disclosure of excimer lamps containing gas mixtures that emit particular wavelengths of monochromatic UV radiation. Ex. 1003 ¶ 40; Ex. 1004 ¶ 38, claim 12; Pet. 19 (asserting that "Brown-Skrobot teaches KrCl, XeI, and XrBr excimer lamps as exemplary monochromatic UV radiation sources that can be used with its disclosed invention, which a POSITA would understand generate photons at about 222 nm, 253 nm, and 282 nm, respectively.").

Next, Patent Owner argues that Brown-Skrobot "teaches away from using a radiation source below 240 nm." PO Resp. 15 (citing Ex. 1004 ¶ 54); *id.* at 18–19 (similar argument); PO Sur-reply 12. Patent Owner's argument is based on the following disclosure in Brown-Skrobot.

> For many polymers which are commonly used for contact lens containers and contact lenses, which were described earlier, radiation at wavelengths less than 240 nm is absorbed by the polymers and may cause chain scissions within the polymers. Since the laser emits at a single wavelength or a narrow range of wavelengths, a source which produces radiation below 240 nm

> can be avoided which is a benefit over broad band radiation sources.

Ex. 1004 ¶ 54. Patent Owner's argument overlooks the breadth of Brown-Skrobot's disclosure, which is not limited to contact lenses or lasers, as discussed above. Nor is Brown-Skrobot's process limited to sterilization of polymeric materials; the medical devices that may be sterilized include those made from metals. Ex. 1004 ¶ 45; Ex. 1037 ¶ 18. The disclosure of a preferred embodiment does not, in any event, teach away from non-preferred embodiments. *Mouttet*, 686 F.3d at 1333–34; *see also In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004) ("The prior art's mere disclosure of more than one alternative does not constitute a teaching away from any of these alternatives because such disclosure does not criticize, discredit, or otherwise discourage the solution claimed.").

Patent Owner argues that "KrCl excimer lamps were not commercially available at the time" and "[s]uch lamps were used only in experimental research settings." PO Resp. 18; *see also id.* at 28 ("the 222 nm KrCl lamp was rare and expensive and could only be obtained by researchers and not in a commercial setting"); PO Sur-reply 13–14. Contrary to Patent Owner's argument, the evidence shows that 222 nm KrCl lamps were commercially available at the time of the invention. The '605 patent itself states that "[d]uring the past few years, new UV emitting lamps based on the excitation of excimers are becoming commercially available." Ex. 1001, 2:4–6. Several prior art references identify commercial sources for KrCl excimer lamps. Ex. 1005, 583 ("Special thanks go to the Radium Lampenwerk GmbH for the supply of the KrCl excimer lamp."); Ex. 1008, 1530 (KrCl excimer lamp used in 2000 study was "purchased from Heraeus Noblelight Ltd., Cambridge, UK."). Mr. Lawal testifies that the KrCl excimer lamp "has been around for over 60 years" and that "KrCl lamps emitting 222 nm wavelengths, were becoming commercially available as early as . . . 1996." Ex. 1003 ¶¶ 43, 44 (referencing Appendix C to his declaration).[14] At deposition, Mr. Lawal testified that he saw 222 nm KrCl excimer lamps being manufactured by Heraeus in Germany. Ex. 2002, 50:8–51:16. And Patent Owner's expert, Dr. Hernandez, did not disagree that, at the time of Neister's invention, a researcher who wanted to investigate a specific wavelength of light generated by an excimer lamp could obtain one for research purposes. Ex. 1041, 83:7–21.

Patent Owner additionally argues that "Brown-Skrobot does not explain how to make or use a KrCl excimer lamp." PO Resp. 18. Patent Owner's argument runs counter to established law that "prior art patents and publications enjoy a presumption of enablement, and the patentee/applicant has the burden to prove nonenablement for such prior art." *Apple Inc. v. Corephotonics, Ltd.*, 861 F. App'x 443, 450 (Fed. Cir. 2021). Furthermore, Brown-Skrobot provides extensive information about how to use a monochromatic UV radiation source, such a KrCl excimer lamp, in a process for sterilizing a medical device. Ex. 1004 ¶¶ 34–38, 40–55. Brown-Skrobot provides at least as much information as the '605 patent about how to use a monochromatic UV radiation source in a disinfection process. *See Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 781 (Fed. Cir. 1985) (answering the prior art enablement question by comparison with appellee's own patent application).

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[14] *UV Disinfection for Water and Wastewater Treatmen*t, Report CR-105252 prepared by Black & Veatch, Kansas City, MO and The Electric Power Research Institute, Community Environmental Center, Washington University, St. Louis, MO (December 1995) (Ex. 1003, 543–553).

Patent Owner argues that "Clauβ is a study of two separate excimer lamps" and does not disclose or suggest the combination of 222 nm and 254 nm wavelengths. PO Resp. 19–20. We disagree. Although there is no explicit disclosure of this combination, Clauβ suggests that 222 nm and 254 nm wavelengths provide complementary benefits. As discussed above, Clauβ discloses that a 254 nm low-pressure mercury lamp provides better results when no photoreactivation occurs, and a KrCl excimer lamp provides better results when photoreactivation does occur. *Id.* at 579, 582, 583. By combining these two UV sources, a POSITA would achieve a process that provides effective disinfection, regardless of whether the sample subsequently undergoes photoreactivation. Even if a POSITA uses a light-tight chamber, as disclosed in Brown-Skrobot, there would still be a benefit to employing a combination of 222 nm and 254 nm UV sources to achieve both improved resistance to photoreactivation and improved inactivation because, as Mr. Lawal testifies, exposure to light "is generally inevitable." Ex. 1004 ¶ 58; Ex. 1005, 579, 582, 583, Figs. 2, 3; Ex. 1037 ¶ 13.

