

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SCIENTIFIC DESIGN COMPANY, INC.,
Petitioner,

v.

SHELL USA, INC., f/k/a SHELL OIL COMPANY,¹
Patent Owner.

IPR2022-00159
Patent 8,084,825 B2

Before GRACE KARAFFA OBERMAN, KRISTINA M. KALAN,
and JULIA HEANEY, *Administrative Patent Judges*.

HEANEY, *Administrative Patent Judge*.

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

¹ Patent Owner represents that it has changed its name to Shell USA, Inc.
Paper 31, 1.

I. INTRODUCTION

Scientific Design Company, Inc. (“Petitioner”) filed a Petition (“Pet.”) requesting *inter partes* review of claims 1–28 of U.S. Patent No. 8,357,825 B2 (Ex. 1001, “the ’825 patent”). Paper 1. Shell USA, Inc. (“Patent Owner”) filed a Preliminary Response (Paper 6).

We instituted *inter partes* review of claims 1–28 of the ’825 patent on the grounds of unpatentability alleged in the Petition. Paper 7 (“Dec.”). After institution of trial, Patent Owner filed a Patent Owner Response. Paper 10 (“PO Resp.”). Petitioner filed a Reply. Paper 19 (“Reply”). Patent Owner filed a Sur-Reply. Paper 30 (“Sur-Reply”). We held an oral hearing on January 5, 2023, and a transcript of the hearing is included in the record. Paper 35 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 1–28 of the ’825 patent. For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–28 of the ’825 patent are unpatentable.

A. *Related Proceedings*

The parties identify IPR2021-01537 and IPR2022-00158 as related matters. Pet. ix; Paper 5, 1. IPR2021-01537 is an *inter partes* review of U.S. Patent No. 8,084,390 (“the ’390 patent”) and IPR2022-00158 is an *inter partes* review of U.S. Patent No. 8,357,813 (“the ’813 patent”). Pet. ix. Petitioner also identifies European Patent EP 1 890 807, a counterpart to the ’390 patent, which was revoked by the European Patent Office “over *inter alia*, a combination of prior art references, which includes Liu and Lockemeyer.” *Id.* (citing Ex. 1017).

B. Real Parties-in-Interest

Petitioner identifies itself as the real party-in-interest. Pet. vii. Patent Owner identifies itself as a real party-in-interest. Paper 5, 1; Paper 31, 1.

C. The '825 Patent

The '825 patent, titled "Process for the Production of a 1,2-Diol, a 1,2-Diol Ether, or an Alkanolamine," describes a process for the production of a 1,2-diol, a 1,2-diol ether, or an alkanolamine. Ex. 1001, code (54), 1:19–21. The '825 patent explains that olefin epoxidation includes contacting a feed having an olefin and an oxygen source with a catalyst under epoxidation conditions. *Id.* at 1:25–27. The resulting olefin oxide may be reacted with water to produce a 1,2-diol, with alcohol to produce a 1,2-diol ether, or with an amine to form an alkanolamine. *Id.* at 1:30–32.

The '825 patent describes catalysts for olefin epoxidation as including a silver component on a carrier, such as a carrier formed of a refractory material (e.g., alpha-alumina). *Id.* at 1:37–40. According to the '825 patent, the carrier

comprises at least 85 weight percent α -alumina and has a surface area of at least 1.3 m²/g, a median pore diameter of more than 0.8 μ m, and a pore size distribution wherein at least 80% of the total pore volume is contained in pores with diameters in the range of from 0.1 to 10 μ m and at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10 μ m contained in pores with diameters in the range of from 0.3 to 10 μ m.

Id., code (57), 4:13–19. In addition, the '825 patent describes the carrier as being based on a wide range of materials, including α -alumina as the most preferred material, with a typical carrier comprising at least 85 weight percent α -alumina. *Id.* at 5:49–58.

The '825 patent explains that “in modern catalysts the tendency is to use a carrier with a relatively low surface area, for example a surface area of less than $1.3 \text{ m}^2/\text{g}$, or even less than $1 \text{ m}^2/\text{g}$.” *Id.* at 1:49–52. The '825 patent also describes that when the number of pores having a diameter in the range of 0.3 to $10 \text{ }\mu\text{m}$ is maximized for the carrier, and the pore volume of pores having diameters less than $0.3 \text{ }\mu\text{m}$ is minimized, the catalyst based on the carrier is advantageous over others prepared from carriers having a substantial pore volume of pores with a diameter less than $0.3 \text{ }\mu\text{m}$. *Id.* at 3:17–24. According to the '825 patent, those advantages include excellent catalyst activity and selectivity with significantly improved stability in a commercial operation. *Id.* at 3:24–27.

D. Illustrative Claim

Claim 1, reproduced below, is illustrative of the challenged claims:

1. A process for preparing a 1,2-diol, a 1,2-diol ether or an alkanolamine comprising converting an olefin oxide into the 1,2-diol, the 1,2-diol ether or the alkanolamine wherein the olefin oxide has been obtained by a process for the epoxidation of an olefin comprising reacting a feed comprising an olefin and oxygen in the presence of a catalyst comprising a carrier and silver deposited on the carrier, which carrier comprises at least 85 weight percent α -alumina and has a surface area of at least $1.3 \text{ m}^2/\text{g}$, a median pore diameter of more than $0.8 \text{ }\mu\text{m}$, and a pore size distribution wherein at least 80% of the total pore volume is contained in pores with diameters in the range of from 0.1 to $10 \text{ }\mu\text{m}$ and at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to $10 \text{ }\mu\text{m}$ is contained in pores with diameters in the range of from 0.3 to $10 \text{ }\mu\text{m}$.

Ex. 1001, 18:44–58.

E. Instituted Grounds of Unpatentability

We instituted *inter partes* review of claims 1–28 of the ’825 patent on the following grounds:

Ground	Claim(s) Challenged	35 U.S.C. § ²	Reference(s)/Basis
1	1–5, 7–14, 17–22, 24, 25, 27, 28	103	Liu, ³ Ullmann ⁴
2	6, 23, 26	103	Liu, Ullmann, Lockemeyer-II ⁵
3	1–14, 17–28	103	Lockemeyer, ⁶ Liu
4	15, 16	103	Lockemeyer, Liu, Lockemeyer-II, Kowaleski ⁷

In support of its unpatentability arguments, Petitioner relies on the declarations of Dr. Gary L. Haller. Ex. 1014; Ex. 1038. Patent Owner relies on the declaration of Dr. Kevin E. Howard. Ex. 2018.

² The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. § 103. Because the ’825 patent has an effective filing date prior to the effective date of the applicable AIA amendments, we refer to the pre-AIA version of § 103.

³ European Patent Application No. 0480538 A1 (Ex. 1002).

⁴ Ullmann’s Encyclopedia of Industrial Chemistry, 609–635 (Wiley-VCH, vol. 12, 6th ed. 2003) (Ex. 1013).

