

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Symrise AG and Symrise Inc.,
Petitioner,

v.

Inolex Investment Corp.,
Patent Owner

IPR2023-01035
U.S. Patent No. 10,995,048

SECOND DECLARATION OF DOUGLASS F. TABER

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I, Dr. Douglass F. Taber, declare as follows:

I. INTRODUCTION

1. I have been retained on behalf of Symrise AG and Symrise Inc. (collectively “Petitioner”) in connection with the above captioned *Inter Partes* Review (IPR) of U.S. Patent No. 10,995,048 (’048 Patent). I have been asked to study and provide my opinions as an independent expert witness regarding technology described in the ’048 Patent. I am being compensated at my usual and customary rate for my time. Such compensation, however, does not influence my opinion nor does the outcome of this proceeding impact my compensation.

2. I have carried out research in organic chemistry and taught graduate and undergraduate classes on organic chemistry, including organic reaction mechanisms, throughout my 40-year career. I have published more than 200 research articles. In 2023, 72 of those articles were cited by other research groups, 24 of them more than once. I am the author of the weekly online scientific publication, *Organic Synthesis Highlights*, used by research groups all around the world.

3. I have conducted research and published scholarly papers on the preparation and reactions of alkenes, alcohols, epoxides, and esters. These have included the dehydration of alcohols to the corresponding alkenes with the control of regioselectivity. In fact, I published a new protocol for the conversion of a 1-

alkene to the corresponding 1-epoxide. Throughout my career I have routinely used the conversion of an epoxide to the corresponding 1,2-diol. I maintain a database of the most important organic chemical transformations, which currently contains more than 60,000 entries, any one of which I can access in minutes.

4. A copy of my *curriculum vitae* is attached as Appendix A. It includes a list of testimony I have provided in other legal proceedings, an outline of my research experience, and a list of my publications.

II. MATERIALS REVIEWED

5. In forming my opinions provided in this declaration, I have read and considered the items listed in the table below. I have also relied on my education, knowledge, and experience in organic chemical synthesis.

Document Reviewed	
1.	U.S. Patent No. 10,995,048 (“ the ’048 Patent ”) and the corresponding prosecution history of U.S. Application No. 16/682,059
2.	U.S. Patent Publication No. 2011/0196114 (“ Le ”)
3.	WIPO Publication WO 03/024910 (“ De Bruyn ”)
4.	U.S. Patent No. 10,894,750 (“ Vecchini ”)
5.	WIPO Publication WO 2004/078336 (“ Ziehe ”)
6.	U.S. Patent No. 8,173,850 (“ Furuya ”)
7.	W.G. Appleby <i>et al.</i> “Vapor Phase Dehydration of 1-Heptanol over Activated Alumina,” J. AM. CHEM. SOC. 66: 1938-1939, 1944 (“ Appleby ”)

Document Reviewed	
8.	V. I. Komarewsky <i>et al.</i> “Catalytic Dehydration of 1-Hexanol and 1-Octanol,” J. AM. CHEM. SOC. 67: 557-558, 1945 (“ Komarewsky ”)
9.	L. G. Wade, Jr. Organic Chemistry (8 th Ed. 2013) (“ Wade ”)
10.	Daniel Swern <i>et al.</i> “Hydroxylation and Epoxidation of Some 1-Olefins with Per-acids,” J. AM. CHEM. SOC. 68, 1504-1507, 1946 (“ Swern ”)
11.	Kuladip Sarma <i>et al.</i> “Rapid 1,2-dihydroxylation of alkenes using a lipase and hydrogen peroxide under microwave conditions,” TETRAHEDRON LETTERS 48 (2007) 6776-6778 (“ Sarma ”)
12.	Azhong Wang <i>et al.</i> “Palladium-Catalyzed Diacetoxylation of Alkenes with Molecular Oxygen as Sole Oxidant,” J. AM. CHEM. SOC. 131: 3486, 2009 (“ Wang ”)
13.	William E. Fristad and John R. Peterson “Iron(III) Catalyzed Persulfate Oxidation of Alkenes to Vicinal Diacetates,” TETRAHEDRON LETT. 24: 4547-4550, 1983 (“ Fristad ”)
14.	Chi-Ming Ho <i>et al.</i> “Ruthenium Nanoparticles Supported on Hydroxyapatite as an Efficient and Recyclable Catalyst for cis-Dihydroxylation and Oxidative Cleavage of Alkenes,” ANGEW. CHEM. INT. ED. 43:3303-3307, 2004 (“ Ho ”)
15.	Isao Sakurada <i>et al.</i> “Dichlorotin oxide-catalyzed new direct functionalization of olefins: synthesis of trans β -azidohydrins and 1,2-diols,” TETRAHEDRON LETT. 41: 2415-2418, 2000 (“ Sakurada ”)
16.	Wolfgang A. Herrmann <i>et al.</i> “Methyltrioxoruthenium as Catalyst for Olefin Oxidation,” ANGEW. CHEM. INT. ED. 30:1638-1641, 1991 (“ Herrmann ”)
17.	David R. Williams <i>et al.</i> “Total Synthesis of (-)-Ratjadone,” ORG. LETT. 3: 1383, 2001 (“ Williams ”)

