# UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SCIENTIFIC DESIGN COMPANY, INC., Petitioner,

v.

SAINT-GOBAIN CERAMICS & PLASTICS, INC, Patent Owner.

> IPR2022-00433 Patent 7,825,062 B2

Before KRISTINA M. KALAN, JEFFREY W. ABRAHAM, and ELIZABETH M. ROESEL, *Administrative Patent Judges*.

ABRAHAM, Administrative Patent Judge.

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

#### I. INTRODUCTION

Scientific Design Company, Inc. ("Petitioner") filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 1–29 of U.S. Patent No. 7,825,062 B2 (Ex. 1001, "the '062 patent"). Saint-Gobain Ceramics & Plastics, Inc. ("Patent Owner") filed a Preliminary Response (Paper 6).

On August 8, 2022, we instituted *inter partes* review of all of the challenged claims based on all of the grounds identified in the Petition. Paper 7. After institution, Patent Owner filed a Response to the Petition (Paper 12, "PO Resp."), Petitioner filed a Reply to Patent Owner's Response (Paper 15, "Reply"), and Patent Owner filed a Sur-reply (Paper 16, "Sur-reply").

On May 10, 2023, the parties presented arguments at an oral hearing for this proceeding. We have entered a transcript of the hearing into the record. Paper 24 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6. We issue this Final Written Decision pursuant to 35 U.S.C. § 318(a). Based on the record before us, we conclude that Petitioner has shown by a preponderance of the evidence that claims 1–29 of the '062 patent are unpatentable.

#### II. BACKGROUND

#### A. Related Proceedings

Petitioner identifies IPR2021-01537, involving U.S. Patent No. 8,084,390 B2 ("the '390 patent"), IPR2022-00158, involving U.S. Patent No. 8,357,813 B2 ("the '813 patent"), and IPR2022-00159, involving U.S. Patent No. 8,357,825 B2 ("the '825 patent"). Pet. ix. Petitioner states that the '062 patent and the '390 patent have the same

inventive entity and same filing date, and "[m]any of the limitations recited in the claims of the '390 patent are identical to those recited in the '062 patent." Pet. ix. Petitioner also states that the '813 and '825 patents are in the same family as the '390 patent. Pet. ix. Additionally, Petitioner states that "European Patent EP1901842–the European counterpart to the '062 patent–was revoked by the European Patent Office . . . over, *inter alia*, a combination of prior art references, which includes Liu and Lockemeyer." Pet. x (citing Ex. 1017).

Patent Owner states that it is not aware of any related matters.

Paper 4, 1.

#### B. Real Parties-In-Interest

Petitioner identifies itself as the real party-in-interest. Pet. ix. Patent Owner identifies itself as a real party-in-interest. Paper 4, 1.

C. The '062 Patent

The '062 patent is titled "Catalyst Carrier and a Process for Preparing the Catalyst Carrier," and issued on November 2, 2010. Ex. 1001, codes (45), (54). The '062 patent is directed to a carrier for olefin epoxidation catalysts, particularly:

[a] carrier, which comprises non-platelet alumina and/or a bond material, has a surface area of at least 1.3 m<sup>2</sup>/g, a total pore volume and a pore size distribution such that at least 80% of the total pore volume is contained in pores with diameters in the range of from 0.1 to 10  $\mu$ m and at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m and at least 80% of the pore volume contained in pores with diameters in the range of from 0.1 to 10  $\mu$ m and at least 1.3 m<sup>2</sup>/g, a total pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m and at least 1.3 m<sup>2</sup>/g, a total pore volume contained in pores with diameters in the range of from 0.1 to 10  $\mu$ m and a process for the preparation of a carrier . . . .

Ex. 1001, code (57), 1:10–11.

The '062 patent explains that "catalyst performance may be assessed on the basis of selectivity, activity and stability of operation," wherein selectivity refers to the fraction of the converted olefin yielding the desired olefin oxide. Ex. 1001, 2:31–34. According to the '062 patent, "the longer the selectivity can be maintained at a high level and the epoxidation can be performed at an acceptably low temperature, the longer the catalyst charge can be kept in the reactor and the more product is obtained." Ex. 1001, 2:43–47.

The catalysts of the '062 patent purportedly "show excellent activity and selectivity, and they are believed to provide significant improvements in stability under conditions of commercial operation." Ex. 1001, 3:26–29. The '062 patent states that these advantages are obtained "by maximizing for carriers having a surface area of at least  $1.3 \text{ m}^2/\text{g}$  and non-platelet alumina and/or a bond material the number of pores having a diameter in the range of 0.3 to 10 µm, in particular by minimizing the pore volume in pores having diameters less than 0.3 µm." Ex. 1001, 3:18–23.

By way of background, the '062 patent states that "[c]arriers for olefin epoxidation catalysts can be made by different processes that result in carriers having distinct morphologies." Ex. 1001, 1:36–38. A "first process" known in the art produces a carrier with a platelet morphology, and uses a fluorine recrystallizing agent to convert alumina to alphaalumina having at least one substantially flat surface. Ex. 1001, 1:38–46. This process produces fluoride mineralized alpha-alumina ("FMA") carriers. Ex. 1001, 1:43–46; PO Resp. 4. A "second process" produces a "conventional" carrier (i.e., a carrier comprising non-platelet alumina), and does not use a fluorine recrystallizing agent. Ex. 1001, 1:67–2:3. The '062

patent states that the "second process typically uses small amounts of one or more bond materials to facilitate bonding of the alumina particles to one another," and that "[t]he morphology of the carrier made by the second process impacts physical characteristics of the carrier, such as surface area, pore size distribution and particle size." Ex. 1001, 2:9–17. According to the '062 patent, the bond material may comprise an alkali metal silicate or an alkaline earth metal silicate and may further comprise a hydrated alumina, a titanium component, and/or a zirconium component. Ex. 1001, 6:2–11, 7:8–67.

D. Illustrative Claim

Claim 1 is representative of the challenged claims, and is reproduced below:

1. A carrier comprising alumina and a bond material, said carrier comprising a surface area of at least  $1.3 \text{ m}^2/\text{g}$ , a median pore diameter of more than 0.8 µm, and a total pore volume 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, 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.

Ex. 1001, 18:22–30. Claim 29 is the only other independent claim challenged. Claim 29 does not require a bond material, and is directed to a carrier having the properties recited in claim 1 that is "produced by a process comprising the steps of forming a mixture comprising alumina; shaping the mixture into formed bodies; and firing the bodies at a temperature of from 1250 to 1550° C." Ex. 1001, 20:25–35.

#### E. Unpatentability Challenges

Ground	Reference(s)	<b>Basis</b> <sup>1</sup>	Claim(s) Challenged
1	Liu <sup>2</sup>	§ 102/§ 103	1–5, 8, 10, 16, 17, 23–27
2	Liu	§ 103	28
3	Liu, Lockemeyer, <sup>3</sup>	§ 103	6–10, 16–18
4	Liu, Lockemeyer-II <sup>4</sup>	§ 103	29
5	Lockemeyer, Liu	§ 103	1-10, 16-18, 23-29
6	Lockemeyer, Liu, Lockemeyer-II, Kowaleski <sup>5</sup>	§ 103	11–15, 19–22

Petitioner presents the following challenges in the Petition:

Petitioner relies on declarations from Gary L. Haller, Ph.D.

Ex. 1014; Ex. 1038. Patent Owner deposed Dr. Haller and filed a transcript of the deposition as Exhibit 2008 in this proceeding.

Patent Owner relies on the declaration of William M. Carty, Ph.D. Ex. 2006. Petitioner deposed Dr. Carty, and filed the transcript of the deposition as Exhibit 1037 in this proceeding.

<sup>&</sup>lt;sup>1</sup> The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA"), amended 35 U.S.C. §§ 102 and 103. Because the '062 patent has an effective filing date prior to the effective date of the applicable AIA amendments, we refer to the pre-AIA versions of §§ 102 and 103.

<sup>&</sup>lt;sup>2</sup> European Patent Application No. 0480538 A1 (Ex. 1002).

<sup>&</sup>lt;sup>3</sup> U.S. Patent Application Publication No. US 2003/0162984 A1 (Ex. 1003).

<sup>&</sup>lt;sup>4</sup> U.S. Patent No. 5,929,259 (Ex. 1004).