⁵ U.S. Patent No. 5,929,259 (Ex. 1004).

⁶ U.S. Patent Application Publication No. US 2003/0162984 A1 (Ex. 1003).

⁷ International Publication No. WO 97/40933 (Ex. 1005).

II. ANALYSIS

A. *Legal Standards*

A claim is unpatentable under 35 U.S.C. § 103(a) 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 to a person of ordinary skill in the art at the time the invention was made. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Obviousness is resolved based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) differences between the prior art and the claims at issue; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness, i.e., secondary considerations.⁸ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Subsumed within the *Graham* factors are the requirements that all claim limitations be found 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). A decision on obviousness must include “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006). The

⁸ Neither Patent Owner nor Petitioner argued objective indicia during trial. *See generally* PO Resp., Reply, Sur-Reply; *cf.* Pet. 48–51 (section captioned “Secondary Considerations” and preemptively discussing lack of unexpected results). Patent Owner represented “that it has made no secondary consideration showing in this proceeding.” Paper 18, 6. Petitioner agreed that Patent Owner “has waived such arguments.” Reply 12. To the extent that secondary considerations are before us in the form of Petitioner’s discussion of unexpected results (Pet. 48–51), we address those arguments in our discussion of Petitioner’s Ground 3 arguments, *infra*.

obviousness analysis “should be made explicit” and it “can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.” *KSR*, 550 U.S. at 418.

Petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). Petitioner must demonstrate unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d); *see also Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)).

B. Level of Ordinary Skill in the Art

In our Institution Decision, we accepted Petitioner’s undisputed contention that a person of ordinary skill in the art “would have held a Bachelor’s or Master’s degree in chemical engineering or a related discipline with five or more years of experience in the catalyst field.” Pet. 12 (citing Ex. 1014 ¶¶ 12–14); Dec. 6. Patent Owner represents that it “does not challenge Petitioner’s . . . POSA definition.” PO Resp. 21.

Neither party argues that the outcome of this case would differ based on our adoption of any particular definition of a person of ordinary skill in the art. Accordingly, we adopt Petitioner’s definition, because it is consistent with the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (prior art itself can reflect the appropriate level of ordinary skill in the art).

C. Claim Construction

We apply the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b). Under that standard, claim terms “are generally given their ordinary and customary meaning” as understood by a person of ordinary skill in the art at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303 at 1312–13 (Fed. Cir. 2005) (en banc). Petitioner argues the term “non-platelet morphology” as recited in claim 27 should be construed as “the morphology of the carrier when imaged by scanning electron microscopy at a magnification of 2000, and to the substantial absence in such images of structures having substantially flat surfaces,” because of the description in the ’825 specification. Pet. 11 (citing Ex. 1001, 5:33–37). Otherwise, Petitioner argues that the challenged claims should be given their ordinary and customary meaning. *Id.*

Patent Owner does not dispute Petitioner’s proposed claim construction. PO Resp. 21.

On this record, we determine we need not explicitly construe any claim terms. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 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))).

D. Asserted Obviousness based on Lockemeyer and Liu (Ground 3)

Petitioner argues that the combination of Lockemeyer and Liu would have rendered obvious claims 1–14 and 17–28. Pet. 16–17, 43–62. Patent Owner disagrees. PO Resp. 52–60.

1. Lockemeyer (Ex. 1003)

Lockemeyer is titled “Catalyst and a Process Using the Catalyst,” and is directed to a catalyst “which comprises a carrier and silver deposited on the carrier, which carrier has a surface area of at least $1 \text{ m}^2/\text{g}$,” and a pore size distribution (“PSD”) in which “pores with diameters in the range of from 0.2 to $10 \mu\text{m}$ represent at least 70% of the total pore volume and such pores together provide a pore volume of at least 0.27 ml/g , relative to the weight of the carrier.” Ex. 1003, codes (54), (57). More particularly, Lockemeyer’s catalyst is intended for use in olefin epoxidation, in which “catalyst performance may be assessed on the basis of selectivity, activity and stability of operation.” *Id.* ¶¶ 1–2. Lockemeyer teaches that the “nature of the porosity of the carrier, in particular the pore size distribution and the pore volume provided by the pores which have a pore size within a defined range, has now been found to play a significant role” in the performance of olefin epoxidation catalysts, such that on “this basis it was possible to prepare olefin epoxidation catalysts with excellent activity, selectivity and unusually prolonged retention of the activity and stability level.” *Id.* ¶ 5. Lockemeyer presents four exemplary α -alumina carriers identified as Carrier A, Carrier B, Carrier C, and Carrier D. *Id.* ¶¶ 96–110. Table I, which discloses characteristics of Carriers A–D, is reproduced below.

TABLE I

Carrier	Surface area (m ² /g)	Water absorption (g/g)	Pore volume (ml/g)	Pore size distribution		
				<0.2 μm (% v)	0.2– 10 μm (% v; ml/g)	>10 μm (% v)
A	2.04	0.42	0.41	5	92; 0.37	3
B	2.11	0.49	0.42	9	72; 0.30	19
C	2.51	0.55	0.56	3	95; 0.53	2
D*)	0.73	0.40	0.40	<1	64; 0.26	36

*)comparative

Table I provides, for each of Carriers A–D, the surface area, water absorption, pore volume, and PSD in terms of “the volume fraction (% v) and the volume (ml/g) of the, pores having diameters in the specified ranges (<0.2 μm , 0.2–10 μm , and >10 μm), relative to the total pore volume.” *Id.* ¶ 110 (Table I).

2. *Liu (Ex. 1002)*

Liu is a European patent application titled “Alkylene oxide catalysts having enhanced activity and/or stability,” and is directed to catalysts that “comprise a silver-containing support, and a sufficient amount of cobalt component to enhance at least one of activity and/or efficiency and/or stability as compared to a similar catalyst which does not contain cobalt component.” *Ex. 1002*, codes (54), (57). More particularly, *Liu* is directed to “silver-containing, supported catalysts for the epoxidation of alkene, especially ethylene, to the corresponding alkylene oxide, e.g., ethylene oxide, which contain a stability and/or efficiency and/or activity enhancing amount of a cobalt-containing component.” *Id.* at 2:3–5.

Liu provides that its preferred alpha-alumina carriers have a surface area of from about 0.05–5 m²/g, preferably from 0.1–3.0 m²/g, and more

preferably from about 0.1–2.0 m²/g. *Id.* at 9:47–49, 9:53–55. Liu’s preferred carriers have median pore diameters from about 0.5–50 microns. *Id.* at 9:57–58. Liu also provides data on eleven examples to demonstrate that a cobalt component increases a catalyst’s activity and/or efficiency and/or stability. *Id.* at 17:40–25:18. Liu’s data on Carriers S, T, and V is reproduced below.