Patent Owner asserts that Petitioner's combination would not have been obvious because the mercury lamp and excimer lamp of Clauβ are not monochromatic UV sources as required by Brown-Skrobot. PO Resp. 22–23 (citing Ex. 1005, 580–581, Fig. 1). Patent Owner's assertion is not supported by Clauβ, which identifies the lamps as a "222 nm excimer lamp" and a "254 nm low-pressure mercury lamp," using a single wavelength to characterize the lamps. Ex. 1005, *passim*. Clauβ expressly states that low-pressure mercury lamps have a "nearly monochromatic emission of 254 nm." *Id.* at 580. Brown-Skrobot likewise characterizes excimer lamps, including a KrCl lamp, as monochromatic. Ex. 1004, ¶¶ 34, 38, 54, claims 10, 12. Mr. Lawal testifies that both mercury and KrCl lamps "emit light predominately in a narrow wavelength range, known as 'monochromatic' light." Ex. 1003 ¶ 40.

Petitioner's evidence is not effectively rebutted by Patent Owner and Dr. Hernandez. PO Resp. 22–23; Ex. 2001 ¶¶ 24, 26. Dr. Hernandez testifies that "a POSITA would not consider a UV lamp to be a monochromatic UV light source because UV lamps emit radiation across a broad spectrum." Ex. 2001 ¶ 24 (citing Ex. 1005, 580). According to Dr. Hernandez, Clauβ explains that "mercury lamps and excimer lamps emit radiation 'in the whole UV region' between 200 and 380 nm)." *Id.* The quoted portion of Clauβ states: "Figure 1 shows the measured irradiance of both lamps plotted logarithmically against the wavelength. The irradiance of the mercury lamp in the whole UV region (200 ... 380 nm) is 22.10 W/m^2 and therefore much higher than that of the excimer lamp with 3.55 W/m^2." Ex. 1005, 580. We agree with Mr. Lawal that Clauβ "is simply noting the difference in overall output irradiance between the two kinds of lamps." Ex. 1037 ¶ 16. We find that Dr. Hernandez's testimony is not sufficient to rebut Mr. Lawal's testimony, Brown-Skrobot, and Clauβ, all of which support that, in the relevant field of UV radiation for sterilization, excimer lamps are considered monochromatic UV radiation sources. Ex. 1003 ¶ 96; Ex. 1004 ¶¶ 34, 38, 54; Ex. 1005, 580; Ex. 1037 ¶ 17 ("[W]hile excimer lamps may emit at other wavelengths, generally over 90% of the light is emitted in a single narrow band. An excimer lamp is thus considered to have an emission centered around a single wavelength—i.e. is effectively monochromatic.").

Patent Owner criticizes Petitioner's argument for "disregard[ing]" Brown-Skrobot's preferred embodiment that uses a 257 nm laser and "cherry-pick[ing] the single reference to a KrCl lamp" and combining it with Clauβ's 254 nm low-pressure mercury lamp. PO Resp. 24. We disagree with Patent Owner's characterization. A KrCl excimer lamp is disclosed in ***both*** Brown-Skrobot and Clauβ, and the lamp is taught for the same purpose—deactivating bacteria. Ex. 1004 ¶ 38, claim 12; Ex. 1005, 579. Combining a KrCl excimer lamp with Clauβ's 254 nm low-pressure mercury lamp flows naturally from the disclosure of these references and particularly Clauβ, which compares these UV sources and provides reasons to combine them in a process for disinfection. Ex. 1005, 579, 582, 583. We do not agree with Patent Owner's characterization of Brown-Skrobot as presenting "over 58,000 possible combinations" of wavelengths within the range 160 nm to 400 nm. PO Resp. 26; *see also* PO Sur-reply 6 (A "POSITA would be left to test tens of thousands of combinations of wavelengths to determine which actually provide increased levels of sterility."). Patent Owner's argument overlooks Brown-Skrobot's disclosure of only ten gas mixtures, two of which generate wavelengths of 222 nm and 253 nm. Ex. 1003 ¶ 40; Ex. 1004 ¶ 38, claim 12; Pet. 19.

Patent Owner argues that a POSITA would have had no reason to believe that the combination of a 254 nm wavelength with a 222 nm wavelength would be successful, and there was no testing to show the effectiveness of the combination. PO Resp. 25, 27 (A "POSITA could not know this without testing."). Patent Owner applies an incorrect legal standard. "A finding of a reasonable expectation of success does not require absolute predictability of success." *Almirall, LLC v. Amneal Pharms. LLC*, 28 F.4th 265, 275 (Fed. Cir. 2022). "[O]bviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success." *Pfizer*, 480 F.3d at 1364. Petitioner does not need to show that the combination of 222 nm and 254 nm wavelengths ***would*** succeed, only that it would have been reasonable to expect it to do so. *Id.* Testing to show the effectiveness of the combination is not required. *See Eli Lilly & Co. v. Teva Pharms. Int'l GmbH*, 8 F.4th 1331, 1345 (Fed. Cir. 2021) ("[W]hat is required is not proof that the recited method would *actually* bring about the recited result, but rather proof that a person of ordinary skill in the art would have had a reasonable expectation that performing the recited method would bring about the recited result."); *Endo Pharms. Inc. v. Actavis LLC*, 922 F.3d 1365, 1379 (Fed. Cir. 2019) (The trial court erred by requiring proof that a prior art technique "was actually used and worked . . . . [O]bviousness requires only a reasonable expectation of success, not proof of actual success.").