Document Reviewed	
18.	Waldemar Adam and Lluís Blancafort “ <i>Steric and Stereoelectronic Control of the Mode of Selectivity as a Function of Alkene Structure in the Reaction with Dimethyl α-Peroxy Lactone: Cycloadducts and Ene Products versus Epoxides</i> ,” J. AM. CHEM. SOC. 118: 4778-4787, 1996 (“ Adam ”)
19.	N. Miyaura and J. K. Kochi “ <i>Chromyl Complexes in the Direct Epoxidation of Alkenes</i> ,” J. AM. CHEM. SOC. 105: 2368-2378, 1983 (“ Miyaura ”)
20.	W. E. Schiegl and J. C. Vogel “ <i>Deuterium Content of Organic Matter</i> ,” EARTH AND PLANETARY SCIENCE LETTERS 7:303-313, 1970 (“ Schiegl ”)
21.	Harmon Craig, “ <i>Standard for Reporting Concentrations of Deuterium and Oxygen-18 in Natural Waters</i> ,” SCIENCE 133: 1833-1834, 1961 (“ Craig ”)
22.	U.S. Patent No. 9,029,619 (“ Vermeiren ”)
23.	U.S. Patent No. 9,908,837 (“ Colby ”)
24.	U.S. Patent No. 8,765,430 (“ Parek ”)
25.	U.S. Patent No. 8,597,922 (“ Alibhai ”)
26.	JAOCS Vol. 62, No. 2, 355-365 (1985) (“ Reck ”)
27.	JAOCS Vol. 61, No. 2, 343-347 (1984) (“ Kreutzer ”)
28.	N.P Makgoba et al “ <i>Silication of γ-alumina catalyst during the dehydration of linear primary alcohols</i> ,” Applied Catalysis A: General 297 (2006) 145-150 (“ Makgoba ”)
29.	U.S. Patent No. 7,795,484 (“ Koulisalmi ”)
30.	WO 2001/044145 (“ Tiitta ”)
31.	U.S. Patent No. 4,234,752 (“ Wu ”)
32.	German Patent DE3915493 (“ Voeste ”) (translation)

Document Reviewed	
33.	EP 2 990 395 B1 to (“ Takamura ”)
34.	WIPO Publication WO 2015/130451 (“ Wright ’451 ”)
35.	Sivaraj Chokkaram <i>et al.</i> “ <i>Conversion of 2-octanol over nickel-alumina, cobalt-alumina, and alumina catalysts,</i> ” Journal of Molecular Catalysis A: Chemical 121:157-169, 1997 (“ Chokkaram ”)
36.	G. G. Cortez <i>et al.</i> “Study of the Poisoning of γ -Al ₂ O ₃ by Alkali Metals Addition,” J. Chem. Tech. Biotechnol., 53:177-180, 1992 (“ Cortez ”)
37.	P. Berteau and B. Belmon “ <i>Modified Aluminas : Relationship Between Activity in 1-Butanol Dehydration and Acidity Measured by NH₃ TPD,</i> ” Catalysis Today, 5:121-137, 1989 (“ Berteau ”)
38.	Deposition Testimony of Michael E. Wright, Ph.D (“ Wright Deposition ”)

III. SUMMARY OF MY OPINIONS

6. I understand the following table summarizes the grounds of challenge (“Grounds”) raised in the Petition:

Ground	Prior Art	Basis	Challenged Claims
1	No Written Description Support	§112	29-44
2	Le in view of De Bruyn	§103	29-44
3	Wright ‘788	§103	29-44
4	Wright ‘451	§103	29-44
5	Wu in view of Chokkaram	§103	29-44

7. After a review of the ’048 Patent, the Substitute Claims, and the prior art, it is my opinion that the Substitute Claims are invalid under the proposed

Grounds. My opinions, and the bases for my opinions, are detailed throughout this Declaration.

IV. LEGAL PRINCIPLES

8. I am not an attorney and will not be offering legal conclusions. However, I have been informed of several principles concerning legal issues relevant to my analysis of the Challenges to the claims of the '048 Patent, and I relied on these principles to arrive at my conclusions.

9. I understand a claim is anticipated if all limitations are found in a single prior art reference, arranged as in the claim. The identical invention must be shown in as complete detail as is contained in the patent claim.

10. I understand a prior art reference can disclose an element not expressly identified in a reference if the element is “inherently present” in the reference. To be “inherent,” I understand the missing element must necessarily be present in the reference. An element is not “inherent” if the missing element is only probably present or if there is merely a possibility it is present.

11. I understand a claim is invalid as obvious under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time of the patent’s filing date to a Person of Ordinary Skill in The Art (POSITA). It is my understanding that the following factors are used to determine

whether or not the claimed subject matter would have been obvious: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the field of the invention; and (iv) any relevant objective considerations of non-obviousness.

12. I understand a party asserting obviousness based on a combination of prior art references must demonstrate that one of ordinary skill in the art would have been motivated to combine the teachings of those references to achieve the claimed invention with a reasonable expectation of success. It is my understanding that it is not sufficient to show that one of ordinary skill in the art *could* combine elements of multiple references. Instead, there must be a rational reason that would have prompted a POSITA to combine the elements in the way the claimed invention does; and the reason should be explained or articulated.