Carrier S:

Physical Properties of Carrier S

Surface Area ⁽¹⁾	1.24 m ² /g
Pore Volume ⁽²⁾	0.77 cc/g
Packing Density ⁽³⁾	0.50 g/ml
Medium Pore Diameter ⁽⁴⁾	1.7 microns

Pore Size Distribution, % Total Pore Volume

Pore Size Microns	% Total Pore Volume
P ₁ (<0.1)	0.5
P ₂ (0.1-0.5)	3
P ₃ (0.5-1.0)	9.5
P ₄ (1.0-10)	81
P ₅ (10-100)	2
P ₆ (>100)	4

Id. at 18:32–55. The tables reproduced above set forth the properties of surface area, pore volume, packing density, and medium pore diameter for Liu’s Carrier S, and show a pore size distribution in which 81% of the total pore volume has a pore size of 1.0–10 microns, 9.5% of the total pore volume has a pore size of 0.5–1.0 microns, and 3% of the total pore volume has a pore size of 0.1–0.5 microns.

Carrier T:

Physical Properties of Carrier T

Surface Area(1)	1.13 m ² /g
Pore Volume(2)	0.75 cc/g
Packing Density(3)	0.51 g/ml
Medium Pore Diameter(4)	2.1 microns

Pore Size Distribution, % Total Pore Volume

Pore Size Microns	% Total Pore Volume
P ₁ (<0.1)	0
P ₂ (0.1-0.5)	1
P ₃ (0.5-1.0)	4.5
P ₄ (1.0-10)	90.5
P ₅ (10-100)	1.5
P ₆ (>100)	2.5

Id. at 19:17–38. The tables reproduced above set forth the properties of surface area, pore volume, packing density, and medium pore diameter for Liu’s Carrier T, and show a pore size distribution in which 90.5% of the total pore volume has a pore size of 1.0–10 microns, 4.5% of the total pore volume has a pore size of 0.5–1.0 microns, and 1% of the total pore volume has a pore size of 0.1–0.5 microns.

Carrier V:

Physical properties	
surface area (1)	1.16 m ² /g
pore volume (2)	0.76 cc/g
packing density (3)	0.50 g/ml
median pore diameter (4)	2.3 microns

Pore size distribution	
pore size, microns	%total pore volume
<0.1	0
0.1-0.5	1
0.5-1.0	5
1.0-10	88
10-100	2
>100	4

Id. at 20:15–34. The tables reproduced above set forth the properties of surface area, pore volume, packing density, and median pore diameter for Liu’s Carrier V, and show a pore size distribution in which 88% of the total pore volume has a pore size of 1.0–10 microns, 5% of the total pore volume has a pore size of 0.5–1.0 microns, and 1% of the total pore volume has a pore size of 0.1–0.5 microns.

3. *Petitioner’s Arguments*

Petitioner argues that the combination of Lockemeyer and Liu renders obvious all of claim 1’s limitations. Pet. 43–53. Petitioner presents a claim chart identifying where it believes every element of claim 1 is disclosed by Lockemeyer and Liu.

Claim 1	Prior Art
A process for preparing a 1,2-diol, a 1,2-diol ether or an alkanolamine	Lockemeyer discloses a method of converting an olefin oxide for into a 1,2-diol, a 1,2-diol ether or an alkanolamine. Ex. 1003, [0019], [0089].

comprising converting an olefin oxide into the 1,2-diol, the 1,2-diol ether or an alkanolamine	
wherein the olefin oxide has been obtained by a process for the epoxidation of an olefin, which process comprises reacting a feed comprising an olefin and oxygen in the presence of a catalyst	Lockemeyer discloses a process for the epoxidation of an olefin by reacting a feed containing an olefin and oxygen in the presence of a catalyst. <i>Id.</i> , [0014].
comprising a carrier and silver deposited on the carrier,	Lockemeyer discloses a catalyst comprising “a carrier and silver deposited on the carrier.” <i>Id.</i> , [Abstract].
which carrier comprises at least 85 weight percent α -alumina	Lockemeyer discloses a carrier comprising “at least 85% w, ... frequently up to 99.9% w α -alumina.” <i>Id.</i> , [0032].
and has a surface area of at least 1.3 m ² /g,	Lockemeyer discloses that the surface area is at least 1 m ² /g ... and more preferably from 1.4-2.6 m ² /g. <i>Id.</i> , [0030]. Lockemeyer’s Carriers A, B, and C have surface areas of 2.04, 2.11, and 2.51 m ² /g, respectively. <i>Id.</i> , [0110] (Table I).
a median pore diameter of more than 0.8 μ m,	Carrier D of the ’813 patent (Carrier A of Lockemeyer) has a median pore diameter of 2.2 μ m. Ex. 1001, Table I. Liu discloses that preferred carriers

	have median pore diameters having a preferred range of from about 0.5-50 μm . Ex. 1002, 9:57-58. Further, Carriers S, T, and V have median pore diameters of 1.7, 2.1, and 2.3 μm , respectively. <i>Id.</i> , 18:40, 19:24, 20:21.
and a pore size distribution wherein at least 80% of the total pore volume is contained in pores with diameters in the range of from 0.1 to 10 μm	Lockemeyer discloses that preferably, the pore size distribution is such that the pores with diameters from 0.2-10 μm represent more than 75%, in particular more than 80% of the total pore volume. Ex. 1003, [0026]. Carriers A and C have pore size distributions meeting this limitation. <i>Id.</i> , [0110] (Table I); Ex. 1014, ¶¶ 235-36.
and at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10 μm is contained in pores with diameters in the range of from 0.3 to 10 μm .	<p>Lockemeyer does not disclose a breakdown in the range of pores with diameters of 0.3-10 μm. It, however, discloses that the pore size distribution has “been found to play a significant role” in preparing carriers for catalysts with excellent properties. Ex. 1003, [0005]. A POSA would have been motivated to obtain the pore size distribution that achieves optimal performance with routine experimentation. Ex. 1014, ¶¶ 185-86, 237-38.</p> <p>Liu’s Carriers S, T, and V have pore size distributions meeting this limitation. Ex. 1002, 18:45-55, 19:27-38, 20:24-34; Ex. 1014, ¶¶ 92-93, 238.</p>

Id. Petitioner argues that although “Lockemeyer does not disclose a breakdown of the percentage of the pores that are contained in pores with

diameters from 0.3-10 μm ,” it “discloses a pore size distribution in the range of 0.2-10 μm ,” and a person of ordinary skill in the art “would have been motivated to modify the pore size distribution of carriers to optimize performance, as a matter of routine.” *Id.* at 44–45 (citing Ex. 1014 ¶¶ 185–186). Additionally, Petitioner argues, “each of [Liu’s] Carriers S, T, and V has a pore size distribution within the ranges taught by Lockemeyer” and Liu teaches that the “nature of the carrier is a factor that impacts ‘optimum performance’ of the catalyst.” *Id.* at 46 (citing Ex. 1014 ¶¶ 194–195). Petitioner argues that this teaching, together with Lockemeyer’s teaching that pore size distribution with pore size within a defined range plays “a significant role,” demonstrates that a person of ordinary skill in the art “would have been motivated to use Liu to direct the pore size distribution within the general ranges taught by Lockemeyer.” *Id.* at 47 (citing Ex. 1014 ¶¶ 196–198). Petitioner further argues catalysts made from Liu’s Carrier S, in particular, achieve high selectivity, activity, and stability, which “plays a significant role in achieving the enhanced properties of the catalysts.” *Id.* at 47–48 (citing Ex. 1014 ¶¶ 199–201).