<sup>&</sup>lt;sup>5</sup> International Publication No. WO 97/40933 (Ex. 1005).

#### III. ANALYSIS

"In an [*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).

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 at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *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.<sup>6</sup> *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

To show obviousness, it is not enough to merely show that the prior art includes separate references covering each separate limitation in a

<sup>&</sup>lt;sup>6</sup> The parties have not asserted or otherwise directed our attention to any objective evidence of non-obviousness. *See* Tr. 58:16 (counsel for Patent Owner stating that "[w]e have not made an unexpected results argument here").

challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). "This is so because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR*, 550 U.S. at 418–419.

On the other hand, an obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." KSR, 550 U.S. at 418; accord In re Translogic Tech., Inc., 504 F.3d 1249, 1259 (Fed. Cir. 2007). However, 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). Instead, a petitioner must articulate a reason why a person of ordinary skill in the art would have combined or modified the prior art references. In re NuVasive, Inc., 842 F.3d 1376, 1382 (Fed. Cir. 2016); see also Metalcraft of Mayville, Inc. v. The Toro Co., 848 F.3d 1358, 1366 (Fed. Cir. 2017) ("In determining whether there would have been a motivation to combine prior art references to arrive at the claimed invention, it is insufficient to simply conclude the combination would have been obvious without identifying any reason why a person of skill in the art would have made the combination."); Belden Inc. v. Berk-Tek LLC, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.") (citing InTouch Techs., Inc. v. VGO *Commc'ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014)).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

A. Claim Construction

We apply the claim construction standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b) (2021). Under *Phillips*, claim terms are afforded "their ordinary and customary meaning." *Phillips*, 415 F.3d at 1312. The "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. Only terms that are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Neither party proposes an express construction for any claim terms. Pet. 10; *see generally* PO Resp. On this record, we determine that no claim terms require express construction.

B. Level of Ordinary Skill in the Art

In the Petition, Petitioner asserts 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. 11 (citing Ex. 1014 ¶¶ 12–14). In response, Patent Owner argues that the '062 patent relates to catalyst carriers and a process for preparing catalyst carriers, and argues that "[a]lthough it is possible that a person 'with five or more years of experience in the catalyst field' may have experience with catalyst carriers, nothing in Petitioner's definition requires it." PO Resp. 15–16. Accordingly, Patent Owner asserts 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 *carrier* field." PO Resp. 16 (citing Ex. 2006 ¶ 90). In its Reply, Petitioner states that "[t]he claims of the '062 patent would be unpatentable under either Petitioner or [Patent Owner's] definition, and to the extent [Patent Owner's] definition requires more expertise with carriers, Petitioner accepts that definition." Reply 2–3.

In light of the record before us, we adopt Patent Owner's proposal regarding the level of ordinary skill in the art because it is acceptable to both parties, and is consistent with the disclosures of the applied prior art references and the '062 patent. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

C. Claims 1–10, 16–18, and 23–29 – Obviousness in view of Lockemeyer and Liu

Petitioner argues that claims 1–10, 16–18, and 23–29 are unpatentable as obvious in view of Lockemeyer and Liu. Pet. 1, 41–60; Reply 3–8, 18–24. Patent Owner disputes Petitioner's contentions. PO Resp. 16–35; Sur-reply 5–23.

1. Lockemeyer (Ex. 1003)

Lockemeyer is a patent 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" in which "pores with diameters in the range of from 0.2 to 10  $\mu$ 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). Lockemeyer also states

that it is "a common expedient to use a bond material, i.e. a material which reduces the length of sintering time applied to bond the particles together, and it is preferred to employ such bond material when practicing this invention." Ex. 1003 ¶ 35. Lockemeyer includes examples illustrating the preparation of carriers and lists certain properties for each carrier, including surface area, pore volume, and pore size distribution (sometimes referred to herein as "PSD"). Ex. 1003 ¶¶ 95–110, Table I. Table I of Lockemeyer is reproduced below.

					Pore size distribution	
Carrier	Surface	Water	Pore	<0.2	0.2–	>10
	area	absorption	volume	µm	10 µm	µm
	(m <sup>2</sup> /g)	(g/g)	(ml/g)	(% v)	(% v; ml/g)	(% 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

TABLE I

\*)comparative

Table I of Lockemeyer shows properties for Carriers A–C prepared according to Lockemeyer, and comparative Carrier D.

According to Lockemeyer:

The present invention teaches that the picture with respect to carrier surface area is significantly more complicated than was at first appreciated since 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. 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.

Ex. 1003 ¶ 5.

# 2. Liu (Ex. 1002)

Liu is a publication titled "Alkylene oxide catalysts having enhanced activity and/or stability," and 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." Ex. 1002, code (54), 2:3–5.

Liu explains that "[a]s with any catalyst for making ethylene oxide which provides optimum performance, a correlation exists among many factors," including, *inter alia*, "the nature of the support." Ex. 1002, 9:7–9. Liu further explains that "the optimal performance will depend upon optimizing the carrier in terms of its chemical composition (including impurities), surface area, porosity and pore volume." Ex. 1002, 10:49–50.

Liu provides data on eleven examples to demonstrate improvements in a catalyst's activity and/or efficiency and/or stability. Ex. 1002, 17:40– 25:18. Liu's data on Carriers S, T, and V is reproduced below, beginning with data on Carrier S.

Physical Properties of Carrier S

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

Pore Size Distribution, % Total Pore Volume

Pore Size Microns	% Total Pore Volume
P <sub>1</sub> (<0.1)	0.5
P <sub>2</sub> (0.1-0.5) P <sub>3</sub> (0.5-1.0)	9.5
P <sub>4</sub> (1.0-10)	81
P <sub>5</sub> (10-100)	2
F6 (2100)	4

Ex. 1002, 18:32–55. The tables reproduced above set forth the physical properties of surface area, pore volume, packing density, and median pore diameter<sup>7</sup> 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. The physical properties table includes footnotes (1)–(4), which provide the methods of measurement. Ex. 1002, 20:35–41.

Data on Carrier T is reproduced below.

<sup>&</sup>lt;sup>7</sup> The reference to "medium pore diameter" in the tables for Carriers S and T appears to be a typographical error. We understand that "median pore diameter" is intended, consistent with the tables for Carriers N and V. Ex. 1002, 18:7, 20:20.

Physical Properties of Carrier T

Surface Area(1)	1.13 m <sup>2</sup> /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
P1 (<0.1)	0
P <sub>2</sub> (0.1-0.5)	1
P <sub>3</sub> (0.5-1.0)	4.5
P₄ (1.0-10)	90.5
P <sub>5</sub> (10-100)	1.5
P <sub>6</sub> (>100)	2.5

Ex. 1002, 19:17–38. The tables reproduced above set forth the properties of surface area, pore volume, packing density, and median 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.

Data on Carrier V is reproduced below.

Physical properties			
surface area (1)	1.16 m <sup>2</sup> /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 0.1-0.5 0.5-1.0 1.0-10 10-100 >100	0 1 5 88 2 4			

Ex. 1002, 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.

*3. Claim 1* 

# *a)* Whether Lockemeyer and Liu teach or suggest each limitation of claim 1

Claim 1 requires "[a] carrier comprising alumina and a bond material, said carrier comprising a surface area of at least  $1.3 \text{ m}^2/\text{g.}$ " Ex. 1001, 18:22–23. Petitioner argues that Lockemeyer discloses a carrier containing alumina and a bond material and that Lockemeyer discloses the surface area of its carriers is "at least  $1 \text{ m}^2/\text{g.}$ ... and more preferably from  $1.4-2.6 \text{ m}^2/\text{g.}$ " Pet. 51 (quoting Ex. 1003 ¶ 30; citing Ex. 1003 ¶¶ 44–45). Petitioner also notes that Carriers A, B, and C in Lockemeyer have surface areas of 2.04, 2.11, and 2.51 m<sup>2</sup>/g, respectively. Pet. 51 (citing Ex. 1003 ¶ 110, Table I). Patent Owner does not dispute Petitioner's arguments regarding these limitations. *See* PO Resp. 16–19; Sur-reply 5–19. Based on the undisputed evidence presented in the Petition, Petitioner has demonstrated persuasively that Lockemeyer discloses a carrier comprising alumina and a bond material, and comprising a surface area of at least 1.3 m<sup>2</sup>/g. Pet. 51; Ex. 1003 ¶¶ 30, 44, 45, 110, Table I.