13. I understand a combination of references would not have been obvious if the alleged modification(s) to be made to the reference(s) are inconsistent with the stated goals of the reference(s). I understand a combination of references would not have been obvious if the modification of the reference(s) to derive what is claimed would render the reference(s) unsatisfactory or inoperable for their intended purpose. I further understand the party asserting obviousness must explain why a POSITA would have selected components for combination in the manner claimed.

14. It is my further understanding that an invention would not have necessarily been obvious simply because all the elements of the invention may have been known separately in the prior art; there must be a reason to combine the separately known elements. Obviousness cannot be based on a hindsight combination of components selectively picked from the art using the claims as guide.

A. Level of Ordinary Skill in the Art

15. I understand that certain issues in an IPR, such as claim construction and whether a claim is invalid as obvious, are assessed from the view of a hypothetical POSITA at the time of the invention. I understand there are multiple factors relevant to determining the level of ordinary skill in the art, including: (1) the level of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems

16. I reiterate my view that based on my experience and knowledge, I believe a hypothetical POSITA with regard to the '048 Patent is someone having a bachelor's degree and two or more years of experience or a master's degree in organic synthesis or chemical engineering, with education substituting for experience and *vice versa*.

B. Priority of '048 Patent

17. The '048 Patent claims priority to a chain of applications originating with U.S. provisional application no. 62/623,985, filed on January 20, 2018 (Priority Date). *See* the '048 Patent.

C. Claim Construction

18. I understand claim construction in an IPR proceeding is a legal question for the Patent Trial and Appeal Board (PTAB or Board). In general, I understand the Board construes claim terms according to their ordinary and customary meaning, as understood by a POSITA, in the context of the patent at the time of the Priority Date.

19. I also understand that when construing claim terms, the Board looks to what claim terms would mean to a POSITA in the relevant art in view of the plain language of the claim, the description in the patent, and the prosecution history of the patent. The Board may also consider extrinsic evidence, such as dictionaries; however, the descriptions in the patent and prosecution history carry more weight than extrinsic evidence.

1. “Calcined”

20. Dr. Wright states that “calcined” is “heating to a sufficient temperature that chemical changes result into the catalyst itself.” Ex. 2001 at ¶19. It is my opinion that calcined should be interpreted to include “sufficient heating

to complete the chemical change to the catalyst”. This is in line with Dr. Wright’s Declaration and the specification of the ’048 patent. ’048 Patent at 17:27-37.

2. “Silanized”

21. Dr. Wright testified that “silanized” requires an affirmative step during the catalyst preparation. Wright Deposition at 23:14-24:2. I agree and it is my opinion that silanization requires an affirmative step in catalyst preparation. The “catalyst has not been silanized” means there was “no affirmative step taken to silanize the catalyst”.

V. BACKGROUND

22. Reading the prior art identified in the table above, the POSITA would understand the importance of catalyst preparation –“the surface activity of gamma-alumina available from some sources can be different from that of others”. Wu at 2:25-27. It is my understanding that γ -alumina can have some particularly acidic sites that are especially active for isomerizing the initially-produced alkene. By passivating such sites, alkene isomerization can be reduced. The POSITA would understand from Wu that such particularly active sites can be passivated by treating the γ -alumina with base, including sodium hydroxide or potassium hydroxide. Wu at 2:25-36. A POSITA would be motivated to reduce alkene isomerization to deliver the 1-alkene with high regioselectivity. A POSITA would be motivated to assess the literature and determine what other bases had

been employed for passivation of the γ -alumina, and investigate those for which promising results were reported.

23. The POSITA would also understand from Wu that after base treatment, the base treated γ -alumina should be dried before use. Wu at 2:25-36. A POSITA would understand that the drying step is to remove excess solvent and/or water prior to calcination.

24. A POSITA would understand from Chokkaram that calcination of γ -alumina delivers an active catalyst with conversion of at least 95% of longer chain 1-alcohols. Combining this with Wu, the POSITA would be motivated to treat the γ -alumina with base and dry that product and then calcine it to create an active catalyst that would improve the conversion of Wu to at least 95% conversion while maintaining the minimal tendency towards alkene isomerization. *See e.g.*, Cortez; and Takamura. The POSITA would understand that the purpose of calcination is to effect a chemical change in the treated γ -alumina.

25. The POSITA would know from Chokkaram that optimization of the calcination temperature was important, as lower temperatures are not effective and higher temperatures can lead to unwanted changes in γ -alumina structure. Chokkaram at 3. Results and discussion. Chokkaram teaches that optimal temperature for calcination is in the range of 673K-773K (400-500 °C). Chokkaram teaches that calcination at 973K (700 °C) is too high.

26. Berteau would teach the POSITA that treated γ -alumina catalysts could be calcined at 823 K (550 °C). Berteau at 123, Experimental. A POSITA reviewing the teachings of Berteau with the teachings of Chokkaram would be motivated to try calcination temperatures in the range of 400-550 °C. Takamura also teaches the POSITA that following salt addition, e.g., calcium phosphate, and drying, calcination should optimally be carried out between 400 °C and 550 °C. Takamura at [0052], [0057]. Takamura also teaches optimal calcining time of 2-4 hours. Takamura at [0063]. Following these parameters a POSITA would expect to achieve 1-alcohol conversion of at least 95% with less than 1% alkene isomerization.