Petitioner further argues “there is no evidence that the pore size distributions claimed in the ’825 patent exhibit any unexpected results over those of Lockemeyer.” *Id.* at 48. First, Petitioner argues, the experiments in the ’825 patent do not compare with the closest carrier in Lockemeyer, because the ’825 patent does not reproduce Carriers B or C of Lockemeyer (and there is no comparison with Carrier S of Liu, which Petitioner alleges is the closest prior art carrier of record). *Id.* at 49; *id.* at 50 n.5. Second, Petitioner argues, the results in the ’825 patent are not commensurate in scope with the claims, because Carriers A, B, and C of the ’825 patent “do

not represent the full scope of ‘at least 80%’ or ‘at least 90%’ as recited in the claims of the ’825 patent.” *Id.* at 50–51. Third, Petitioner argues, the results in the ’825 patent are not sufficient to establish unexpected results. *Id.* at 51. Petitioner relies on Dr. Haller’s testimony to explain why one of ordinary skill in the art “would not have compared Catalysts A, B, and C with Catalyst D to ascertain whether any improvement in the performance of the catalyst was due to the difference in pore size distribution” (*id.* (citing Ex. 1014 ¶ 216)) and to argue “there is nothing to show that the results [in Table III of the ’825 patent] were different in kind [from Catalyst D].” *Id.* (citing Ex. 1014 ¶ 220).

Regarding claims 2–6, which recite additional limitations relating to the composition of the feed, the olefin, and the work rate for forming the olefin oxide recited in claim 1, Petitioner relies on Lockemeyer’s disclosure. *Id.* at 54–55 (citing Ex. 1003 ¶¶ 76, 81, 85, 87; Ex. 1014 ¶¶ 242–244).

Regarding claim 7, Petitioner argues that Liu’s Carriers S, T, and V meet limitations a)–d) of claim 7, and that one of ordinary skill in the art would have been motivated to look to the pore size distributions of Carriers S, T, and V “to modify the pore size distributions of the carriers disclosed by Lockemeyer to obtain carriers with improved performance and with a reasonable expectation of success.” *Id.* at 55–56 (citing Ex. 1014 ¶¶ 104–107, 193–202, 245–251).

Regarding claim 8, Petitioner argues that Lockemeyer discloses “pores with diameters greater than 10 μm preferably represent ‘less than 5% of the total pore volume’” and Carriers A and C also meet this limitation; Petitioner relies on Liu to disclose pore size distributions. *Id.* at 56 (citing

Ex. 1003 ¶¶ 26, 110, Table I; Ex. 1002, 18:45–55, 19:27–38, 20:24–34; Ex. 1014 ¶¶ 108, 252–254).

Regarding claim 9, which requires “a) a median pore diameter of at most 2 μm , b) a total pore volume from 0.25-0.8 ml/g, c) a surface area of at most 5 m^2/g , d) a total pore volume from 0.3-0.7 ml/g, and e) a surface area from 1.3-3 m^2/g ,” Petitioner argues that “Lockemeyer discloses that the total pore volume is at least 0.28 ml/g and at most 0.8 ml/g” as in b) and d), as well as limitations c) and e). *Id.* at 56–57. For limitation a), Petitioner argues that Liu’s “Carriers S, T, and V have a median pore diameter of 1.7, 2.1, and 2.3 μm , respectively,” “selecting the claimed range would have been a simple design choice” or a matter of routine experimentation, and there is “no evidence showing the claimed range is critical or exhibits any unexpected results.” *Id.* at 57–58 (citing Ex. 1002, 9:57–58, 18:40, 19:24, 20:21; Ex. 1014 ¶¶ 256–257).

Regarding claims 10–14 and 17–23, Petitioner relies on Lockemeyer to disclose the additional limitations of those claims. *Id.* at 58–61. Petitioner argues that “Lockemeyer does not expressly disclose a breakdown in the range of pores with diameters of 0.4-10 μm , recited in claim 21, nor does it disclose a breakdown in the range of pores with diameters of 5-10 μm ” as recited in claim 22, but that the “recited pore size distribution ranges would have been obtained with routine experimentation and show no unexpected results.” *Id.* at 60–61 (citing Ex. 1014 ¶¶ 158–160, 193–202, 276–282).

Regarding independent claim 24 (“identical to claim 1, except it requires the surface area to be at least 1 m^2/g and a bond material”) and dependent claim 25 (“requires the surface area to be at least 1.3 m^2/g ”),

Petitioner relies on Lockemeyer. *Id.* at 61 (citing Ex. 1003 ¶¶ 30, 35, 43, 110). For independent claim 26, which requires “a surface area of at least 1 m²/g and that the carrier is formed of bodies fired at temperature of at least 1250°C,” Petitioner relies on Lockemeyer. *Id.* (citing Ex. 1003 ¶¶ 30, 56).

Regarding independent claim 27, which is “virtually identical to claim 1 except that it requires that the carrier has a surface area of at least 1 m²/g and a non-platelet morphology,” Petitioner argues that Lockemeyer discloses the surface area, and “because Lockemeyer’s procedure does not include adding a fluorine-containing compound to effect conversion to a platelet morphology, the carriers described in Lockemeyer have a non-platelet morphology.” *Id.* at 62 (citing Ex. 1003 ¶ 30; Ex. 1014 ¶¶ 165, 289; Ex. 1016, 11:67–12:2, 14:14–15:5). Petitioner further argues “there is no evidence showing that a non-platelet morphology would exhibit any advantages or unexpected results over a platelet morphology.” *Id.* (citing Ex. 1014 ¶¶ 166, 290).

Regarding independent claim 28, which “is virtually identical to claim 1, except it requires a water absorption of at most 0.6 g/g and a surface area of at least 1 m²/g,” Petitioner again relies on Lockemeyer. *Id.* (citing Ex. 1003 ¶¶ 30, 31, 110).

We focus on the disputed claim limitations and issues in our discussion of Patent Owner’s arguments and Petitioner’s reply, below. *See In re NuVasive, Inc.*, 841 F.3d 966, 974 (Fed. Cir. 2016) (“[t]he Board, having found the only disputed limitations together in one reference, was not required to address undisputed matters.”).