Through the testimony of its expert, Petitioner shows persuasively that the combination of a 254 nm wavelength with a 222 nm wavelength would yield predictable results. Mr. Lawal testifies: "Both wavelengths were known to be effective for disinfecting substances and surfaces: light of wavelength 254 nm because it destroys DNA through dimer production and of wavelength 222 nm due to the absorption maxima of protein." Ex. 1003 ¶ 72 (citing Ex. 1005, 580). Mr. Lawal's testimony is supported by Clauβ, which teaches that UV radiation at 254 nm wavelength causes damage to DNA and at 222 nm wavelength causes damage to proteins and their constituent amino acids. Ex. 1005, 580. In view of Clauβ's teaching, Mr. Lawal reasonably concludes that the combined effects of these wavelengths were predictable. Ex. 1003 ¶ 72. Mr. Lawal also reasonably concludes that using a UV light source comprising 222 nm and 254 nm wavelengths would yield predictable advantages, including the potential for increased levels of sterility and reduced energy expenditure. Ex. 1003 ¶ 73 (citing Ex. 1004 ¶ 42). These advantages are expressly disclosed by Brown-Skrobot (Ex. 1004 ¶ 42) and reinforced by Clauβ's disclosure that these wavelengths target different molecules within a microorganism (Ex. 1005, 580).

Patent Owner argues that "Mr. Lawal's own study from 2017 regarding potential synergy between 260 and 280 nm showed that no synergy existed." PO Resp. 25 (citing Ex. 2002, 118:10–18; Ex. 2004). That argument does not effectively rebut Petitioner's evidence for two reasons. First, it does not address Petitioner's proposed combination of 254 nm and 222 nm wavelengths, and second, it is based on post-invention date information. *Bristol-Myers Squibb Co. v. Teva Pharmaceuticals, Inc.*, 752 F.3d 967, 976 (Fed. Cir. 2014) ("[T]he skilled artisan's reasonable expectation of success is measured 'as of the date of the invention'" (quoting *Amgen Inc. v. Hoffman-La Roche*, 580 F.3d 1340, 1362 (Fed. Cir. 2009)).).

Patent Owner relies on Ramsay's observation that, at maximum mercury lamp intensity and industrially useful flow rates, "no additional bacterial 'kill'" was observed when 254 nm radiation was supplemented with radiation at 222 nm. PO Resp. 25–26 (citing Ex. 1008, 1532); *see also* PO Sur-reply 10–11 (discussing Ramsay). As discussed above, Ramsay's observation does not negate that, for some bacteria, synergy was shown at reduced mercury lamp power and flow rate. Ex. 1008, 1531, Table 2, 1532 ("Synergy between the sterilizing effects of irradiation at 222 and 254 nm in aqueous solution has been established in the case of" some bacteria, including *E. coli*.); *see also* Ex. 1037 ¶ 21 ("Ramsay clearly notes a level of synergy between 222 nm and 254 nm light.").

Patent Owner argues that Petitioner has not shown synergy. PO Resp. 25–27; PO Sur-reply 2, 8–9. We disagree. As discussed above, Petitioner has shown some evidence of synergy. Regardless, it is ***not necessary*** for Petitioner to show that a POSITA would have expected to achieve a synergistic effect by combining 254 nm and 222 nm wavelength radiation. As the patent challenger, Petitioner is required to show that a POSITA would have had a reason to combine the teachings of the prior art references with a reasonable expectation of achieving the claimed invention. *PAR Pharm., Inc. v. TWI Pharm., Inc.*, 773 F.3d 1186, 1193 (Fed. Cir. 2014). In this case, the claims do not require synergy between the two photon wavelengths. Therefore, Petitioner can show a reason to combine and a reasonable expectation of success by demonstrating that a POSITA would have expected to achieve a beneficial result that was ***additive***, but not necessarily synergistic. *Teva Pharms. USA, Inc. v. Corcept Therapeutics, Inc.*, 18 F.4th 1377, 1381 (Fed. Cir. 2021) ("The reasonable-expectation-of-success analysis must be tied to the scope of the claimed invention."); *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016) ("The reasonable expectation of success requirement refers to the likelihood of success in combining references to meet the limitations of the claimed invention.").

Patent Owner argues that Ramsay, Brown-Skrobot, and Clauβ each "points in the same direction—toward using a 254 nm lamp or a 257 nm laser and away from using a 222 nm lamp." PO Resp. 28. We disagree. As discussed above, Brown-Skrobot teaches the potential benefits of using multiple wavelengths (Ex. 1004 ¶ 42), and Clauβ teaches that a 222 nm lamp provides better results than a 254 nm lamp when photoreactivation occurs (Ex. 1005, 579, 582, 583). A POSITA would have had a reason to combine these wavelengths to obtain the cumulative benefits of both.

For these reasons, we find that Petitioner has established that it would have been obvious to combine the teachings of Brown-Skrobot and Clauβ.

4. Claim [1pre]

Petitioner contends that the combination of Brown-Skrobot and Clauβ discloses the preamble of claim 1, which recites a "process for destroying or deactivating the DNA organic bonds and proteins of microorganisms." Pet. 16 (citing Ex. 1003 ¶¶ 88–92; Ex. 1004 ¶¶ 2, 6, 34; Ex. 1005, 580). Patent Owner does not dispute Petitioner's contention.