27. The POSITA would understand that the alcohol dehydration should be carried out at elevated temperature, e.g., 200 °C -500 °C, optimally 300 °C-450 °C. *See e.g.*, Wu at 2:51-54; Berteau at 124-126.

28. A POSITA would understand that the conversion of the 1-alcohol to the desired 1-alkene can exceed 98%. *See e.g.*, Takamura at [0081]. A POSITA would also understand that by conversion to the desired 1-alkene exceeding 98%, the regioselectivity also exceeds 98%.

VI. CLAIMS 29-44 ARE NOT SUPPORTED BY THE '048 SPECIFICATION

29. It is my understanding that 35 USC §112(a) states “The specification shall contain a written description of the invention,…”

30. I have been informed that “to satisfy §112, a patent's written description ‘must ‘clearly allow persons of ordinary skill in the art to recognize that [the inventor] invented what is claimed.’” *Novozymes v. DuPont Nutrition Biosciences APS*, 723 F.3d 1336, 1346 (Fed. Cir. 2013) (internal citations omitted). I have also been informed that “There are, however, a few broad principles that hold true across all cases. ... the specification itself that must demonstrate possession. And while the description requirement does not demand any particular form of disclosure, or that the specification recite the claimed invention in haec verba, a description that merely renders the invention obvious does not satisfy the requirement.” *Ariad Pharms., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1352 (Fed. Cir. 2010) (internal citations omitted).

31. It is my opinion that the Patent Owner has failed to identify support in the originally filed application or current specification that demonstrates they possessed the invention as claimed in the Substitute Claims.

A. Claim 29: “Base-Treated and Calcined”

32. The specification of the '048 patent does not indicate that the Patent Owner had possession of calcined and then base-treated γ -alumina catalysts that achieve at least 95% conversion and a 92-99% regioselectivity. While the '048 patent provides 5 separate examples, none of those examples involve a γ -alumina catalyst that has been calcined and then base-treated, which after base-treatment

achieves at least 95% conversion of alcohol and a 92-99% regioselectivity to the 1-alkene. '048 Patent at 26:40-29:42. Even outside of the examples, in each embodiment described in the specification, the γ -alumina catalyst is first treated with a base to create a "second catalyst". *See e.g.*, '048 Patent at 15:45-49. The "second catalyst" is then calcined to create a "third catalyst". *See e.g.*, '048 Patent at 15:50-58, 16:4-22. No embodiments are described or examples provided where the catalyst is calcined and then base-treated and achieves at least 95% conversion and a 92-99% regioselectivity. Finally, I agree with Dr. Wright, when asked if a catalyst was calcined and then base-treated, how would that impact the dehydration reaction, he stated "That's a good question. I don't know." Wright Deposition at 20:6-10. It is my opinion that a POSITA reviewing the '048 patent would not be able to prepare a catalyst that is first calcined, then treated with a base, and achieves at least 95% conversion and a 92-99% regioselectivity. Accordingly, it is my opinion that Dr. Wright did not possess this catalyst, and a catalyst that is calcined and then base-treated is not supported by the '048 specification.

33. In my opinion, a POSITA would understand that an example of ordered claims includes the originally filed claims 11, 13, and 15. Original Claim 11 states "The method according to claim 1, wherein the catalyst is a γ -alumina catalyst is treated with a base to form a modified γ -alumina catalyst." Original

Claim 13 states “The method according to claim 11, wherein the γ -alumina catalyst is treated with a calcium promoter to provide a modified γ -alumina catalyst.” Original Claim 14 states “The method according to claim 13, wherein the modified γ -alumina catalyst is calcined to provide a calcined γ -alumina catalyst.”

34. Because there is no disclosure of a catalyst preparation that is currently claimed, it is my opinion that Patent Owner did not possess a calcined and then base treated γ -alumina catalyst that achieves at least 95% conversion and a 92-99% regioselectivity.

B. Claim 29: “Base-Treated”

35. A POSITA would not understand, based on the specification of the '048 patent, that Patent Owner possessed all base-treated γ -alumina catalysts, that achieve at least 95% conversion and a 92-99% regioselectivity. The '048 specification states that “[t]he catalyst may be a γ -alumina catalyst treated with a base to form a modified γ -alumina catalyst.” '048 Patent at 8:33-34. A POSITA would understand “base” to mean a substance that can accept protons. The '048 specification also mentions that the base can include “a Group I or Group II metal”. However, there is still no explanation provided that would indicate to a POSITA that Patent Owner possessed all γ -alumina catalysts that are treated with any Group I or Group II metals. Instead, the '048 patent merely provides a

statement that the catalyst can be treated with a base, and the base can be a Group I or Group II metal. '048 at 8:32-36. While this provides a list of possible treatments for a γ -alumina catalyst, it does not, in my opinion, signify possession of all bases, Group I metals, or Group II metals, for use in treating a γ -alumina catalyst.

36. In my opinion, the only discussion that a POSITA would understand to be a “treatment” that is described in the '048 patent involves using calcium acetate. '048 at 16:5-8. This discussion of calcium acetate does not signify to a POSITA that the Patent Owner possessed more than a calcium acetate treatment. The '048 does not explain to a POSITA how to treat the γ -alumina catalyst with any other Group I or Group II metals, or how to treat them and achieve at least 95% conversion and a 92-99% regioselectivity. Instead, a POSITA would be forced to run experiments and try each base separately. Wright Deposition at 141:11-142:22 (“...depending on the alcohol, depending on the promoter, one would have to investigate that and find out if there is a correlation or if a promoter is even a promoter that promotes selectivity and reaction....”).