4. *Patent Owner's Arguments and Petitioner's Reply*

Patent Owner argues that “Petitioner fails to establish *prima facie* obviousness,” which is “fatal” to Ground 3 and “renders Petitioner’s arguments about ‘unexpected results’ not only wrong, but legally irrelevant.” PO Resp. 52–53. More particularly, Patent Owner argues that Petitioner failed to demonstrate that Liu would have motivated one of ordinary skill to modify Lockemeyer’s PSD. *Id.* at 53–58. Patent Owner alleges that Petitioner failed to establish a non-hindsight reason to modify Lockemeyer’s catalysts to have the claimed PSD, arguing that Lockemeyer teaches minimizing the number of pores having a diameter greater than 10 μm , whereas Liu’s Carriers S, T, and V have a higher percentage of pores greater than 10 μm than Lockemeyer’s carriers A and C. *Id.* at 53, 60–61. First, Patent Owner alleges that the examples include vastly different amounts of silver and different promoters, and “even minor differences in silver and promoter content would foreclose a POSA from drawing any conclusion about the impact of their PSD on selectivity.” *Id.* at 55–56. Second, Patent Owner alleges that one of ordinary skill in the art “would not have looked to the PSD of Liu’s carriers S, T, or V to improve Lockemeyer’s carriers because under comparable reaction conditions, Liu’s carriers had *worse* selectivity than Lockemeyer’s carriers.” *Id.* at 56. Third, Patent Owner alleges that “Liu’s carriers S, T, and V are FMA carriers,” whereas “Lockemeyer’s carriers are sintered α -alumina carriers,” which are “profoundly different.” *Id.* at 56–57. Patent Owner summarizes that Petitioner fails to explain “why a POSA would have compared performance of Liu’s catalyst having 143% more silver, a different promoter, and tested

using a different reaction process (using nitric oxide) than Lockemeyer's Catalysts A-B and D." *Id.* at 57.

Additionally, Patent Owner argues that Petitioner fails to allege or prove that routine optimization would have led one of ordinary skill in the art to the claimed PSD. *Id.* at 58–60. More particularly, Patent Owner argues that even if it were considered “routine optimization” to “experiment with changing the lower (0.2 μm) and/or upper (10 μm) end(s) of Lockemeyer's single PSD range,” there was nothing “routine” about “abandoning use of a single-range PSD in favor of two nested ranges that allowed for **reducing** the contribution to total pore volume from pores between 0.2 and 0.3 μm relative to Lockemeyer to increase selectivity,” while “simultaneously tolerating an **increased** contribution from small pores (below 0.2 μm) to maintain a high surface area and high activity.” *Id.* at 59.

Patent Owner also argues that Petitioner fails to establish a reasonable expectation of success: “Establishing a reasonable expectation of success in arriving at a claim **as a whole** is required to establish *prima facie* obviousness.” *Id.* at 61. Patent Owner alleges that Petitioner's failure “to explain why adopting Liu's PSDs would not have led to the smaller surface areas Liu discloses” is fatal to Ground 3. *Id.* at 63. Finally, Patent Owner argues that “no caselaw supports presuming *prima facie* obviousness based on Lockemeyer/Liu and Petitioner never alleges there is,” elaborating that “no presumption of obviousness applies where the claim recites interdependent variables in a complex and unpredictable art” and the “overlapping range caselaw does not apply because Lockemeyer does not disclose the 0.3–10 μm nested range.” *Id.* at 63–65.

Petitioner replies that “Lockemeyer teaches *every* limitation of the claims except PSD” and it is “undisputed that each of Liu’s Carriers S, T, and V has a PSD that falls within the range taught by Lockemeyer and the challenged claims.” Reply 21. Petitioner reiterates that “Lockemeyer *explicitly* invites a POSA to investigate PSD within its range.” *Id.* (citing Ex. 1003 ¶ 5; Ex. 1014 ¶¶ 178–202). Petitioner also addresses Patent Owner’s arguments: First, regarding silver content, Petitioner argues that “Lockemeyer discloses that silver is present preferably in an amount of 10–500 g/kg, which is equivalent to 1–50% by weight of silver,” such that “the silver in Liu’s Example 1 falls within Lockemeyer’s preferred range.” *Id.* at 22 (citing Ex. 1003 ¶¶ 69–70; Ex. 1038 ¶¶ 135–139). Second, regarding a potassium or cesium promoter, Petitioner argues that “Lockemeyer also teaches using a potassium promoter,” “cesium is a more effective promoter than potassium,” and that “Liu’s Example 1 catalysts achieved high selectivity using potassium instead of cesium would have further demonstrated to a POSA that Liu’s Carrier S played an important role to the catalyst performance.” *Id.* (citing Ex. 1003 ¶ 66; Ex. 1013, 616; Ex. 1038 ¶¶ 140–142). Third, regarding nitric oxide, Petitioner argues that “Lockemeyer also discloses using feed gas containing nitrogen oxides.” *Id.* at 23 (citing Ex. 1003 ¶ 81; Ex. 1038 ¶ 143). Fourth, regarding percentage of pores in the >10 micron range, Petitioner argues that “Lockemeyer’s Carrier B—which also falls within Lockemeyer’s invention—has a percentage of pores in the >10 µm range that is significantly greater than that of Carriers S, T, and V.” *Id.* (citing Ex. 1003 ¶ 110, Table I; Ex. 1038 ¶ 144). According to Petitioner, Liu’s Carrier S has high selectivity after 11 days and is maintained for 30 days, whereas Lockemeyer only reported

initial selectivity, which “would have motivated a POSA to look to the PSD of Carrier S.” *Id.* at 23–24. Finally, regarding FMA-made carriers, Petitioner argues that “processes are not claimed or relevant to carrier performance,” and Liu’s “teachings are applicable to ‘all carrier types.’” *Id.* at 24–25 (citing Ex. 1003 ¶¶ 125–126; Ex. 1038 ¶¶ 145–146).

Patent Owner responds that there is “no supportable reason to modify Lockemeyer’s PSD.” Sur-Reply 20. More particularly, Patent Owner argues that Liu’s carriers performed worse under comparable reaction conditions, and one of ordinary skill in the art “would not have been motivated by the performance of Liu’s carriers to modify Lockemeyer’s PSD.” *Id.* at 21. Additionally, Patent Owner argues that “silver content differences eviscerate Petitioner’s motivation,” because one of ordinary skill in the art “would not have attributed any performance differences to PSD.” *Id.* Patent Owner also argues that the Petition never made the argument that one of ordinary skill in the art, undertaking the proposed modification, would have had a reasonable expectation of success, and even “if the Petition is considered to have made this argument, it cited no evidence to support it.” *Id.* at 22–23 (emphasis omitted).

5. *Analysis*

After reviewing both parties’ evidence and arguments, we are persuaded that Petitioner has met its burden by a preponderance of the evidence.