Claim 1 next requires the carrier to have a median pore diameter of more than 0.8  $\mu$ m. Ex. 1001, 18:23–24. Petitioner argues that Carrier A of Lockemeyer has a median pore diameter of 2.2  $\mu$ m based on the disclosure in the '062 patent that (1) Carrier A of Lockemeyer was reproduced as Carrier D of the '062 patent, and (2) Carrier D has a median pore diameter of 2.2 μm. Pet. 41 (citing Ex. 1001, 14:21–24, Table I), 51; *see also* Reply 18 (arguing that it is undisputed that the '062 patent replicated carrier A of Lockemeyer as Carrier D and reports Carrier D has an MPD of 2.2 μm). Petitioner contends that this disclosure in the '062 patent regarding Lockemeyer constitutes an admission by Patent Owner which is binding for purposes of an obviousness inquiry. Reply 18 (citing *PharmaStem Therapeutics, Inc. v. ViaCell, Inc.*, 491 F.3d 1342, 1362 (Fed. Cir. 2007)). Petitioner also argues that Liu discloses carriers having a median pore diameter range of about 0.5 to 50 μm, and that Carriers S, T, and V of Liu have median pore diameters of 1.7, 2.1, and 2.3 μm, respectively. Pet. 51 (citing Ex. 1002, 9:57–58, 18:40, 19:24, 20:21).

Patent Owner contends that Lockemeyer does not disclose the median pore diameter limitation, and that it is improper for Petitioner to rely on the specification of the challenged patent to demonstrate that Lockemeyer discloses a limitation of the challenged claims. PO Resp. 18. According to Patent Owner, the '062 patent is "not saying that the Carrier A that is disclosed in Lockemeyer had this median pore diameter. It said there is a process disclosed in Lockemeyer for how to make a carrier." Tr. 30:8–10. Patent Owner further argues that "it is improper to rewrite the disclosure of Lockemeyer because a new carrier was made for comparative purposes and disclosed in the '062 patent." Tr. 30:16–18. Patent Owner does not challenge Petitioner's argument that Liu discloses carriers having a median pore diameter of more than 0.8 µm. *See* PO Resp. 16–19, 25–27; Sur-reply 5–19.

After considering the record developed during trial, we determine Petitioner has demonstrated persuasively that the teachings of Lockemeyer

and Liu disclose or suggest a carrier having a median pore diameter of more than 0.8 µm. Pet. 51; Ex. 1002, 9:57–58, 18:40, 19:24, 20:21. Petitioner correctly relies on statements in the '062 patent regarding Lockemeyer's Carrier A. Pet. 41, 51; Ex. 1001, 14:21–24, Table I; Reply 18. According to the Federal Circuit, "[a]dmissions in the specification regarding the prior art are binding on the patentee for purposes of a later inquiry into obviousness." PharmaStem, 491 F.3d at 1362; see also Qualcomm Inc. v. Apple Inc., 24 F.4th 1367, 1375–76 (Fed. Cir. 2022) (holding that "a patentee's admissions about the scope and content of the prior art provide a factual foundation as to what a skilled artisan would have known at the time of invention"); Koninklijke Philips N.V. v. Google LLC, 948 F.3d 1330, 1339 (Fed. Cir. 2020) ("[I]t is appropriate to rely on admissions in a patent's specification when assessing whether that patent's claims would have been obvious."); Constant v. Advanced Micro-Devices, Inc., 848 F.2d 1560, 1570 (Fed. Cir. 1988) ("A statement in the patent that something is in the prior art is binding on the applicant and patentee for determinations of anticipation and obviousness.").

Applying the case law to the facts of this case, we are persuaded that the statements in the '062 patent support Petitioner's assertion that Lockemeyer discloses or suggests a carrier having "a median pore diameter of more than 0.8 μm," as claim 1 requires. The '062 patent states that a carrier, Carrier D, was prepared "according to the process as described for 'Carrier A' in the Examples of US 2003/016298," which is Lockemeyer. Ex. 1001, 14:21–24. At the very least, these statements constitute an admission that Lockemeyer discloses a process for forming a carrier having a median pore diameter of 2.2 μm. Moreover, we discern no meaningful

dispute within Patent Owner's Response, Patent Owner's Sur-reply, or Dr. Carty's Declaration that the '062 patent's Carrier D replicates Carrier A of Lockemeyer. *See* PO Resp. 18; Ex. 2006 ¶¶ 200–203; *see generally* Surreply. Indeed, as Dr. Carty points out, during prosecution of the application leading to the '062 patent, Patent Owner characterized Carrier D as being *"disclosed as* carrier A in [Lockemeyer]." Ex. 2006 ¶ 134 (quoting Ex. 1018, 29) (emphasis added). Furthermore, we note that the water absorption and pore volume values reported for Carrier A in Lockemeyer and Carrier D in the '062 patent are identical, and the surface area values reported differ by only 0.04 m<sup>2</sup>/g. *See* Ex. 1001, Table I (col. 13–14); Ex. 1003 ¶ 110 (Table I). This supports a finding that, based on the statements in the '062 patent, a person of ordinary skill in the art would have understood Lockemeyer to disclose a carrier (Carrier A) having a median pore diameter greater than 0.8 µm.

Finally, to the extent Lockemeyer does not disclose this limitation, undisputed evidence establishes that Liu discloses a carrier having a median pore diameter of more than 0.8  $\mu$ m. Pet. 51; Ex. 1002, 9:57–58, 18:40, 19:24, 20:21.

Additionally, claim 1 requires that the carrier comprises "a total pore volume 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  $\mu$ m." Ex. 1001, 18:24–27. Petitioner asserts that Lockemeyer discloses its carriers have PSDs wherein pores with diameters from 0.2–10  $\mu$ m represent more than 75%, 80%, or 90% of the total pore volume. Pet. 51 (citing Ex. 1003 ¶ 26). In addition, Petitioner states that Carriers A and C of Lockemeyer have PSDs wherein at least 90% of the total pore volume is

contained in pores with diameters of  $0.2-10 \ \mu\text{m}$ . Pet. 42 (citing Ex. 1003 ¶ 110, Table I). According to Petitioner and Dr. Haller, "it follows mathematically that these carriers have a PSD wherein at least 80% of the total pore volume [is] contained in pores with diameters of  $0.1-10 \ \mu\text{m}$ ." Pet. 42 (citing Ex. 1014 ¶ 170). Patent Owner does not dispute that Lockemeyer discloses this limitation. *See* PO Resp. 16–19; Sur-reply 5–19. Based on the undisputed information presented in the Petition and Dr. Haller's Declaration, Petitioner has demonstrated persuasively that Lockemeyer discloses a carrier comprising "a total pore volume 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  $\mu$ m." Pet. 42, 51; Ex. 1003 ¶¶ 26, 110, Table I; Ex. 1014 ¶ 170.

Claim 1 additionally requires that "at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m is contained in pores with diameters in the range of from 0.3 to 10  $\mu$ m." Ex. 1001, 18:27–30 (sometimes referred to as the "range-within-a-range" limitation). Petitioner acknowledges that, although Lockemeyer does not expressly disclose the claimed 0.3 to 10  $\mu$ m range, Lockemeyer discloses a pore size distribution in the range of 0.2 to 10  $\mu$ m. Pet. 42 (referring to Lockemeyer's disclosure that at least 90% of the total pore volume is contained in pores with diameters of 0.2–10  $\mu$ m). Petitioner argues that Carriers S, T, and V of Liu have PSDs within the ranges taught by Lockemeyer and recited in claim 1 (Pet. 45, 51–52 (citing Ex. 1002, 18:33–55, 19:17–40, 20:15–34; Ex. 1014 ¶¶ 85–88, 182–183, 223)), and that Liu shows Carriers S, T, and V provide catalysts with good selectivity, activity, and stability (Pet. 46 (citing Ex. 1002, 6:1–2)).

Patent Owner contends that the information regarding Carriers S, T, and V in Liu is insufficient to teach a person of ordinary skill in the art to "implement the claimed PSD range-within-a-range limitation" because Liu is "devoid of any reference generally to a range within a range, let alone any emphasis on the importance of a range-within-a-range and minimizing the pore volume in certain ranges." PO Resp. 25–26 (citing Ex. 2006 ¶ 236).