37. A POSITA would be required to undertake experimentation because the outcomes of a dehydration reaction with different bases is unpredictable based on the disclosure of the '048 patent. Wright Deposition at 42:2-22, 43:18-44:15, 139:2-20, 144:18-145:14. A POSITA's best way to determine if a γ -alumina

catalyst discussed by the '048 patent that is treated with a specific Group I or Group II metal would achieve the claimed conversion and regioselectivity is to run the experiments. Without experimental results, it is not known if a base-treated and calcined catalyst discussed by the '048 patent will work to achieve a specific conversion or a specific regioselectivity. Due to the lack of disclosure in the '048 patent, for every base considered, a POSITA would need to determine the weight percent of the modifier, if the modifier is a promoter, dehydration temperature, calcination temperature, flow rate, and catalyst activity, amongst other reaction variables. For example, I agree with Dr. Wright when he was asked "So would you, based on the experiments provided [i]n the '048 patent, would you be able to extrapolate that beyond calcium to other promoters?"

Dr. Wright answered:

Oh, I think, much like my previous patents and other patents in the area, you would think the other base-type promoters would work. Would they work as well as the calcium? I would not want to have to predict that.

If I was, again, working at a company as a POSITA, I walk into my boss' office. He says, hey, I want you to use this promoter. It's not the calcium that we're using, but I want to obtain every bit of yield in conversion and selectivity. If it doesn't work, you're fired. I would be looking for another job pretty quick. I wouldn't be convinced that I could produce it with barium.

You might, but you might not.

Wright Deposition at 144:22-145:13. Based on the '048 specification, a POSITA is unable to predict if a similar Group II metal, barium, would modify a catalyst to achieve the conversion and regioselectivity provided in the '048 patent's experimental section. With a single Group II salt, calcium acetate, included in the Examples, a POSITA would not know if they could make a catalyst using some other calcium salt, a different Group II metal, or a Group I metal. Because there is no guidance in the '048 specification to determine what bases would be promoters and, therefore, improve conversion and selectivity, a POSITA would not understand Patent Owner to possess every base-treated γ -alumina catalyst that achieves the claimed conversion and regioselectivity.

38. Instead of support for all Group I and Group II bases, the specification only lists three specific bases: calcium acetate, sodium hydroxide, and potassium hydroxide. '048 patent at 16:5-8. While the '048 patent lists sodium hydroxide and potassium hydroxide it provides no further details to allow a POSITA to understand the amount of either base that is needed or the weight percent of the sodium or potassium in the final catalyst that would lead to at least 95% conversion of a 1-alcohol and a 92-99% regioselectivity to the 1-alkene.

39. The Substitute Claims identify a problem with many solutions, but only provides information on one of those many solutions. It is my opinion that

Patent Owner did not possess all “base-treated and calcined γ -alumina catalyst, wherein the catalyst has not been silanized” by identifying one possible solution in calcium acetate.

40. The specification only discusses modifying the catalyst with calcium acetate and the weight percentage of calcium in the modified catalyst after calcination. '048 Patent at 16:5-29. However, there is no indication that the '048 patent ever considered other bases that involve calcium. A POSITA reading the '048 patent would not know if e.g., calcium hydroxide, calcium carbonate, calcium phosphate, etc., can be used to treat and/or modify the γ -alumina catalyst and achieve at least 95% conversion of a 1-alcohol and a 92-99% regioselectivity to the 1-alkene as presently claimed.

41. Even within the discussion of calcium acetate, a POSITA would understand the '048 specification to only provide results for a γ -alumina catalyst with 1.5 weight percent CaO after calcination. '048 Patent at 27:12-19. The specification mentions weight percentages from 0.01% up to 4%. A POSITA would not understand Patent Owner to have possession of a catalyst with 0.01 weight percent or 4.0 weight percent CaO after calcination that achieves at least 95% conversion of a 1-alcohol and a 92-99% regioselectivity to the 1-alkene as presently claimed. Dr. Wright admits that 0.01 weight percent calcium would most likely not promote a γ -alumina catalyst. Wright Deposition at 140:16-20; see

also 139:1-140:15. By failing to describe more than a single species of a base that includes calcium, the specification has not shown that Patent Owner possessed a catalyst that includes all calcium compounds or a genus of all γ -aluminas with a Group I or a Group II metal salt and then calcined.

42. There are many ways to describe a catalyst, its preparation, and activity levels to achieve specific outcomes. The specification would need to explain what γ -alumina was used, pore size and distribution, distribution of acid sites, salts and solvents for the promoters used, etc. *See e.g.*, Takamura. The '048 patent fails to utilize any of these tools to explain to a POSITA a broader scope than a specific implementation in an Example.