Petitioner’s challenges rely primarily on Lockemeyer to meet the limitations of the challenged claims, and secondarily on Liu’s Carriers S, T, and V to disclose the “nested range” limitations. Pet. 52–53. Contrary to Patent Owner’s claims that Petitioner is demonstrating a “modification” of

Lockemeyer's PSD, we find that Lockemeyer already discloses a PSD "such that pores with diameters from 0.2–10 μm represent more than 75%, in particular more than 80% of the total pore volume" (*id.* (citing Ex. 1003 ¶ 26)), although Lockemeyer does not disclose a sub-PSD within that range. Accordingly, relying on Liu to disclose a sub-PSD within the range of 0.2–10 μm where "at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10 μm is contained in pores with diameters in the range of from 0.3 to 10 μm " is not so much a modification of Lockemeyer as an optimization of Lockemeyer's PSD within the range of 0.2–10 μm . Lockemeyer discloses that PSD has "been found to play a significant role" in preparing carriers for catalysts with excellent properties. Ex. 1003 ¶ 5 (cited in Pet. 53). Liu presents a desirable PSD in carriers such as Carriers S, T, and V, which Liu describes through its results as making catalysts that are selective, active, and stable. *See* Pet. 47 (citing Ex. 1002, 6:1–2, 21:10–22:16). We are persuaded by Petitioner's reasoning and supporting testimony regarding why one of ordinary skill in the art would have been motivated to make the combination with a reasonable expectation of success. *Id.* at 46–48 (citing Ex. 1014 ¶¶ 196–202). We find credible Dr. Haller's explanation that a person of ordinary skill "would have been motivated to use Liu to direct the pore size distribution, especially ones that are within the ranges taught by Lockemeyer" with "a reasonable expectation of success" (Ex. 1014 ¶¶ 198–202) and would have pursued Lockemeyer's "invitation to optimize PSD, where Liu's PSDs show outstanding performance" (Ex. 1038 ¶ 152).

With regard to Patent Owner's arguments, first, we do not find persuasive Patent Owner's argument that different amounts of silver and

promoters in Lockemeyer and Liu's examples "eviscerate" a motivation to modify Lockemeyer's PSD. *See* Sur-Reply 21. Regarding silver, we find more persuasive Petitioner's argument that a person of ordinary skill would have understood the 35.5 wt% silver in Liu's Example 1 catalyst to be within Lockemeyer's preferred range of 1–50 wt% silver. *See* Reply 22 (citing Ex. 1003 ¶¶ 69–70; Ex. 1038 ¶¶ 135–139). We credit Dr. Haller's testimony that one of ordinary skill in the art seeking to improve upon Lockemeyer's carriers "would not have ignored the high performance of Liu's exemplified carriers simply because they were used in catalysts with a higher amount of silver because the amount used in Liu's examples are well within the preferred range taught by Lockemeyer." Ex. 1038 ¶ 137. Further, Dr. Haller's testimony is responsive to Patent Owner's argument (*see* PO Resp. 55) and not improper new argument.

Second and third, regarding Liu Example 1's use of a different promoter (potassium) and different feed gas (nitric oxide) from Lockemeyer's, Patent Owner's argument (*see id.* at 55–56) is not persuasive in view of Lockemeyer's teaching of a potassium promoter and feed gas using nitrogen oxides. *See* Ex. 1038 ¶¶ 140–143 (citing Ex. 1003 ¶¶ 66, 81, claim 19). We credit Dr. Haller's testimony that one of ordinary skill in the art seeking to improve upon Lockemeyer's carriers would not have ignored the high performance of Liu's exemplified carriers "simply because they were used in catalysts with potassium instead of cesium as a promoter since both potassium and cesium are taught by Lockemeyer as most preferred promoters" or "simply because they were used in catalysts tested with nitric oxide in the feed gas since Lockemeyer teaches that catalysts made from its carriers can also be tested with nitric oxide in the feed gas." *Id.* ¶¶ 141, 143.

We also find that Dr. Haller's testimony regarding Lockemeyer's teachings is properly responsive to Patent Owner's argument in the Response. *See* PO Resp. 55–56.

Fourth, regarding the percentage of pores in the $>10\ \mu\text{m}$ range, we find persuasive Petitioner's argument that Lockemeyer's Carrier B has a percentage of pores in the $>10\ \mu\text{m}$ range that is significantly greater than that of Liu's Carriers S, T, and V. Reply 23. Dr. Haller's testimony on this point is credible and properly responsive. Ex. 1014 ¶¶ 90–93; Ex. 1038 ¶ 144 (responding to arguments at PO Resp. 54). We also agree with Petitioner's concerns with Dr. Howard's testimony on this point. Reply 23 n.4 (citing Ex. 1044, 52:25–53:5, 78:17–79:22, 30:13–35:18, 28:10–29:3, 24:16–25:9).

Finally, regarding FMA carriers, we do not find persuasive Patent Owner's argument concerning FMA carrier differences (*see* PO Resp. 56–57), in view of Petitioner's reply arguments (Reply 1–4, 24–25) and testimony that “the PSD characteristic is a fundamental property that is applicable to both FMA and non-FMA carriers.” Ex. 1038 ¶ 155 (citing Ex. 1044, 189:11–15, 191:4–192:3 (deposition testimony of Dr. Howard, opining that the PSD for FMA carriers is determined in the same way as non-FMA carriers and is of importance in determining performance for both FMA and non-FMA carriers)). We credit Dr. Haller's testimony, which is persuasive on these points, and further find that it is responsive to Patent Owner's argument (*see* PO Resp. 56–57) and not improper new argument.

Regarding routine optimization, we disagree with Patent Owner's argument that Petitioner fails to allege or prove that routine optimization would have led one of ordinary skill in the art to the claimed PSD. *See id.* at 58–60. The Petition alleges that “Lockemeyer discloses the '825 patent's

claimed limitation that at least 80% of the total pore volume is contained in pores with diameters from 0.1–10 μm ,” and a person of ordinary skill in the art “would have been motivated to modify the pore size distribution of carriers to *optimize performance, as a matter of routine*.” Pet. 43–45 (citing Ex. 1014 ¶¶ 182, 185–186) (emphasis added). We also credit Dr. Haller’s testimony:

As I stated in my previous declaration, Lockemeyer discloses a PSD that encompasses the claimed distributions (as exemplified in Carriers A-C of the ’825 patent) and a process for making the carrier that is virtually identical to the process disclosed in the ’825 patent. EX1014, ¶¶ 184, 187–192. Accordingly, based on Lockemeyer’s disclosure, a POSA would have made the claimed carriers with routine experimentation.