We disagree with Patent Owner's argument and find that Petitioner shows persuasively that the teachings of Lockemeyer and Liu disclose or suggest a carrier that meets the range-within-a-range limitation of claim 1. Lockemeyer discloses carriers having more than 90% of the total pore volume within the range  $0.2-10 \mu m$ , which is close to the recited range of 0.3–10 µm. Ex. 1003 ¶¶ 26, 110, Table I (Carriers A and C). Liu discloses pore size distributions in which a pore size of  $0.5-1.0 \mu m$  corresponds to 9.5%, 4.5%, or 5% of the total pore volume, and a pore size of 1.0–10  $\mu$ m corresponds to 81%, 90.5%, or 88% of the total pore volume. Ex. 1002, 18:32–55, 19:17–38, 20:15–34 (data tables for Carriers S, T, and V, respectively). Both of these ranges fall within the recited range of  $0.3-10 \,\mu\text{m}$ . Although neither Lockemeyer nor Liu expressly refers to one pore size distribution range "nested" within another range, linguistic differences between the prior art and challenged patent are not fatal to a determination that the prior art discloses the subject matter recited in the claim. Dow Chem. Co. v. Astro-Valcour, Inc., 267 F.3d 1334, 1341 (Fed. Cir. 2001); see also Teva Pharm. Indus. Ltd. v. AstraZeneca Pharms. LP, 661 F.3d 1378, 1384 (Fed. Cir. 2011) (holding that a prior art inventor need

not "conceive of its invention using the same words as the patentee would later use to claim it").

We are persuaded by the analysis of Petitioner and Dr. Haller, who direct us to data in the "Pore Size Distribution, % Total Pore Volume" tables for Carriers S, T, and V in Liu, and use the information contained in these tables to demonstrate that for Carriers S, T, and V, at least 90% of the total pore volume is contained in pores with diameters from 0.5–10  $\mu$ m. Ex. 1001, 18:27–30; Pet. 18–19, 45, 51–52; Ex. 1002, 18:33–55, 19:17–40, 20:15–34; Ex. 1014 ¶¶ 85–88, 182–183, 223. For Liu's Carrier S, for example, Dr. Haller calculates that 93.5% of the pore volume has a pore diameter between 0.1 and 10  $\mu$ m. Ex. 1014 ¶ 85. Dr. Haller then uses the ratio of these numbers to determine the percent pore volume contained in 0.1–10  $\mu$ m diameter pores that is contained in 0.5–10  $\mu$ m diameter pores (i.e., 90.5/93.5 = 96.79%). Ex. 1014 ¶ 87. Based on calculations for Liu's Carrier S, T, and V, Dr. Haller concludes that since

1) at least 96% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m is contained in pores with diameters in the range of from 0.5 to 10  $\mu$ m, and 2) 0.5 to 10  $\mu$ m is within the range of 0.3 to 10  $\mu$ m, it follows that at least 96% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m is contained in pores with diameters in the range of from 0.3 to 10  $\mu$ m. This is just an issue of simple mathematics that a [person of ordinary skill in the art] would have readily understood in reading Liu.

Ex. 1014 ¶ 88. Patent Owner does not challenge these calculations. *See* PO Resp. 25–27; Sur-reply 5–19; Tr. 24:19–20 ("For Liu, I would agree that it does disclose mathematically the range within the range."). In view

of this, Petitioner has demonstrated persuasively that Liu discloses carriers wherein "at least 80% of the pore volume contained in the pores with diameters in the range of from 0.1 to 10  $\mu$ m is contained in pores with diameters in the range of from 0.3 to 10  $\mu$ m," as claim 1 requires.

After considering the parties' arguments and evidence, we determine Petitioner has demonstrated by a preponderance of evidence that Lockemeyer and Liu teach or suggest all of the limitations in claim 1.

Petitioner contends that a person of ordinary skill in the art would have been motivated to combine the teachings of Lockemeyer and Liu. Pet. 44–46; Reply 19–24. Patent Owner disagrees. PO Resp. 26–32; Surreply 5–18.

Petitioner states that Lockemeyer "discloses that '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 preparing carriers for catalysts with excellent activity, selectivity, prolonged retention of activity and stability level." Pet. 43 (quoting Ex. 1003 ¶ 5). Based on this, Petitioner argues that a person of ordinary skill in the art "would have been motivated to modify the PSD of carriers to optimize performance." Pet. 43 (citing Ex. 1014 ¶¶ 173–174).

Petitioner further contends that Liu teaches that the nature of the carrier is a factor that impacts "optimum performance" of the catalyst and that Carriers S, T, and V provide catalysts with good selectivity, activity, and stability. Pet. 45–46 (quoting Ex. 1002, 9:7–14; citing Ex. 1002, 6:1–2). Petitioner recognizes Liu states that the inclusion of cobalt can provide

*b)* Whether a person of ordinary skill in the art would have had a reason to combine the teachings of Lockemeyer and Liu

for increased activity and/or selectivity, but argues that a catalyst made from Carrier S, even without cobalt, achieves a selectivity greater than 85% and maintains it after 30 days, which is an indication of stability. Pet. 46 (citing Ex. 1002, 22:12–16; Ex. 1014 ¶ 189). Petitioner thus argues:

Given that Liu's carriers, like the carriers taught by Lockemeyer, are composed of at least 85% by weight of  $\alpha$ -alumina, have PSDs within the ranges taught by Lockemeyer, and are capable of achieving high selectivity, stability, and activity, a [person of ordinary skill in the art] would have been motivated to look to the teachings in Liu, e.g., the PSDs of Carriers S, T, or V, to modify the PSDs of Lockemeyer's carriers to obtain the claimed carriers and with a reasonable expectation of success.

Pet. 46–47 (citing Ex. 1014 ¶ 190); *see also* Pet. 16 (presenting a similar argument about motivation to modify Lockemeyer in view of Liu).

We find Petitioner's arguments to be persuasive. Lockemeyer states:

The present invention teaches that the picture with respect to carrier surface area is significantly more complicated than was at first appreciated since 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*. 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.

Ex. 1003 ¶ 5 (emphasis added). This language demonstrates a person of ordinary skill in the art would have understood the importance of carrier pore size distribution in achieving catalysts with excellent properties. *See* Pet. 45–46; Ex. 1014 ¶ 186. Thus, based on Lockemeyer's own teaching regarding the role of PSDs in preparing catalysts with excellent activity, selectivity, and prolonged retention of activity and stability level, we agree

with Petitioner that a person of ordinary skill in the art would have had reason to optimize the PSDs of Lockemeyer's carriers. *See* Pet. 43; Ex. 1014 ¶¶ 173–174. Furthermore, Liu's teachings (1) that the "nature of the carrier" is a factor that impacts "optimum performance" of the catalyst, (2) that Liu's Sample Carriers S, T, and V have PSDs falling within the ranges taught by Lockemeyer, and (3) that Carriers S, T, and V provide catalysts with good selectivity, activity, and stability, support Petitioner's argument that a person of ordinary skill in the art would have had reason to look to Liu to optimize the PSD within the ranges Lockemeyer teaches. Ex. 1002, 6:1–2, 9:7–14, 18:33–55, 19:17–40, 20:15–34, 21:10–22:16; Ex. 1014 ¶¶ 85–88, 182–183, 187–190, 223; Pet. 44–46.

Although Petitioner frames its argument in terms of motivation to "modify" the PSD of Lockemeyer's carriers to optimize their performance (Pet. 43), the record shows Liu's Carriers S, T, and V not only meet the range-within-a-range limitation, but also fall within the PSD range disclosed in Lockemeyer. Tr. 10:10–15, 24:14–20; Pet. 45, 51–52; Reply 18; Ex. 1002, 18:45–55, 19:27–38, 20:24–34; Ex. 1014 ¶¶ 85–88; Ex. 1038 ¶¶ 117–118. In other words, the PSD of Liu's Carriers S, T, and V are examples of a PSD that falls within the broader range disclosed by Lockemeyer. Petitioner shows persuasively that a person of ordinary skill in the art would have had a reason to choose the narrower PSD range disclosed in Liu in order to optimize the performance of the catalyst consistent with the teachings of both Lockemeyer and Liu. Pet. 43–46; Reply 19–24; Ex. 1002, 6:1–2, 9:7–14, 18:33–55, 19:17–40, 20:15–34, 21:10–22:16; Ex. 1014 ¶¶ 85–88, 173–174, 182–183, 186–190, 223.