43. The '048 specification provides little to no physical or reactivity data associated with its γ -alumina catalyst. The '048 patent says the “catalyst used may be prepared by treating γ -alumina (e.g., Porocel ® CatGuard®) with at least one base, preferably a promoter, such as with sodium hydroxide, potassium hydroxide, calcium acetate and the like to create a second catalyst.” '048 Patent at 15:45-49. The specification provides one embodiment, where the γ -alumina powder has a surface area of about 50 to about 400 m²/g. '048 Patent at 17:13-14. Then in the Examples, Example 4, states that it uses “Porocel ® CatGuard®” but no details of which CatGuard catalyst is chosen or why a specific CatGuard catalyst was chosen. In Examples 1, 2, and 10 there is no specific catalyst

mentioned, just that it is a γ -alumina powder, providing no way for a POSITA reading the Specification to understand what the characteristics of the underlying γ -alumina catalyst are or how to predict which γ -alumina works to achieve the results claimed.

44. A POSITA is left to discover specific calcination temperatures, reaction temperatures, weight percentages, flow rates, pore size, pore distribution, alterations of the reaction conditions based on the amount of calcium, and alterations of the reaction based on the alcohol chosen, among others. By claiming a reaction outcome, i.e., conversion and regioselectivity, instead of a process for making a catalyst for a dehydration reaction, it is my opinion that the claims exceed the support provided in the '048 specification.

VII. SUBSTITUTE CLAIMS 29-44 ARE OBVIOUS OVER THE PRIOR ART OF RECORD

45. The Petition applied three prior art references, Le, De Bruyn, and Wright '788. In my opinion, Le, De Bruyn, and Wright '788 are all material to and render obvious the Substitute Claims

A. Le and De Bruyn render claims 29-44 Obvious

46. A POSITA would understand Le teaches that “According to a first version of the invention, a basic catalyst, for example a barium-doped γ -alumina, is used to further increase the selectivity of the dehydration.” Le at [0064]. A POSITA would understand that barium is a Group II metal, and that it can be used

to modify a commercially available γ -alumina such as the ESM 110 taught by Le. Further, the regioselectivity of greater than 95% 1-heptene, in the disclosed example, is further supported by the products of the polymerization reaction. As Dr. Wright notes, a POSITA would understand that the polymerization reaction would not involve the alkene impurities, but only the 1-alkene. Ex. 2001 at ¶46 (stating that 2-and/or 3-alkene isomers could be removed following polymerization). However, Le provides the polymerization reaction data to the POSITA, which allows the POSITA to determine inputs to the reaction. For example, [0184] of Le provides the composition of the inlet to the polymerization reactor after separation of the polymer products and recycling the non-reacted products. Based on Dr. Wright's statement of how this polymerization would proceed, if there was a measurable amount of any 2- and/or 3-heptene in the mixture, it would be listed in the Table. However, even though it measures hydrogen at the ppm concentration, there is no 2-heptene listed. Le at [0184]. Further, Le knew how to measure the alkene impurities, as demonstrated when the 2-alcohol is used, they found 1- and 2-alkene produced. Le at [0109]. So, a POSITA would understand both that the 2-heptene was not measurably present even with Le looking for this byproduct.

47. De Bruyn teaches a POSITA at least 95% conversion of the 1-alcohol because it teaches that 94% of the 1-hexanol is converted to alkenes which means

the overall conversion must have been at least 95%, because there are always additional byproducts created during a dehydration reaction. De Bruyn also teaches a POSITA that the regioselectivity to 1-alkenes is greater than 92%. De Bruyn provides a direct experiment on point that discloses the conversion and regioselectivity claimed.

48. Dr. Wright disagrees with the explicit teachings of the document in a footnote in his Declaration. *See e.g.*, Ex. 2001 at FN 1 on page 20. However, in my opinion a POSITA would be able to recreate Example 3 of De Bruyn. In Example 3, De Bruyn provides the reactor type and size, vertical pipe reactor 400 mm in length and 25.4 mm ID, amount of γ -alumina catalyst, 12 grams, reaction temperature, 315 C, feed content and speed, 98% 1-hexanol at LHSV of 5 hr⁻¹, recycle mass ratio, 0.75:2.0, to create the 94% conversion to 1-alkenes and 97.5% regioselectivity to 1-alkene. De Bruyn at [0053]; *see also* Takamura. This information is sufficient to allow a POSITA to recreate Example 3, and with the disclosed catalyst and a recycle stream, a POSITA would expect to achieve the results taught by Example 3.

49. While Dr. Wright indicates that he thinks Examples 4 and 5 are more reproducible, it is my opinion that all three examples are reproducible, and by recycling the unreacted 1-alcohol and the dihexyl ether, additional 1-alkenes will be produced, achieving the stated conversion. De Bruyn at [0053].

50. Le in view of De Bruyn specifically describes a γ -alumina catalyst that was prepared by calcium treatment and then calcination. De Bruyn explains that “dehydration processes are known and they are accordingly not discussed in any detail in this specification” and then states that the catalyst for dehydration can include “a promoted alumina catalyst e.g., $\text{CaO} \cdot \text{Al}_2\text{O}_3$, $\text{Ca}_2\text{O}_3 \cdot \text{Al}_2\text{O}_3$.” De Bruyn at [0037]. As Dr. Wright explains, such catalysts are the product of calcium salt treatment of the γ -alumina followed by drying and calcination. Wright Deposition at 116:4-18, 131:20-132:14. Therefore, a POSITA would understand that the calcium promoted catalysts taught by De Bruyn were prepared by calcium salt treatment of the γ -alumina followed by drying and calcination.