Ex. 1038 ¶ 163 (cited in Reply 25). Relatedly, the Petition relies on Federal Circuit precedent establishing that “a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art” (Pet. 15 (citing *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003))), and that once overlap of the claimed range and prior art are shown, a patentee must establish criticality of the claimed range to rebut a determination of obviousness. *Id.* (citing *E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006, 1008 (Fed. Cir. 2018); *see also* Tr. 6:5–6 (“There is no evidence that any of the claimed ranges exhibit any criticality or unexpected results, which should end the inquiry regarding obviousness.”), 76:18–77:2. Patent Owner does not carry its burden of producing evidence of criticality adequate to rebut the presumption of obviousness that is established by Petitioner’s information regarding the overlapping ranges.

We also disagree with Patent Owner’s argument that, because the challenged claims recite “interdependent variables,” the result is controlled by a different line of caselaw such as *ModernaTX v. Arbutus Biopharma Corp.*, 18 F.4th 1364, 1376 (Fed. Cir. 2021). PO Resp. 29–35. Because that case did not involve an overlapping range between the claimed composition and prior art, and the evidence there showed that the claimed variables interacted in an unpredictable way, we do not find Patent Owner’s argument persuasive. In particular, Patent Owner does not direct us to evidence that shows persuasively that the claimed variables at hand, in this challenge, interact in a manner that is unpredictable such that this line of cases controls the outcome here.

Relatedly, Patent Owner argues that the “‘catalyst carrier art’ is ‘even more unpredictable than other chemical process art.’” *Id.* at 4 (quoting Ex. 1004, 1:45–47), 12. Such concerns about unpredictability are mitigated because the asserted references are directed to essentially the same chemical reaction using essentially the same chemical reagents. *See, e.g.*, Ex. 1038 ¶ 163 (Lockemeyer discloses “a process for making the carrier that is virtually identical to the process disclosed in the ’825 patent”). Concerns about unpredictability are further mitigated because Lockemeyer discloses all limitations of the challenged claims apart from providing a breakdown of PSD within its range of 0.2–10 μm . As discussed above, Lockemeyer “invites a POSA to investigate PSD within its range” of 0.2–10 μm (Reply 21), and looking to Liu to identify a sub-PSD range within Lockemeyer’s PSD range does not invoke undue concerns about unpredictability because it involves refinement of a single variable within an already established range. We disagree with Patent Owner’s position that

Petitioner has failed to “explain why adopting Liu’s PSDs would not have led to the smaller surface areas Liu discloses” (PO Resp. 63), because, as discussed above, Petitioner relies on Lockemeyer to disclose a PSD range and a surface area range (Pet. 52–53), and on Liu for the sub-PSD range (*id.* at 53). Petitioner thus demonstrates that one of ordinary skill in the art would have been motivated and able to maintain the surface area within the claimed range while optimizing the sub-PSD range. *See id.* (citing Ex. 1014 ¶¶ 185–186); *see also* Ex. 1038 ¶ 163.

Regarding reasonable expectation of success, having considered the full record, we find that Petitioner persuasively argued reasonable expectation of the success in the Petition, and reiterated its position in a properly responsive manner in the Reply. Pet. 46–48; Reply 25; Ex. 1014 ¶¶ 187–192; Ex. 1038 ¶¶ 162–168.

Patent Owner also incorporates its “as a whole” argument into its reasonable expectation of success arguments (PO Resp. 61), i.e., the general allegation that “Petitioner’s obviousness Grounds 1–5 suffer similar problems—they only allege individual limitations would have been obvious,” but “[i]t is a ‘claim as a whole’ that must be proven obvious.” *Id.* at 6 (citing 35 U.S.C. § 103); *see also id.* at 27 (citing *Gillette v. S.C. Johnson & Son*, 919 F.2d 720, 723–24 (Fed. Cir. 1990)); Tr. 72:19–25 (applying “as a whole” argument to Ground 3). Petitioner characterizes Patent Owner’s “as a whole” argument as “a highly, hyper-technical argument,” arguing that the “purpose of this requirement is to prevent someone from just making a showing that all the limitations are disclosed in the prior art, without a showing of motivation to combine.” Tr. 77:15–22. Petitioner reiterates that the only difference “between Lockemeyer and the

claims is pore size distribution,” and “we did make a motivation to combine analysis in our petitions, and that would be sufficient.” *Id.* at 77:17–23. We have reviewed Petitioner’s mapping of the challenged limitations to the prior art, an approach with which Patent Owner agrees (*id.* at 49:20–24), and have also considered Petitioner’s challenge to each claim “as a whole,” including motivation to combine, as detailed in our analysis above. To the extent that Patent Owner asserts that Petitioner’s challenge to the claims in this ground does not adequately demonstrate obviousness of the claims “as a whole,” those assertions are conclusory or, at best, rest on information about promoters, silver content, EO processes, or the unpredictability of the art, all of which we find unpersuasive for the reasons given above.

Having reviewed the complete record, we find that Petitioner has demonstrated obviousness of the claims challenged under Ground 3 by a preponderance of the evidence. In reaching this conclusion, we have evaluated each claim as a whole and applied the evidence in view of Petitioner’s burdens, finding that Petitioner has met its burden of demonstrating obviousness.

E. Asserted Obviousness based on Lockemeyer, Liu, Lockemeyer-II, and Kowaleski (Ground 4)

Petitioner argues that Lockemeyer and Liu, in combination with Lockemeyer-II and Kowaleski, would have rendered obvious claims 15 and 16. Pet. 17–18, 63–65. Patent Owner disagrees. PO Resp. 66–67.

1. Kowaleski (Ex. 1005)

Kowaleski is titled “Epoxidation Catalyst and Process,” and relates to “a catalyst suitable for the epoxidation of olefines having no allylic hydrogen, in particular ethylene, which contains silver and one or more alkali metal promoters supported on a carrier,” prepared by “a process

comprising the use of ceramic particle components with particle sizes chosen to ensure that a desired degree of porosity is obtained without the use of organic burnout materials.” Ex. 1005, codes (54), (57).

2. *Lockemeyer-II (Ex. 1004)*

Lockemeyer-II is titled “Preparation of Ethylene Oxide and Catalyst” and relates to “a process for preparing an ethylene oxide catalyst by depositing silver and one or more alkali metal promoters on an alpha alumina carrier.” Ex. 1004, codes (54), (57). The Lockemeyer-II process results in catalyst carriers with a finished surface area of 0.4–5 m²/g. *Id.* at 4:8–14, 16:11–12 (Table 1). Lockemeyer-II discloses “[c]onventional ceramic bond materials” such as silica and alkaline earth metal oxides, and that “[p]articularly suitable bond materials include calcium silicate and magnesium silicate.” *Id.* at 4:62–5:8. Lockemeyer-II further discloses shaping a mixture into carrier bodies and firing them at about 1200°C–1500°C to form the carriers. *Id.* at 2:3–20, 3:55–67.