To the extent Lockemeyer does not disclose the median pore diameter limitation in claim 1, Liu's teachings that (1) the "nature of the carrier" is a factor that impacts "optimum performance" of the catalyst, (2) Carriers S, T, and V provide catalysts with good selectivity, activity, and stability, and (3) the optimal performance of a catalyst depends on "optimizing the carrier in terms of its chemical composition . . . surface area, porosity, and pore volume," support Petitioner's argument that a person of ordinary skill in the art would have had reason to combine the teachings of Liu and Lockemeyer, including Liu's disclosure that Carrier's S, T, and V have median pore sizes greater than 0.8 μm. Ex. 1002, 6:1–2, 9:7–14, 18:33–55, 19:17–40, 20:15–34; 21:10–22:16; Ex. 1014 ¶¶ 85–88, 182–183, 187–190, 223; Pet. 45–46; Reply 22.

Patent Owner argues that a person of ordinary skill in the art would not have been motivated to combine the teachings of Lockemeyer with the teachings of Liu because it involves "the combination of two fundamentally different processes for forming two distinct types of carriers." PO Resp. 27. Patent Owner asserts that Lockemeyer discloses conventional carriers that have alpha-alumina as a starting material and contain bond materials, whereas Liu's Sample Carriers S, T, and V are fluoride FMA carriers that contain a fluorine component and do not contain bond materials. PO Resp. 9–10 (citing Ex. 1003 ¶¶ 33, 110; Ex. 2006 ¶¶ 143, 149–153), 12 (citing Ex. 1002, 18:15–19, 18:57–19:2, 19:46–51; Ex. 2006 ¶ 169), 29. Patent Owner contends that a person of ordinary skill in the art "would not have been motivated to combine the process of forming Lockemeyer's conventional carriers with the process of forming Liu's sample FMA carriers." PO Resp. 27–28.

Patent Owner's argument is unavailing, as Petitioner does not present an argument based on combining the *process* of forming Lockemeyer's conventional carriers with the process of forming Liu's FMA carriers. Reply 20; Pet. 44–46. To the contrary, Petitioner relies on Lockemeyer's disclosure of a conventional carrier that has a PSD that encompasses the claimed PSD ranges and Lockemeyer's disclosure of a process for making the carrier that is virtually identical to the process disclosed in the '062 patent. Pet. 41–44. Petitioner relies on Liu for its disclosure of carriers having PSDs falling within the ranges taught by Lockemeyer. Pet. 41–46. As discussed above, Petitioner shows persuasively that a person of ordinary skill in the art would have had a reason to optimize the PSD of Lockemeyer's carriers to meet the range-within-a-range limitation. Petitioner also shows that such optimization would have been achieved by following the general process disclosed in Lockemeyer. Pet. 42–44; Ex. 1014 ¶¶ 173–178; Ex. 1003 ¶¶ 36–40, 51–55; Ex. 1001, 6:12–22, 14:5– 7.

Additionally, Petitioner presents evidence, including testimony from both Dr. Carty and Dr. Haller, that a person of ordinary skill in the art would have expected carriers having the same parameters, such as PSD, to have similar performance results, regardless of the process used to prepare the carrier. Reply 4 (citing Ex. 1037, 26:20–27:3, 28:18–24, 123:20–124:3; Ex. 1038 ¶¶ 16, 110). This evidence supports Petitioner's arguments regarding the combination of Lockemeyer and Liu, and contradicts Patent Owner's argument that a person of ordinary skill in the art "would not have been motivated to combine references describing carriers formed by these fundamentally different processes." Sur-reply 10.

Patent Owner also argues that the '062 patent Specification undermines any motivation to combine. PO Resp. 28. Patent Owner bases this argument on statements in the '062 patent regarding differences in the *processes* used to make the different carriers, and how those differences can result in carriers having distinct morphologies, which "impacts the physical characteristics of the carrier, such as surface area, [PSD] and particle size." PO Resp. 28 (quoting Ex. 1001, 1:26–2:17; citing Ex. 2006 ¶¶ 246–250). For the same reasons discussed above, namely because Petitioner does not rely on the combination of different processes for forming carriers, we find this argument to be unavailing.

Additionally, Patent Owner argues that the difference in starting materials for FMA carriers (whose starting materials do not contain a bond material) and conventional carriers (whose starting materials contain a bond material) would dissuade a person of ordinary skill in the art from combining Liu's carriers with Lockemeyer's carriers. PO Resp. 29. In particular, Patent Owner argues that a person of ordinary skill in the art "would recognize that adding a bond material to [Liu's] Carriers STV would serve no purpose and could potentially cause 'aggressive reactions' with the fluorine component in Carriers STV." PO Resp. 29. Our determination, however, is not premised on adding a bond material to Liu's carriers. See Reply 21 ("It is undisputed that Lockemeyer—the primary reference—already discloses a 'conventional' carrier *containing a bond material.*" (citing Ex. 1003 ¶¶ 35, 39, 43, 44; Ex. 1038 ¶ 124)). Instead, we determine that it would have been obvious to optimize the PSD of Lockemeyer's carriers, which contain a bond material, to meet the rangewithin-a-range limitation.

Patent Owner also contends that Petitioner's arguments regarding a reason to combine the teachings of Lockemeyer and Liu are "riddled with hindsight bias." PO Resp. 30. As explained above, however, Petitioner has directed us to evidence within the prior art references themselves that support Petitioner's assertion that a person of ordinary skill in the art would have had reason to consider implementing Liu's teachings in combination with Lockemeyer. *See In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971) (holding that, to some extent, any obviousness determination is "necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure, such a reconstruction is proper").

Patent Owner also argues that Liu "does not teach a person of ordinary skill in the art anything about the PSD range, let alone direct a person of ordinary skill in the art to narrow the ranges of PSDs." PO Resp. 30. Patent Owner first contends that "Liu explicitly attributes any 'high selectivity' to the presence of cobalt in its catalyst," and therefore a person of ordinary skill in the art would not attribute any high selectivity to the PSD range of the carriers. PO Resp. 30–31 (quoting Ex. 1002, 22:12–16); Sur-reply 10, 13 (arguing that "Liu never describes the importance or impact of the PSD on performance" (emphasis omitted)).

Patent Owner's argument here stems from Liu's discussion of Examples 1–3. PO Resp. 30–31; Ex. 1002, 21:11–22:16. It is undisputed that Examples 1–3 of Liu comprise Carrier S. PO Resp. 31; Pet. 46; Ex. 1002, 21:14–15. Liu states that cobalt-containing catalysts in Examples

2 and 3 provide increased activity and efficiency compared to the non-cobalt containing catalyst used in Example 1, and explains that "the inclusion of cobalt in the catalyst can provide for increased activity and/or increased efficiency." Ex. 1002, 22:12–16. Patent Owner's argument, however, does not squarely address Petitioner's showing that Liu's Example 1 (without cobalt) shows a selectivity greater than 85%, which is higher than the selectivity reported for the catalysts in Lockemeyer. Ex. 1002, 22:3–14; Ex. 1003 ¶¶ 125–126 (Table II); Ex. 1014 ¶ 188. We agree with Petitioner and Dr. Haller that this demonstrates that Liu's Carrier S itself, cobalt notwithstanding, plays a role in achieving the properties of the catalyst made from Liu's Carrier S. Ex. 1014 ¶ 189.

Patent Owner next contends that "any argument that Liu would improve the Lockemeyer carriers is misguided," because Liu and Lockemeyer report selectivity for different time periods and different performance conditions (e.g., temperatures), such that a person of ordinary skill in the art "would not have directly compared the selectivity of the carriers in Liu and Lockemeyer to come to any conclusion that the catalysts in Liu showed increased selectivity over the catalysts in Lockemeyer." PO Resp. 31–32. Additionally, Dr. Carty states that "[b]ecause of the difference in measurement conditions, a [person of ordinary skill in the art] would not have looked to Liu and determined that the catalysts in Liu exhibited higher selectivity than the catalysts in Lockemeyer." Ex. 2006 ¶ 272.