We find that the combination of Brown-Skrobot and Clauβ discloses the claim 1 preamble. Our finding is supported by Brown-Skrobot, which discloses a process of sterilizing a medical device by irradiating the device with monochromatic UV radiation to damage the DNA of microorganisms. Ex. 1004 ¶¶ 2, 6, 34 (stating "every surface of the medical device receives a sterilizing dose of radiation"). Our finding is also supported by Clauβ, which discloses deactivating bacteria by irradiating samples with a 254 nm low-pressure mercury lamp and a 222 nm KrCl excimer lamp and further discloses that the mercury lamp's emission corresponds to an absorption maximum of DNA and causes damage to DNA. Ex. 1005, 580–582.

5. Claim Element [1a]

Petitioner contends that the combination of Brown-Skrobot and Clauβ discloses claim element [1a], which recites "generating photons of at least two single line wavelengths from a non-coherent light source selected from the group consisting of at least two wavelengths being of 222 nm, 254 nm, and 282 nm." Pet. 17–19 (citing Ex. 1003 ¶¶ 93–98; Ex. 1004 ¶¶ 33, 34, 38, 42, 54; Ex. 1005, 580).[15]

Patent Owner argues that "a non-coherent light source" means "a single non-coherent light source" (PO Resp. 14), a construction we do not adopt for the reasons discussed in Section II.C. above. Patent Owner also disputes Petitioner's contentions regarding reasons for combining the prior art teachings and a reasonable expectation of success, which are addressed in Section II.D.3. above. Aside from these arguments, Patent Owner does not dispute Petitioner's contention that the combination of Brown-Skrobot and Clauβ discloses claim element [1a].

We find that Petitioner has proven its contention. Our finding is supported by Brown-Skrobot's disclosure of sterilizing a medical device with radiation from two or more monochromatic UV sources, as follows:

> Additionally, multiple monochromatic radiation sources, where at least one is a monochromatic uv radiation source can be used together to accomplish sterilization. ***Two or more monochromatic uv radiation sources can be used together to provide*** the same or different amounts of energy of the same wavelengths of monochromatic uv radiation to the medical device, or they can provide ***the same or different amounts of***

[15] Claim element [1a] is written in Markush form. For such claim elements, it is well-established that, "the entire element is disclosed by the prior art if one alternative in the Markush group is in the prior art." *Fresenius USA, Inc. v. Baxter Int'l, Inc.*, 582 F.3d 1288, 1298 (Fed. Cir. 2009). Here, claim element [1a] recites that "at least two" members of the group must be present. Therefore, claim element [1a] is disclosed by the prior art if two of the listed wavelengths are in the prior art.

> ***energy at different wavelengths of monochromatic uv radiation***.

Ex. 1004 ¶ 42 (emphasis added). We find that Brown-Skrobot's disclosure that "[t]wo or more monochromatic uv radiation sources can be used together to provide . . . the same or different amounts of energy at different wavelengths" (*id.*) teaches "generating photons of at least two single line wavelengths," as recited in claim element [1a].

Our finding concerning claim element [1a] is further supported by Brown-Skrobot's definition of "monochromatic UV radiation" as having "a wavelength or wavelengths between from 160 to 400 nm," preferably "within about 220 to 320 nm" and "the majority of the radiation is concentrated within a bandwidth of 3 nm," preferably "within a bandwidth of 2 nm, more preferably within 1 nm." Ex. 1004 ¶ 33. The wavelengths recited in claim element [1a]—"222 nm, 254 nm, and 282 nm"—fall within Brown-Skrobot's disclosed preferred range of 220 to 320 nm. *See* Ex. 1003 ¶ 96 (Mr. Lawal's testimony).

Our finding concerning claim element [1a] is further supported by Brown-Skrobot's disclosure of excimer lamps as sources of monochromatic UV radiation. Ex. 1004 ¶ 34 ("Examples of monochromatic UV radiation sources that produce monochromatic UV radiation include . . . excimer lamps."); *id.* ¶ 38 ("Other sources of monochromatic UV radiation include gas discharge tubes filled with gas mixtures in . . . an excimer lamp which produce excimers in an electric discharge."); *id.* ¶ 54 ("[T]he high intensity monochromatic ultraviolet radiation can be generated and directed to the container by one or more monochromatic UV radiation sources, e.g. . . . excimer lasers or lamps."); *id.* claims 1, 10. Patent Owner does not dispute Mr. Lawal's testimony that an excimer lamp, as disclosed in Brown-Skrobot, is a non-coherent light source. Ex. 1003 ¶ 97 ("A 'lamp,' unlike a 'laser,' is a non-coherent light source." (citing App'x C)); Pet. 18–19; PO Resp. 13–14 (agreeing with Petitioner and Mr. Lawal).

Patent Owner does not dispute that Brown-Skrobot's definition of "monochromatic UV radiation" as having "the majority of the radiation is concentrated within a bandwidth of 3 nm," preferably "within a bandwidth of 2 nm, more preferably within 1 nm" (Ex. 1004 ¶ 33) describes a "single line wavelength[]" as recited in claim element [1a]. We credit Mr. Lawal's testimony that a "POSITA would have also understood that a 'monochromatic' light source such as an excimer lamp where 'the majority of radiation within a bandwidth of 2 nm, more preferably within 1 nm' generates photons of a 'single line' wavelength." Ex. 1003 ¶ 96 (quoting Ex. 1004 ¶ 33). Mr. Lawal's testimony is supported by Brown-Skrobot, which describes excimer lamps as monochromatic UV radiation sources. Ex. 1004 ¶ 34, 38, 54.