51. As De Bruyn states, such processes were “known” to a POSITA such that detailed explanation was not required. De Bruyn at [0037]. For example, widely known and used methods of base-treating a γ -alumina catalyst, including impregnation and deposition/precipitation, involve a standard calcination step after treatment. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]. Further, Dr. Wright testified that a POSITA would understand that standard calcination temperatures are around 200-600 °C. Wright Deposition at 19:14-19. I agree, these temperatures are also widely known and operated processes for creating a γ -alumina catalyst using a metal salt. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]. Accordingly, using one of the known methods, impregnation or

deposition, a POSITA could understand how to create both a barium-modified γ -alumina catalyst and a calcium modified γ -alumina catalyst. A POSITA would understand to chemically modify the treated γ -alumina they would calcine it at 200-600 °C. Wright '451 at [0067]; Chokkaram. Then using the modified and calcined γ -alumina catalyst in the dehydration reaction taught by Le and De Bruyn would result in at least 95% conversion and greater than 92% regioselectivity towards 1-alkenes.

52. It is also my opinion that Le in view of De Bruyn teaches the subject matter of each dependent claim, because it discusses creating bio-1-octene using a γ -alumina catalyst that is first base-treated and then calcined at 200-600 °C to achieve at least 95% conversion and greater than 95% regioselectivity of the bio-1-alkene. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]; Wright '451 at [0067]; Chokkaram. Accordingly, the subject matter of the independent claim and each dependent claim of the Substitute Claims is taught by Le in view of De Bruyn.

B. Wright '788 renders claims 29-44 obvious

53. A POSITA would understand that Wright '788 teaches all the elements of independent claim 29 and dependent claims 30-44 of the Substitute Claims. Patent Owner's argument that the examples of the '048 patent provide a distinction with Wright '788 is based on a summary of the examples from the '048

patent that is incomplete. For example, they state that “Experiments reported in the ’048 patent as Example 10 were conducted in which 1-octanol was dehydrated using a γ -alumina catalyst that was first treated with a base, dried, silanized, and then calcined at 400 °C.” PO MTA at 20. However, Experiment 10 actually has significantly more differences than the ones identified by Patent Owner.

54. For example, it is true that in Example 10, the catalyst is first treated with a base. However, the base is NaOH, not calcium acetate as the other Examples, and a POSITA would understand that Group I metals provide different results than Group II metals. ’048 Patent at 28:54-58; Wright Deposition at 108:8-109:1. Example 10 also does not provide a final weight percentage for the sodium in the catalyst. Example 10 provides data for calcination at 400 °C, whereas the other experiments that recite higher conversion and regioselectivity were calcined at 440 °C. ’048 Patent at 26:40-43, 28:63-64. Finally, the reaction was run at 325 °C instead of 315 °C. ’048 Patent at 26:40-43, 28:64-65. Accordingly, Patent Owner’s reliance on Ex. 2004 is misplaced, as it is also evidence that a catalyst calcined at 400 °C performs outside the scope of the Substitute Claims. Further, by altering so many variables between reactions, a POSITA would not consider Example 10 a true comparative example.

55. Further, I agree with Patent Owner when they state that Wright ’788 patent teaches all the elements of the Substitute Claims. Specifically, Patent

Owner writes “POSITA would have expected that a promoted and silanized γ -alumina catalyst would retain the high regioselectivity and conversion for 1-butanol disclosed by Wright for the dehydration of longer alcohols, such as 1-octanol [sic] with which the base-treated and silanized γ -alumina catalyst of Wright dehydrated 1-butanol.” PO MTA at 20-21. This is a statement about what the POSITA would have known at the time of filing the Application of the '048 patent and how they have a reasonable expectation of success for dehydrating bio-1-octanol using the catalyst of Wright '788. Further, a POSITA reading Wright '788 would understand that the disclosure does not require silanization, as there are embodiments that do not undergo silanization. Further, as discussed above, a POSITA would understand that 1-butanol would contain much more water in the feed than 1-octanol. So, using the embodiments of the Wright '788 patent that avoid silanization makes sense for longer alcohols like octanol. Finally, Dr. Wright testified in his Deposition that a POSITA understood that the advantage of silanization is on the order of maybe 1% for batch or shorter timeframe reactions. Wright Deposition at 130:4-14.

56. A POSITA would understand that bio-1-butanol contains more water than alcohols having longer chains, including bio-1-octanol. A POSITA would also understand that the excess water in the bio-1-butanol may have been deactivating the non-silanized γ -alumina catalyst. Silanization to protect the

catalyst from the excess water would not be as necessary when dehydrating alcohols having longer chains. Therefore, a POSITA would not go through the time and expense of silanizing the catalyst when dehydrating longer chain alcohols.