Petitioner's declarant, however, states that a person of ordinary skill is not "an automaton incapable of drawing conclusions or inferences without absolute identity of testing parameters" and "would not be so

limited in thinking." Ex. 1038 ¶ 133. Petitioner's declarant provides ample reasoning that one of ordinary skill in the art would have been motivated to compare the selectivity of the carriers despite the testing parameters' differences. Ex. 1038 ¶¶ 134–137 (citing Ex. 1003 ¶¶ 5, 125–126; Ex. 1014 ¶ 188; Ex. 1002, 22:3–14; Ex. 1045, 139:19–144:7). Because we agree that "[a] person of ordinary skill . . . not an automaton," and we find the supporting evidence and testimony credible, we are persuaded by Petitioner's argument that a person of ordinary skill in the art would have considered the selectivity data for Carrier S in Example 1 even without "absolute identity of testing parameters." Pet. 46; Reply 22–23; *KSR*, 550 U.S. at 421; Ex. 1038 ¶ 133.

Nevertheless, even if we were to agree with Patent Owner's argument that a person of ordinary skill in the art would not have directly compared the selectivity information in Liu and Lockemeyer, the outcome here would not change because comparative selectivity is not the sole reason for combining the references' teachings. Petitioner asserts that Liu's Example 1 shows that catalysts made from Carrier S demonstrate high stability. Pet. 46; Reply 22; Ex. 1038 ¶ 131; Ex. 1002, 22:3–14. Petitioner states that Lockemeyer discloses only initial selectivity, and "does not report any stability performance data, despite its assertion that the catalysts exhibit long term stability." Reply 23 ("The '062 patent itself states that Lockemeyer 'does not contain teachings relevant to the stability of the catalysts."" (quoting Ex. 1001, 3:37–41)). Dr. Haller provides unrebutted testimony that a person of ordinary skill in the art "would have strong motivation to investigate carriers having the PSD of Liu's Carrier S, given the stability performance data." Ex. 1038 ¶ 135; *see also* Pet. 46 (referring

to the stability of Carrier S); Ex. 1014 ¶ 188 (same). Patent Owner does not address these arguments. *See generally* Sur-reply. We are persuaded by Petitioner's argument that "[s]uch outstanding performance in selectivity and *long-term* stability reported in Liu would have motivated a [person of ordinary skill in the art] to look to the PSD of Carrier S." Reply 23; Ex. 1038 ¶¶ 135–137.

For all of the foregoing reasons, we find Petitioner has demonstrated, by a preponderance of evidence, that a person of ordinary skill in the art would have had reason to combine the teachings of Liu and Lockemeyer.

# c) Whether a person of ordinary skill in the art would have had a reasonable expectation of success in arriving at the claimed invention

Petitioner contends that a person of ordinary skill in the art would have had a reasonable expectation of success in using Liu to direct the PSD ranges of Lockemeyer to arrive at the claimed invention. *See* Pet. 45–47; Reply 25. Patent Owner disagrees. PO Resp. 32–35; Sur-reply 18–23.

Petitioner argues that Lockemeyer discloses carriers having PSDs wherein pores with diameters from 0.2–10 µm represent more than 75%, 80%, or 90% of the total pore volume and a process for making the carrier. Pet. 42, 51 (citing Ex. 1003 ¶ 26). Petitioner further argues that Lockemeyer invites a person of ordinary skill in the art to investigate PSD within its disclosed range. Reply 22 (citing Ex. 1003 ¶ 5; Ex. 1014 ¶¶ 173– 174). Petitioner also argues that "the process the '062 patent describes for making the claimed carriers essentially replicates Lockemeyer's process." Pet. 43; *see also* Pet. 44 (noting that "the '062 patent specifically references Lockemeyer's procedure for making the carriers of the purported invention" (citing Ex. 1001, 14:5–7)). In view of this, Petitioner contends that

obtaining PSDs wherein at least 80% of the pore volume contained in the pores with diameters from 0.1–10  $\mu$ m is contained in pores with diameters from 0.3–10  $\mu$ m, based on Lockemeyer, would have been a matter of routine experimentation and design choices. Pet. 43–44; Ex. 1014 ¶¶ 173–174, 180. As an example, Petitioner presents Dr. Haller's testimony that a person of ordinary skill in the art would have understood that "in making a carrier, the appropriate sizes of the  $\alpha$ -alumina particles in the mixture are dictated by the final desired porosity and average pore size for the carrier." Pet. 44 n.4 (citing Ex. 1014 ¶ 179; Ex. 1005, 6:13–23); *see also* Reply 7 (asserting that the prior art "explains that controlling pore sizes (which controls surface area) is mainly achieved by simply selecting the right sizes for the starting particles" (citing Ex. 2006 ¶ 43; Ex. 1038 ¶¶ 78, 96–100; Ex. 1029, 4:3–15; Ex. 1003 ¶¶ 5, 41; Ex. 1004, 4:1–18; Ex. 2031, 217–218, 232; Ex. 1042, 4:6–7; Ex. 1005, 6:13–23, 6:34–7:4)).

Petitioner's arguments, based primarily on Lockemeyer, are persuasive. It is undisputed that Lockemeyer expressly discloses a carrier having nearly all of the properties recited in claim 1, including a pore size distribution wherein at least 80% of the total pore volume is contained in pores with diameters from 0.1–10 µm. *See* Pet. 51–52; PO Resp. 16–19. It is also undisputed that Lockemeyer discloses a procedure for making such carriers that is nearly identical to the process disclosed in the '062 patent. Pet. 41–43; PO Resp. 16–19. We also agree with Petitioner that Lockemeyer "invites a [person of ordinary skill in the art] to investigate PSD within its range," based on Lockemeyer's disclosure that pore size distribution has been found to play a significant role in developing carriers with excellent properties. Reply 22; Ex. 1003 ¶ 5. In view of the fact that

Lockemeyer discloses essentially the same process as disclosed in the '062 patent and almost the same carrier properties as are recited in claim 1, we credit Dr. Haller's testimony that a person of ordinary skill in the art would have had a reasonable expectation of success in modifying the PSDs of Lockemeyer to arrive at the claimed invention. Ex. 1014 ¶ 180; *see also* Ex. 1014 ¶¶ 175–179 (addressing similarities between Lockemeyer's process and the process described in the '062 patent), 190 (testifying that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the teachings of Liu and Lockemeyer).

Patent Owner asserts that Petitioner fails to explain why a person of ordinary skill in the art would have had a reasonable expectation of success in modifying only one variable of the Lockemeyer carriers based on the teachings of Liu. PO Resp. 32-34. Patent Owner argues that "[t]here are at least four variables—surface area, PSD, pore volume, and median pore diameter-that must be accounted for in making any changes to Lockemeyer to arrive at the claimed carrier." PO Resp. 22. Patent Owner contends that the chemical arts-including processes involving catalyst carriers—are considered to be unpredictable, and that Petitioner fails to address the interdependency of these variables in an unpredictable art. PO Resp. 22; see also PO Resp. 32-33 ("Petitioner's argument stems from modifying the PSD ranges of Lockemeyer-which Lockemeyer teaches 'play a significant role'— without adjusting other claimed variables such as the surface area."), 34 (arguing that the prior art recognized the unpredictable nature of carrier art). Patent Owner contends that Lockemeyer recognizes that altering carrier characteristics is "inherently difficult," and argues that the Petition does not contain any discussion as to

how a person of ordinary skill in the art could control the interdependent variables and still reach the claimed invention. PO Resp. 23–24.

Patent Owner's arguments are undermined by the undisputed fact that Lockemeyer's disclosed process for making a carrier is essentially the same as the process disclosed in the '062 patent. Pet. 43; Ex. 1014 ¶¶ 175–179; Ex. 1003 ¶¶ 36–40, 51–56; Ex. 1001, 6:12–22, 13:35–14:21. If a person of ordinary skill in the art would have been able to achieve a carrier having the claimed surface area, PSD, pore volume, and median pore diameter using the process disclosed in the '062 patent, then the same is true for Lockemeyer. Furthermore, a person of ordinary skill in the art would have had a reasonable expectation of successfully achieving the claimed invention based on Petitioner's combination of Lockemeyer and Liu because, as discussed above, the PSD of Liu's Carriers S, T, and V falls within (and is only slightly narrower than) the range disclosed in Lockemeyer.<sup>8</sup>

Although Lockemeyer does state that "carrier surface area is significantly more complicated than was at first appreciated," it also states that "it was possible to prepare olefin epoxidation catalysts with excellent activity, selectivity and unusually prolonged retention of the activity and stability level." Ex. 1003 ¶ 5. Thus, to the extent Lockemeyer does recognize that "altering carrier characteristics is inherently difficult" (PO Resp. 23), it also discloses that it successfully accounted for the interdependent nature of carrier variables such as pore size distribution and

<sup>&</sup>lt;sup>8</sup> Additionally, it is undisputed that Lockemeyer teaches a process for forming a carrier having a median pore diameter greater than 0.8  $\mu$ m. Ex. 1001, 14:21–24, Table I; *see* Reply 18.

pore volume, and produced carriers having parameters falling within or close to the claimed ranges with excellent properties. Ex. 1003 ¶¶ 6, 30, 32, 50, 110.