Furthermore, the '605 Patent demonstrates that the step of "generating photons of at least two single line wavelengths from a non-coherent light source" may be performed by excimer lamps. Ex. 1001, 2:4–8 ("During the past few years, new UV emitting lamps based on the excitation of excimers are becoming commercially available. These emitters produce single line or narrow spectral emission at a wavelength determined by the gas composition of the lamp."). Patent Owner agrees that "[e]xcimers would display a single line wavelength." Tr. 37:14–15.

Our finding concerning claim element [1a] is further supported by Brown-Skrobot's teaching of particular excimer lamps that emit single line wavelengths of 222 nm, 253 nm, and 282 nm. Petitioner presents the unrebutted testimony of Mr. Lawal that "Brown-Skrobot teaches KrCl, XeI, and XrBr excimer lamps as exemplary monochromatic UV radiation sources that can be used with its disclosed invention, which a POSITA would understand generate photons at about 222 nm, 253 nm, and 282 nm, respectively." Ex. 1003 ¶ 98 (citing Ex. 1004 ¶ 38). Mr. Lawal's testimony is supported by Brown-Skrobot, which discloses that "sources of monochromatic UV radiation include gas discharge tubes filled with gas mixtures in a laser or an excimer lamp which produce excimers in an electric discharge." Ex. 1004 ¶ 38. According to Brown Skrobot, "[e]xamples of gas mixtures that produce excimers include krypton and chlorine (KrCl), . . . xenon and iodine (XeI), . . . [and] xenon and bromine (XeBr)." *Id.* Patent Owner and Dr. Hernandez do not dispute Mr. Lawal's testimony that gas mixtures of krypton-chlorine (KrCl), xenon-iodine (XeI), and xenon-bromine (XeBr) have a "characteristic wavelength" of 222 nm, 253 nm, and 282 nm, respectively. Ex. 1004 ¶ 40; *see* Ex. 2001 ¶ 14 ("Mr. Lawal explains that Krypton-Chloride and Xenon-Bromide were known to discharge wavelengths of 222 nm and 282 nm respectively.").

Our finding concerning claim element [1a] is further supported by Clauβ's disclosure of a 222 nm KrCl excimer lamp and a 254 nm low-pressure mercury lamp as sources of UV radiation for deactivating bacteria and disinfection. Ex. 1005, 579, 581–82, Figs. 2, 3. For the reasons discussed above, we determine that it would have been obvious to combine Brown-Skrobot's teaching to use two or more monochromatic UV radiation sources in a method of sterilizing a medical device with Clauβ's teaching of a 222 nm KrCl excimer lamp and a 254 nm low-pressure mercury lamp as sources of UV radiation for disinfection.

6. Claim Element [1b]

Petitioner contends that the combination of Brown-Skrobot and Clauβ discloses claim element [1b], which recites "directing the photons to a substance to be disinfected, whereby the photons destroy or deactivate the DNA organic bonds and proteins of microorganisms." Pet. 20–21 (citing Ex. 1003 ¶¶ 99–102; Ex. 1004 ¶¶ 23, 34, 38, 40, 42; Ex. 1005, 580). Patent Owner does not dispute Petitioner's contention for claim element [1b].

We find that the combination of Brown-Skrobot and Clauβ discloses claim element [1b]. Our finding is supported by Brown-Skrobot, which discloses that "[t]he monochromatic UV radiation source," such as an excimer lamp, "may be used in conjunction with other structural and optical elements to direct the radiation at the target." Ex. 1004 ¶ 40; *see also id.* ¶ 23 ("The process and apparatus of the invention is used to provide sterilized medical devices."); ¶ 34 ("The radiation geometry provided by the apparatus can be beam expanded, line focused or spot scanned. The only requirement is that every surface of the medical device receives a sterilizing dose of radiation."). Brown-Skrobot also teaches that "monochromatic ultraviolet (UV) light is known to damage the DNA of exposed cells." *Id.* ¶ 6.

Our finding is further supported by Clauβ, which discloses deactivating bacteria with UV radiation from a 222 nm KrCl lamp and a 254 nm low-pressure mercury lamp and teaches that photon wavelengths of 222 nm and 254 nm damage a microorganism's proteins and DNA, respectively. Ex. 1005, 579, 580.

7. *Claim Element [1c]*

Petitioner contends that the combination of Brown-Skrobot and Clauβ discloses claim element [1c], which recites "exposing the surface to be disinfected to the generated photons of at least two wavelengths, wherein the exposing achieves a ninety percent kill of microorganisms in a time period of less than one second." Pet. 21–26 (citing Ex. 1003 ¶¶ 103–109; Ex. 1004 ¶¶ 31, 34, 44, 56; Ex. 1005, 581–582; Ex. 1006 ¶ 48; Ex. 1007 ¶ 13; Ex. 1012, 250–252).

Patent Owner argues that "[a]ny combination of Brown-Skrobot and Clauβ to achieve a 90% kill rate in less than one second is based upon impermissible hindsight." PO Resp. 29 (citing Ex. 2001 ¶ 52); PO Sur-reply 16–19 (citing Ex. 1003, 245, 248–49, 268 (Appendix B);[16] Ex. 2017 ¶¶ 3–7; Ex. 2018, 736; Ex. 2019, 2030; Ex. 2020, 391; Ex. 2021, 26).