3. *Petitioner’s Arguments*

Regarding claim 15 (“wherein the bond material comprises an alkaline earth metal silicate bond material”), Petitioner argues that both Lockemeyer and Liu disclose that a bond material may comprise an alkali metal silicate (Pet. 63), Lockemeyer-II teaches both alkali metal silicates and alkaline earth metal silicates are conventional ceramic bond materials, with calcium silicate and magnesium silicate as “particularly suitable bond materials” (*id.* (citing Ex. 1004, 4:62–5:8; Ex. 1014 ¶ 299), and Kowaleski teaches it is desirable to use calcium silicate or magnesium silicate as bond materials. *Id.* at 63–64 (citing Ex. 1005, 8:9–17, 10:3–15; Ex. 1014 ¶¶ 300–301). Petitioner further argues a person of ordinary skill in the art “would

have been motivated to combine the teachings of Lockemeyer and Liu with those of Lockemeyer-II and Kowaleski because all these prior art references disclose high purity alpha-alumina carriers for silver-containing catalysts for making EO.” *Id.* at 64 (citing Ex. 1014 ¶ 302). Because “Lockemeyer-II teaches that calcium silicate and magnesium silicate (as well as alkali metal silicates) are conventional bond materials and Kowaleski teaches that it is desirable to use calcium or magnesium silicate,” Petitioner argues, it would have been obvious to one of ordinary skill in the art “to use calcium or magnesium silicate as a bond material in the carrier of Lockemeyer with a reasonable expectation of success.” *Id.*

Regarding claim 16 (“the bond material further comprises one or more additional components selected from the group consisting of a hydrated alumina, a zirconium component and a titanium component”), Petitioner argues that Lockemeyer and Liu disclose that the bond material may comprise hydrated alumina, Lockemeyer-II discloses titanium or boehmite (hydrated alumina), and Kowaleski teaches that the carrier may contain zirconium or titanium. *Id.* at 64–65. Petitioner further argues that the references demonstrate that the claimed components are commonly used in alpha-alumina carrier and thus their use would have been obvious to a person of ordinary skill in the art. *Id.* at 64 (citing Ex. 1014 ¶ 306).

4. Patent Owner’s Arguments and Petitioner’s Reply

Patent Owner argues that the Petition does not allege Ground 4’s combination meets the limitations of independent claim 1 from which claims 15–16 depend, and thus, Ground 4 fails for this reason. PO Resp. 66. Petitioner replies that Patent Owner’s “as a whole” argument is meritless, as discussed above. Reply 25.

5. *Analysis*

We have reviewed Petitioner’s mapping of limitations, rationale to combine, and arguments regarding reasonable expectation of success, and are persuaded that Petitioner has met its burden by a preponderance of the evidence. Petitioner identifies the additional limitations present in claims 15 and 16, thereby addressing each challenged claim as a whole. Pet. 63–65. Petitioner identifies how and where Lockemeyer-II and Kowaleski disclose the alkaline earth metal silicate bond material and additional limitations of claims 15 and 16. *Id.* Petitioner articulates clearly a motivation to combine with a reasonable expectation of success (*id.* at 64–65), supporting these arguments with persuasive opinion testimony (Ex. 1014 ¶¶ 302, 306).

For the reasons discussed above, we find that Petitioner has established by a preponderance of the evidence that one of ordinary skill in the art would have had a reason to combine Lockemeyer, Liu, Lockemeyer-II, and Kowaleski in the manner claimed and with a reasonable expectation of success, and that the combination would have rendered obvious claims 15 and 16.

F. Grounds 1 and 2

Petitioner’s Grounds 1 and 2 challenge claims 1–14 and 17–28. Petitioner presents arguments based on Liu as a primary reference as the basis for its challenge of claims 1–14 and 17–28 under Grounds 1 and 2. For the purposes of this decision, we do not determine the merits of Grounds 1 and 2, because, as explained above, we determine that every challenged claim in this proceeding would have been obvious over the Lockemeyer-based challenges in Grounds 3 and 4. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding a petitioner “is entitled to a

final written decision addressing all of the claims it has challenged”); *Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App’x 984, 990 (Fed. Cir. 2020) (nonprecedential) (“We agree that the Board need not address [alternative grounds] that are not necessary to the resolution of the proceeding.”).

G. Identification of Allegedly New Arguments

With Board authorization, Patent Owner filed an Identification of alleged new arguments and evidence in the Reply (Paper 23, “Identification”), to which Petitioner responded (Paper 26, “Identification Resp.”). Two of Patent Owner’s identified arguments involve Ground 3: #14 (Reply 2:15–17; Ex. 1038 ¶¶ 132, 145–146); and #15 (Reply 25:4–6; Ex. 1038 ¶¶ 14–16, 162–168; Ex. 1024). Identification 5.⁹

Petitioner responds by identifying where it originally made these arguments in the Petition. Identification Resp. 3 (#14: Pet. 47:6–48:10; Ex. 1014 ¶¶ 199–202; #15: Pet. 16:17–17:16, 44:15–46:5, 48:3–10; Ex. 1014 ¶¶ 187–192).

Having reviewed Patent Owner’s points and Petitioner’s responses, we are persuaded that the identified arguments, which relate to motivation to combine Lockemeyer and Liu (#14) with a reasonable expectation of success (#15), were originally presented properly in the Petition, are properly responsive to Patent Owner’s arguments in the Response, and do not exceed the scope of a proper reply in violation of 37 C.F.R. § 42.23(b).

⁹ Patent Owner identifies argument #14 and #15 as relating to Ground 4, but the portions of Petitioner’s Reply included in #14 and #15 relate to Ground 3. Patent Owner also identifies argument #12 and #13 as relating to Ground 3, but the portions of Petitioner’s Reply included in #12 and #13 relate to Ground 2, which we do not address in this decision.

III. CONCLUSION¹⁰

For the reasons discussed above, we determine Petitioner meets its burden of establishing, by a preponderance of the evidence, that the challenged claims are unpatentable, as summarized in the following table:

Claims	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–5, 7–14, 17–22, 24, 25, 27, 28	§ 103	Liu, Ullman ¹¹		
6, 23, 26	§ 103	Liu, Ullmann, Lockemeyer-II		
1–14, 17– 28	§ 103	Lockemeyer, Liu	1–14, 17–28	
15, 16	§ 103	Lockemeyer, Liu, Lockemeyer-II, Kowaleski	15, 16	
Overall Outcome			1–28	

¹⁰ 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).

¹¹ As noted above, we do not reach the §103 grounds based on Liu as the primary reference, because Petitioner has shown that all of the challenged claims are unpatentable based on Grounds 3 and 4.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner establishes, by a preponderance of the evidence, that claims 1–28 of U.S. Patent No. 8,084,825 B2 are unpatentable; and

FURTHER ORDERED that this is a Final Written Decision; therefore, 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.

IPR2022-00159
Patent 8,357,825 B2

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