Additionally, Petitioner directs us to examples from the prior art demonstrating that a person of ordinary skill in the art would have known how to make carriers with various ranges of surface areas, pore diameters, and PSDs. Reply 6-7 (citing Ex. 1002, 3:6-15, 9:37-10:40; Ex. 1003 ¶¶ 26–32; Ex. 1004, 4:1–18, 4:51–61; Ex. 1016, 12:29–13:39). For example, according to Petitioner, "Liu teaches that surface area can range from about  $0.1-3 \text{ m}^2/\text{g}$ , and that 'practice of the invention requires experimental efforts' but a [person of ordinary skill in the art] 'can readily achieve the optimum performances of the catalysts of this invention." Reply 8 (quoting Ex. 1002, 9:21–26, 9:47–49; citing Ex. 1014 ¶ 82; Ex. 1038 ¶ 77). This disclosure supports Petitioner's assertion and Dr. Haller's testimony that a person of ordinary skill in the art would have been able to achieve various options within the ranges described in Liu and Lockemeyer with normal experimentation and routine optimization. Reply 8; Ex. 1014 ¶ 82; Ex. 1038 ¶¶ 77, 95–105; see also Soft Gel Techs., Inc. v. Jarrow Formulas, Inc., 864 F.3d 1334, 1342 (Fed. Cir. 2017) (holding that "absolute predictability" is not the correct legal standard for obviousness). Similarly, Dr. Carty testified that "[m]odification of the pore size distribution, the pore volume, and then the surface area" would "have been expected at the time [of the invention] to be routine experimentation." Ex. 1037, 227:18–24.

Petitioner also directs us to evidence in Liu that contradicts Patent Owner's assertion that the interdependency of the claimed parameters

would mean that modifying one parameter would result in other claimed parameters falling outside the claimed range. PO Resp. 23. In particular, Petitioner explains that Liu demonstrates that when the surface area is increased from 1.13 (Carrier T) to  $1.24 \text{ m}^2/\text{g}$  (Carrier S)—an increase of  $0.11 \text{ m}^2/\text{g}$ , the PSD changes little and remains within the claimed ranges. Ex. 1038 ¶¶ 54–55; Ex. 1002, 18:14–19:39; *see also* Reply 5–8.

Lockemeyer's teachings also undermine Patent Owner's arguments regarding unpredictability. Patent Owner cites several cases referring to the unpredictability of chemical arts and catalytic processes in general.<sup>9</sup> According to the Federal Circuit, however, the "case law is clear that obviousness 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, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1364 (Fed. Cir. 2007); *see also In re Corkill,* 771 F.2d 1496, 1500 (Fed. Cir. 1985) ("Although [the inventor] declared that it cannot be predicted how any candidate will work in a detergent composition, but that it must be tested, this does not overcome [the prior art's] teaching that hydrated zeolites will work."). Here, Lockemeyer's recognition of the interdependency of variables and disclosure of successfully preparing carriers with excellent properties (Ex. 1003 ¶ 5) outweighs Patent Owner's assertions regarding the unpredictable nature of the chemical arts and catalysts in general.

<sup>&</sup>lt;sup>9</sup> Petitioner cites the following cases in support of this assertion: *Anacor Pharma, Inc. v. Iancu,* 889 F.3d 1372, 1385 (Fed. Cir. 2018); *Asahi Glass Co. v. Guardian Indus. Corp.,* 886 F. Supp. 2d 369, 391 (D. Del. 2012); *Vanderbilt Univ. v. ICOS Corp.,* 594 F. Supp. 2d 482, 507 (D. Del. 2009); *Standard Oil Co. v. Montedison, S.p.A,* 494 F. Supp. 370, 433 (D. Del. 1980); and *Application of Angstadt,* 537 F.2d 498, 502 (C.C.P.A. 1976).

We reach the same conclusion with regard to Patent Owner's unpredictability arguments based on Lockemeyer-II (Ex. 1004) and Kowaleski (Ex. 1005). PO Resp. 34; Sur-reply 20. Patent Owner contends these references support its argument because they state that "[t]he problem is that usually an increase in one can mean a reduction in another property. ... Often the balance is achieved by trial and error making the catalyst carrier art even more unpredictable than other chemical process art." PO Resp. 34 (quoting Ex. 1004, 1:43–47; Ex. 1005, 2:6–11). Patent Owner, however, acknowledges this statement refers to high water absorption and crush strength, not any of the claimed variables. PO Resp. 34. Lockemeyer, on the other hand, addresses the claimed variables, and suggests the opposite. Ex. 1003 ¶ 5.

Patent Owner also contends that a person of ordinary skill in the art would not have modified the PSD of a carrier after it was formed, but instead would have to modify the PSD of the carrier at the beginning of the formation process to attempt to reach the claimed PSD. PO Resp. 24 (citing Ex. 2006 ¶¶ 225–227). According to Patent Owner, "the petition is devoid of any explanation of how a [person of ordinary skill in the art] would have modified the variables impacting carrier performance with any reasonable expectation of doing so successfully." PO Resp. 24. As discussed above, however, Petitioner shows persuasively that a person of ordinary skill in the art would have understood that "in making a carrier, the appropriate sizes of the α-alumina particles in the mixture are dictated by the final desired porosity and average pore size for the carrier." Pet. 44 n.4 (citing Ex. 1014 ¶ 179; Ex. 1005, 6:13–23). Petitioner presents similarly persuasive arguments in its Reply. *See* Reply 7 (asserting that the prior art "explains

that controlling pore sizes (which controls surface area) is mainly achieved by simply selecting the right sizes for the starting particles").

For all of the foregoing reasons, we determine that Petitioner has demonstrated by a preponderance of evidence that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the teachings of Lockemeyer and Liu to arrive at the claimed invention.

## d) Conclusion

After considering the full record developed during this proceeding, we determine that Petitioner has demonstrated by a preponderance of evidence that claim 1 is unpatentable as obvious in view of Lockemeyer and Liu.

#### 4. Claims 2–10, 16–18, and 23–29

Petitioner identifies where it believes every element of dependent claims 2–10, 16–18, and 23–28, and independent claim 29 is found in the combined teachings of Lockemeyer and Liu. Pet. 52–60. Patent Owner does not separately address these claims, and relies on the same arguments discussed above regarding Lockemeyer and Liu. PO Resp. 16–35.

We have reviewed the undisputed evidence and arguments Petitioner presents in the Petition regarding these claims, including the relevant portions of the supporting Haller Declarations, and, based on that information, determine Petitioner has demonstrated by a preponderance of evidence that Lockemeyer and Liu disclose all of the limitations recited in claims 2–10, 16–18, and 23–29. Pet. 52–60; Ex. 1002, 9:57–58, 18:40, 18:45–55, 19:24, 19:27–38, 20:21, 20:24–34; Ex. 1003 ¶¶ 3, 26, 29, 30–32, 35–39, 43, 44, 46, 48, 50–57, 110; Ex. 1014 ¶¶ 117–118, 172–212, 227–230, 232–251, 253–254, 259–261, 263–266, 269. Additionally, for the

reasons discussed above, we determine Petitioner has demonstrated by a preponderance of evidence that a person of ordinary skill in the art would have had reason to combine the teachings of Lockemeyer and Liu to arrive at the claimed invention, and would have had a reasonable expectation of success. Accordingly, we determine Petitioner has demonstrated by a preponderance of evidence that claims 2–10, 16–18, and 23–29 are unpatentable as obvious in view of Lockemeyer and Liu.