We find that Brown-Skrobot discloses the portion of claim element [1c] that recites "exposing the surface to be disinfected to the generated photons of at least two wavelengths." Our finding is supported by Brown-Skrobot, which discloses a method of sterilizing a medical device by exposing its surface to "a sterilizing dose of radiation." Ex. 1004 ¶¶ 34, 44, 56. As discussed above for claim element [1a], Brown-Skrobot discloses that the radiation may be from "two or more monochromatic uv radiation sources" that have "different wavelengths." *Id.* ¶ 42.

Based on Petitioner's contentions, Mr. Lawal's testimony, and the disclosures of Brown-Skrobot and Clauβ, we find that a POSITA would

[16] United States Environmental Protection Agency, *Ultraviolet Disinfection Guidance Manual*, EPA 815-D-03-007 (June 2003 Draft) (Ex. 1003, 64–541)

have understood that, by exposing the surface to be disinfected to photons of 222 nm and 254 nm wavelengths, it would have been possible to achieve "a ninety percent kill of microorganisms in a time period of less than one second," as recited in the "wherein" clause of claim element [1c].

Our finding is supported by Mr. Lawal's testimony that "it would have been obvious to a POSITA that achieving a certain level of kill for a certain organism within a certain amount of time is simply a matter of selecting a UV intensity and exposure time to achieve the UV 'dose' that would reach the desired result." Ex. 1003 ¶ 105 (discussed at Pet. 22; citing Ex. 1016 ¶¶ 23, 24). Mr. Lawal's testimony is supported by Ressler,[17] which discloses methods for sterilization of products using UV light sources and teaches that "individual light sources may be operated at different intensities and/or for different periods of time to achieve the desired sterilization results." Ex. 1016, code (57), ¶¶ 3, 13, 23.

Our finding is supported by Mr. Lawal's testimony that "[t]he UV dose needed to achieve a ninety percent kill of a population of a particular microorganism is often referred to as a 'D-value,'" and "[t]he D-value will vary depending on the sensitivity of the microorganism to UV light, which varies from microorganism to microorganism." Ex. 1003 ¶ 105 (citing Ex. 1004 ¶ 31; Ex. 1005, 582; Ex. 1012, 250–252, Table 1). Mr. Lawal's testimony is supported by Brown-Skrobot, which defines "D_{value}" as "the amount of energy required to kill 90% of the organisms present." Ex. 1004 ¶ 31.

[17] Ex. 1016, US 2005/0173652 A1, published August 11, 2005 ("Ressler").

Mr. Lawal's testimony is further supported by Kowalski,[18] which teaches that microorganisms exposed to ultraviolet germicidal irradiation (UVGI) "experience an exponential decrease in population" dependent upon UV intensity, exposure time, and a rate constant that "defines the sensitivity of a microorganism to UV exposure and is unique to each microbial species." Ex. 1012, 250. Kowalski lists the rate constants for different microorganisms and test media (air, plates, or water). *Id.* at 251–252, Table 1.

Mr. Lawal's testimony is also supported by Clauβ Figures 2 and 3, which show the inactivation results for two bacteria species, *E. coli* and *Y. enerolytica*. Ex. 1005, 582, Figs. 2, 3. According to Clauβ, these results "show only slight differences in the UV sensitivity of the two bacteria species." *Id.* at 581. Clauβ states that a 4 log reduction was achieved by irradiation at 254 nm of 69 J/m^2 for *E. coli* and 59 J/m^2 for *Y. enterolytica*, and the same reduction was achieved with an irradiation at 222 nm of 106 J/m^2 for *E. coli* and 88 J/m^2 for *Y. enterolytica*. *Id.* at 581–582.

Based on data shown in Clauβ Figure 3, Petitioner and Mr. Lawal present a calculation showing that a 254 nm low-pressure mercury lamp can achieve "a ninety percent kill of microorganisms in a time period of less than one second," as recited in claim element [1c]. Pet. 23–24; Ex. 1003 ¶ 106. Mr. Lawal testifies that a "ninety percent kill or 1-log reduction *Yersinia enterolytica* could be achieved with an intensity of 254 nm light of just about 20 J/m^2," which is equivalent to "a surface irradiance of 20.95 W/m^2"

[18] Ex. 1012, Kowalski, W.J. et al., *Mathematical Modeling of Ultraviolet Germicidal Irradiation for Air Disinfection*, 2 QUANT. MICROBIOL. 249 (2000) ("Kowalski").

applied for "about 0.95 seconds." Ex. 1003 ¶ 106 (citing Ex. 1005, 582, Fig. 3).

Patent Owner does not dispute Mr. Lawal's calculation but argues that "Mr. Lawal relies on data from Clauβ taken in water, which does not translate to air and surfaces." PO Resp. 29 (citing Ex. 2001 ¶ 52). Patent Owner elaborates in the sur-reply, arguing that "different media absorb spectral energy at different rates" and "the degree to which a microorganism is hydrated has a significant effect on the UV inactivation rate." PO Sur-reply 18 (citing Ex. 1003, 245, 368; Ex. 2017 ¶¶ 3, 4; Ex. 2019, 2030). Patent Owner concludes that a POSITA would not have considered UV damage to microorganisms in water to be a reliable indicator of UV inactivation in air. *Id.* at 18–19 (citing Ex. 2017 ¶ 5).

After considering Patent Owner's arguments and evidence, including Dr. Hernandez's testimony (Ex. 2001 ¶ 52; Ex. 2017), we are persuaded by Petitioner's argument, supported by Mr. Lawal's testimony, that "it would have been obvious to a POSITA to increase the UV intensity to reach the D-value more quickly for a given microorganism, including in less than one second as claimed." Pet. 24; Ex. 1003 ¶ 108 (citing Ex. 1006 ¶ 48). Mr. Lawal explains that input UV intensity and exposure time determine the applied UV dose, which must be high enough to achieve the desired result. Ex. 1003 ¶¶ 105, 108 (citing Ex. 1006 ¶ 48; Ex. 1007 ¶ 13; Ex 1012, 250–252). Mr. Lawal's testimony is supported by Kowalski, which teaches that exponential microbial decay depends upon UV intensity, exposure time, and a pathogen-specific rate constant. Ex 1012, 250. Mr. Lawal's testimony is also supported by Liang's teaching that "UV power" multiplied by "exposure time" needs to be "higher than the UV death value of any microorganisms." Ex. 1006 ¶ 48. "In other words, the sterilizing dosage of UV radiation should be high enough that there will not be any microorganism survived." *Id.* Mr. Lawal's testimony is further supported by Hunter,[19] which relates to air sterilization in a UV kill chamber and states that the primary reason for pathogens' survival is "non-optimum chamber design where intensity (photon flux) is wildly uneven." Ex. 1007, code (57), ¶¶ 12, 13. These references support Mr. Lawal's opinion that it would have been obvious to a POSITA to increase the UV intensity to reach a ninety percent kill of a population of microorganisms more quickly. Ex. 1003 ¶¶ 105, 108.

Petitioner presents persuasive argument and expert testimony that a POSITA would have known how to account for the factors identified by Patent Owner and Dr. Hernandez, including the effect of different media (air, water, or surfaces) on UV absorbance, to achieve the desired disinfection rate. Pet. Sur-sur-reply 1–2; Ex. 1042 ¶¶ 3–5. Although Patent Owner and Dr. Hernandez assert that Clauβ's findings based on experiments in agar and water cannot be translated to air and surfaces (PO Sur-reply 16–19; Ex. 2017 ¶ 2), they do not contradict Petitioner's position that a POSITA would have known how to account for differences in media.

Petitioner argues, supported by Mr. Lawal's testimony, that one way of increasing UV intensity with a given UV lamp would have been to "move the lamp closer to the surface to be disinfected" based on a POSITA's knowledge that "UV intensity is inversely proportional to the distance." Pet. 25; Ex. 1003 ¶ 108. Alternatively, Petitioner and Mr. Lawal assert that "it would have been obvious to a POSITA that a more powerful UV lamp

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[19] Ex. 1007, US 2007/0102280 A1, published May 10, 2007 ("Hunter").

could be used to increase the UV dosage and reduce the amount of time required to achieve a ninety-percent kill." Pet. 25–26; Ex. 1003 ¶ 109.

Patent Owner disputes Petitioner's first alternative, but not the second. According to Patent Owner and Dr. Hernandez, "the law of inverse proportionality does not hold at short distances." PO Resp. 29; Ex. 2001 ¶ 52; *see also* PO Sur-reply 19; Ex. 2017 ¶¶ 6, 7. We do not need to resolve the parties' dispute about whether UV intensity could be increased by moving a lamp closer to the target surface because it is undisputed that a POSITA would have known that using a more powerful UV lamp would increase the UV dosage and reduce the amount of time required to achieve a ninety-percent kill. Pet. 25–26; Ex. 1003 ¶ 109; *see* Tr. 16:6–7 (Petitioner's argument: "A POSITA would know that all you have to do is just crank it up if you need to achieve a faster rate of kill.").

For these reasons, we find that Petitioner has established that the combination of Brown-Skrobot and Clauβ teaches or suggests the process of claim 1.

8. Claim 2

Claim 2 depends from claim 1 and recites "wherein the protons [*sic*, photons] are directed by reflecting the photons to a desired surface." Ex. 1001, 10:10–11.

Petitioner contends that the combination of Brown-Skrobot and Clauβ discloses the limitation of claim 2. Pet. 26 (citing Ex. 1003 ¶ 111; Ex. 1004 ¶ 40). Patent Owner does not present argument for claim 2 separately from claim 1.

We find that the combination of Brown-Skrobot and Clauβ discloses the limitation of claim 2. Our finding is supported by Brown-Skrobot, which discloses, "The monochromatic UV radiation source may be used in conjunction with other structural and optical elements to direct the radiation at the target. The excimer lamp is preferably used in conjunction with a reflector or reflectors." Ex. 1004 ¶ 40.

E. Petitioner's Challenge based on Brown-Skrobot, Clauβ, and Liang

Petitioner contends that claims 5 and 6 are unpatentable as obvious based on Brown-Skrobot, Clauβ, and Liang. Pet. 26–37. Patent Owner does not present argument for claims 5 and 6 separately from claim 1. *See* PO Resp. 30 (arguing, for claim 1, "Liang does not remedy the deficiencies of Brown-Skrobot and Clauβ"). We provide an overview of Liang before turning to Petitioner's contentions for claims 5 and 6.

1. Liang (Ex. 1006)

Liang is titled "Method and Apparatus for Sterilizing Air in Large Volumes by Radiation of Ultraviolet Rays." Ex. 1006, code (54). Liang explains that air transmission of pathogens such as bacteria and viruses can promote infectious diseases. *Id.* ¶ 4. To combat such transmissions, Liang discloses "an air sterilizing method and apparatus to destroy all live microorganisms in the air in large volumes" resulting in "a killing rate higher than 99.999% by adjusting the number of UV lamps and extending the length of the circuitous sterilizing chamber(s)." *Id.* ¶ 12. Liang discloses that "UV radiation at about 253.7 nm is very effective in killing microorganisms." *Id.* ¶ 13.