- D. Claims 11–15 and 19–22 Alleged Obviousness in view of Lockemeyer, Liu, Lockemeyer-II, and Kowaleski
  - 1. Lockemeyer-II (Ex. 1004)

Lockemeyer-II is a patent titled "Preparation of Ethylene Oxide and Catalyst," and is directed to a process for preparing an alpha-alumina ethylene oxide catalyst. Ex. 1004, codes (45), (57). Lockemeyer-II states that its carrier preferably contains ceramic bond materials, such as silica and alkaline earth metal oxides. Ex. 1004, 4:62–67. According to Lockemeyer-II, catalysts prepared using its alpha-alumina based carrier have "improved initial activity and/or selectivity." Ex. 1004, 2:18–20.

2. Kowaleski (Ex. 1005)

Kowaleski is a publication titled "Epoxidation Catalyst and Process," and is directed to catalysts for the preparation of ethylene oxide that "comprise a catalytically effective amount of silver and a promoting amount of alkali metal supported on an alpha alumina-based catalyst carrier produced by a novel production method which does not require the presence of pore-inducing burnout materials." Ex. 1005, code (54), 1:1–6, 3:29–34. Kowaleski discloses that magnesium compounds, such as

magnesium silicate, can be used to prepare catalyst carriers. Ex. 7:31–35, 8:3–17, 10:3–10.

#### 3. Analysis

Petitioner identifies where it believes every element of dependent claims 11–15 and 19–22 is found in the combined disclosures of Lockemeyer, Liu, Lockemeyer-II, and Kowaleski. Pet. 61–66. Patent Owner does not separately dispute Petitioner's contentions that the combined disclosures of Lockemeyer, Liu, Lockemeyer-II, and Kowaleski teach or suggest all of the limitations in claims 11–15 and 19–22. *See* PO Resp. 35–38; Reply 25. Instead, Patent Owner argues that these claims depend from claim 1, and "Petitioner neglected to explain why this particular combination of art renders claim 1 obvious." PO Resp. 35.

For the reasons discussed in Section III.C.3, *supra*, we determine Petitioner has demonstrated by a preponderance of evidence that claim 1 is unpatentable as obvious in view of Lockemeyer and Liu. We have reviewed the undisputed evidence and arguments Petitioner presents in the Petition regarding dependent claims 11–15 and 19–22, including the relevant portions of the supporting Haller Declarations, and, based on that information, determine Petitioner has demonstrated by a preponderance of evidence that Lockemeyer, Liu, Lockemeyer-II, and Kowaleski disclose or suggest all of the limitations recited in claims 11–15 and 19–22. Pet. 61– 66; Ex. 1002, 9:38–41; Ex. 1003 ¶¶ 32, 44, 50; Ex. 1004, 1:51–64, 2:3–20, 2:30–31, 3:14–18, 4:62–5:8, 8:3–29, 9:11–20, 10:3–6, 15:33–40, 16:11– 12; Ex. 1005, 1:1–4, 3:13–20, 7:31–9:10, 10:13–18, 10:23–34, 11:24–34, 21:30–33, 22:19–23, 22:32–23:3; Ex. 1014 ¶¶ 270–288.

In addition to relying on its arguments regarding the combination of Lockemeyer and Liu, Petitioner argues that a person of ordinary skill in the art would have been motivated to combine Lockemeyer and Liu with Kowaleski and Lockemeyer-II because these references teach that "the claimed features were conventional in the art or conferred certain advantages to the carriers." Pet. 61 (citing Ex. 1014 ¶¶ 270–288); *see also* Pet. 62 (explaining that Kowaleski teaches that it is desirable to use calcium or magnesium silicate as bond materials (citing Ex. 1005, 8:9–17, 10:3–15; Ex. 1014 ¶¶ 275–276)), 64 (explaining that Kowaleski teaches that zirconia confers an advantage to carriers because it "appears to stabilize certain partial oxidation catalyst recipes" (citing Ex. 1005, 10:16–18; Ex. 1014 ¶ 283)), 65 (explaining that Lockemeyer-II indicates that titania has been found to greatly improve certain physical properties of carriers (citing Ex. 1004, 1:51–64; Ex. 1014 ¶ 286)).

Patent Owner does not dispute these teachings in Lockemeyer-II and Kowaleski. Rather, Patent Owner argues only that Petitioner "neglects to explain why a [person of ordinary skill in the art] would be motivated to combine all four of these references to reach the claimed invention," or why a person of ordinary skill in the art "would have had a reasonable expectation of success in modifying the variables in the prior art references to arrive at the claimed invention." PO Resp. 35. Patent Owner relies on the same arguments here as it did in responding to Petitioner's challenge of claim 1. For example, Patent Owner asserts that Liu discloses an FMA carrier, whereas Lockemeyer, Lockemeyer-II, and Kowaleski disclose conventional carriers, and argues that a person of ordinary skill in the art would not have been motivated to combine these references because they

are directed to "fundamentally different processes of forming distinct catalyst carriers." PO Resp. 36. Patent Owner also argues that

For the same reasons discussed [above], given the interdependency of the variables and unpredictability of catalyst carrier art, a [person of ordinary skill in the art] would not have had a reasonable expectation of success in modifying the variables of the carriers described in Lockemeyer with the teachings of Liu, Lockemeyer-II, and Kowaleski. The addition of Lockemeyer-II and Kowaleski do not cure the deficiencies articulated [above].

#### PO Resp. 37.

After reviewing the parties' evidence and arguments regarding these claims, including the relevant portions of the supporting Haller Declarations, we determine Petitioner has demonstrated by a preponderance of evidence that a person of ordinary skill in the art would have had reason to combine the disclosures of Lockemeyer with the teachings of Liu, Lockemeyer-II, and Kowaleski to arrive at the claimed invention, with a reasonable expectation of success. For the reasons discussed above with regard to claim 1 (*see supra* Section III.C.3), we are persuaded by Petitioner's arguments and evidence regarding the combination of Lockemeyer and Liu. We are likewise persuaded by Petitioner's largely undisputed evidence and arguments regarding reasons to combine Lockemeyer-II and Kowaleski. We have considered Patent Owner's arguments challenging Petitioner's combination of prior art references, which are the same as those presented above for claim 1, and for the same reasons given above, do not find them persuasive.

For all of the foregoing reasons, we determine Petitioner has demonstrated by a preponderance of evidence that claims 11–15 and 19–22

are unpatentable as obvious in view of the combined disclosures of Lockemeyer, Liu, Lockemeyer-II, and Kowaleski.

E. Remaining Unpatentability Challenges

Having determined that Petitioner establishes by a preponderance of the evidence that claims 1–10, 16–18, and 23–29 are unpatentable as obvious in view of Lockemeyer and Liu, and claims 11–15 and 19–22 are unpatentable as obvious in view of the combined disclosures of Lockemeyer, Liu, Lockemeyer-II, and Kowaleski, we do not address Petitioner's additional grounds challenging claims 1–29. *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.").

# IV. CONCLUSION

After reviewing the complete record developed during the course of the trial, we conclude that Petitioner has satisfied its burden of demonstrating, by a preponderance of the evidence, that claims 1–29 of the '062 patent are unpatentable.<sup>10</sup>

<sup>&</sup>lt;sup>10</sup> 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

# V. ORDER

It is hereby

ORDERED that, Petitioner established by a preponderance of evidence that claims 1–29 of the '062 patent are unpatentable; and

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

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–5, 8, 10, 16, 17, 23–27	102/103	Liu <sup>11</sup>		
28	103	Liu		
6–10, 16–18	103	Liu, Lockemeyer		
29	103	Liu, Lockemeyer- II		
1–10, 16–18, 23–29	103	Lockemeyer, Liu	1–10, 16–18, 23–29	

such related matters in updated mandatory notices. See 37 C.F.R.  $\S$  42.8(a)(3), (b)(2).

<sup>&</sup>lt;sup>11</sup> As explained above, we do not reach this ground, or the remaining grounds with Liu listed as the first reference, in view of our determination that the challenged claims are unpatentable as obvious in view of Lockemeyer and Liu, or Lockemeyer, Liu, Lockemeyer-II, and Kowaleski.

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
11–15, 19–22	103	Lockemeyer, Liu, Lockemeyer- II, Kowaleski	11–15, 19–22	
Overall Outcome			1–29	

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