2. Combining Teachings

Petitioner contends that it would have been obvious to perform Liang's "air sterilizing method . . . to destroy all live microorganisms in the air in large volumes" using combination of the 222 nm KrCl excimer lamp and 254 nm low-pressure mercury lamp of Clauβ, as taught by Brown-Skrobot's disclosure of using "[t]wo or more monochromatic uv radiation sources." Pet. 30 (citing Ex. 1003, ¶ 80; Ex. 1004, ¶¶ 33, 42; Ex. 1005, 580; Ex. 1006 ¶ 12).

Petitioner presents persuasive reasoning, supported by Mr. Lawal's testimony, showing that a POSITA would have combined the teachings of Brown-Skrobot, Clauβ, and Liang. Pet. 30–33; Ex. 1003 ¶¶ 80–86. For example, Petitioner argues persuasively that "a POSITA reading Liang would have been motivated to optimize Liang even further to maximize the killing of the microorganisms in the air." Pet. 30 (citing Ex. 1003 ¶ 82). Petitioner and Mr. Lawal explain why combining 254 nm photons with 222 nm photons would have provided predictable advantages for Liang's air sterilization method, including mitigation of photoreactivation and increased levels of sterility. Pet. 30–33 (citing Ex. 1003 ¶¶ 82–86, App. B; Ex. 1004 ¶¶ 33, 42; Ex. 1005, 580, 583; Ex. 1006 ¶¶ 4, 5, 7, 9, 13; Ex. 1015, 3:43–5:25).

For these reasons, we find that Petitioner has established that it would have been obvious to combine the teachings of Brown-Skrobot, Clauβ, and Liang.

3. Claim 5

Claim 5 depends from claim 1 and recites that the process "further compris[es] the steps of: directing an air stream to the generated photons of at least two wavelengths selected from the group consisting of 222 nm, 254 nm, and 282 nm; and exposing the air stream to the generated photons." Ex. 1001, 10:16–20.

Petitioner shows persuasively that the combination of Brown-Skrobot, Clauβ, and Liang discloses the limitation of claim 5. Pet. 33–35 (citing Ex. 1003 ¶¶ 113–117; Ex. 1004 ¶¶ 38, 42; Ex. 1006 ¶¶ 12, 13, 47, 49, 50, 52–56, Fig. 3; Ex. 1011, 30). Our finding is supported by Liang, which discloses "an air sterilizing method and apparatus to destroy all live microorganisms in the air in large volumes." Ex. 1006 ¶ 12. Our finding is further supported by Liang Figure 3, which has a "circuitous sterilizing chamber" that "increase[s] both the traveling time of the sterilized air and the number of UV lamps installed." *Id.* ¶ 49. Our finding is also supported by the disclosures of Brown-Skrobot and Clauβ, which in combination teach generating photons of 222 nm and 254 nm wavelengths, as discussed above.

4. Claim 6

Claim 6 depends from claim 5 and recites that the process "further compris[es] the steps of: determining required activity time to disinfect the air stream; and directing the photons to achieve disinfection of the air stream in a single pass."

Petitioner shows persuasively that the combination of Brown-Skrobot, Clauβ, and Liang discloses the limitations of claim 6. Pet. 35–37 (citing Ex. 1003 ¶¶ 118–123; Ex. 1004, 42; Ex. 1005, 582; Ex. 1006 ¶¶ 9, 12, 45, 48; Ex. 1015, 3:43–5:25).

Petitioner relies on Liang's formula for calculating a sterilizing dosage of UV radiation, "UV power" multiplied by "exposure time," asserting that "a POSITA would use this formula and the known 'UV death values' of microorganisms to determine the activity time required to disinfect the air stream." Pet. 36 (quoting Ex. 1006 ¶ 48). Petitioner relies on Johnson[20] to show known "UV death values." Ex. 1015, 3:43–5:25 (Tables 1–5 listing various microorganisms and the energy needed to achieve a 90% kill or 100% kill). Petitioner's evidence demonstrates the first step of claim 6, "determining required activity time to disinfect the air stream."

Petitioner relies on Liang's disclosure that "[t]he employment of circuitous chamber(s) is for the purpose of increasing exposure to UV radiation that is used to kill all live microorganisms that pass through the chamber." Ex. 1006 ¶ 12. Petitioner presents the unrebutted testimony of Mr. Lawal that "a POSITA would have been able to calculate and apply the proper UV dosages to ensure that the photons achieved disinfection of the air stream that flowed through the device in a single pass." Ex. 1003 ¶ 123; Pet. 37. Petitioner's evidence demonstrates the second step of claim 6, "directing the photons to achieve disinfection of the air stream in a single pass."

[20] Ex. 1015, US 6,283,986 B1, issued September 4, 2001 ("Johnson").

III. CONCLUSION

In summary:

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2	103	Brown-Skrobot, Clauβ	1, 2	
5, 6	103	Brown-Skrobot, Clauβ, Liang	5, 6	
Overall Outcome			1, 2, 5, 6	

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has shown that claims 1, 2, 5, and 6 of the ’605 Patent are unpatentable;

FURTHER OREDERED that Petitioner’s unopposed motion (Paper 27) for leave to file a Sur-sur-reply (Paper 28) and Exhibit 1042 as supplemental information is *granted*; and

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

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