57. There appears to be some disagreement about an explicit calcination step in Wright '788. However, widely known and used methods of base-treating a γ -alumina catalyst, including impregnation and deposition/precipitation, involve a standard calcination step after treatment. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]. Further, Dr. Wright testified that a POSITA would understand that standard calcination temperatures are around 200-600 °C. Wright Deposition at 19:14-19. I agree, these temperatures are also widely known and operated processes to treat a γ -alumina catalyst using metal salt. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]. Accordingly, using one of the known methods, impregnation or deposition, a POSITA could create a sodium or potassium modified γ -alumina catalyst, and a POSITA would understand to chemically modify the sodium or potassium, calcination at 200-600 °C would be a standard process to undertake. Wright '451 at [0067]; Chokkaram. Then using the modified and calcined γ -alumina catalyst in the dehydration reaction taught by Wright '788 would result in at least 95% conversion and greater than 92% regioselectivity towards 1-alkenes.

58. It is also my opinion that Wright '788 teaches the subject matter of each dependent claim, because it discusses creating bio-1-octene using a γ -alumina catalyst that is first base-treated and then calcined at 200-600 °C to achieve at least 95% conversion and greater than 95% regioselectivity of the bio-1-alkene. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]; Wright '451 at [0067]; Chokkaram. Accordingly, the subject matter of the independent claim and each dependent claim of the Substitute Claims is also taught by Wright '788.

59. Accordingly, in my opinion the Substitute Claims are rendered obvious by the applied prior art and a POSITA would have a reasonable expectation of success in applying the Wright '788 patent to bio-1-octanol, thereby rendering the Substitute Claims obvious.

VIII. SUBSTITUTE CLAIMS 29-44 ARE INVALID AS ANTICIPATED AND/OR OBVIOUS OVER WRIGHT '451.

60. In my opinion, the Substitute Claims are amended to include further well-known features into the independent and dependent claims. Ex. 2002 at 2002-88 – 2002-91; Takamura at [0057]; Wright '451 at [0067]; Chokkaram. Prior to the '048 Patent, a POSITA would understand that it was well-known and well-understood that treating a γ -alumina with a base followed by drying and then calcination would yield an effective catalyst for dehydration.

A. Claims 29-44 are obvious over Wright '451

29. A method for making a bio-alkene, comprising: dehydrating a bio-1-alcohol by heating the bio-1-alcohol in a reactor with a base-treated and calcined γ -alumina catalyst, wherein the catalyst has not been silanized, and

61. A POSITA would understand that Wright '451 discloses a dehydration process in a reactor for the “conversion of terminal alcohols to the corresponding terminal alkenes with high regioselectivity at high conversion.” Wright '451 at [0002]. The starting alcohols can be bio-1-alcohols. Wright '451 at [0017], [0020]. The catalyst is γ -alumina “...modified with binder, physically formed (e.g., extruded) to a preselected shape (e.g., rods), heat-treated (e.g., calcined), and then modified with Ca^{+2}” Wright '451 at [0014], [0066]. Further, Wright '451 teaches a POSITA that the “... Ca^{+2} is the modifier and the Ca^{+2} compound is calcium acetate ($\text{Ca}(\text{OAc})_2$).” Wright '451 at [0014]. The γ -alumina is placed in the calcium solution to create a “catalyst composition [that] includes Ca^{+2} (as wt% of the modified inorganic support) at about 0.8 to about 3.0 wt%. Wright '451 at [0014]. Accordingly, Wright '451 discloses modifying (i.e., treating) a γ -alumina catalyst with calcium acetate (i.e., a base). As Dr. Wright explains in his Deposition, calcium acetate on heating loses acetic acid and is converted to the base CaO.

62. A POSITA would understand that Wright '451 also teaches that beyond calcium acetate nonlimiting examples of calcium-containing compounds that may be used for production of the catalysts described herein include:

Ca(OAc)₂, Ca(OEt)₂, calcium citrate, calcium borohydride, calcium acetylacetonate, calcium L-ascorbate, calcium bis(2,2,6,6-tetramethyl-3,5-heptanedionate), calcium carbonate, calcium citrate, calcium cyanamide, calcium 2-ethylhexanoate, calcium D-gluconate, calcium hydroxide, calcium isopropoxide, calcium methoxide, calcium oxalate, calcium oxalate hydrate, calcium propionate, calcium bis(triphenylsilanoxy), and hydrates or solvates for any of those listed above. Other calcium and Group 2 compounds, or Group 1 compounds, or Group 3, or Group 4, or rare earth compounds may be employed for this purpose as promoters.

Wright '451 at [0065]. The '048 patent relies on calcium acetate to create the promoter. Therefore, Wright '451 teaches modifying the γ -alumina catalyst using the same compound discussed in the '048 patent as well as additional promoters.

63. Wright '451 teaches that the γ -alumina, after base modification, is calcined. Wright '451 at [0067]. As one example, Wright '451 states that after impregnation of the promoter, the promoted catalyst is "...typically followed by a drying or calcination process" Wright '451 at [0067]. The calcination

process takes place in a vessel “at about 100 °C to about 900 °C or about 200 °C to 600 C” “for a period of time of about 1h to about 8h”. Wright ’451 at [0067]. This range is consistent with what a POSITA would understand to be standard calcination temperatures for both treated and untreated γ -alumina.

64. Dr. Wright testified that silanization is an affirmative step taken in some catalyst preparations. A POSITA would understand that because the process described in at least paragraph [0067] is completed without undertaking an affirmative step of silanization, the catalyst is not silanized.

wherein the resulting bio-alkene has a carbon chain of 6 to 14 carbon atoms and is produced in a conversion of at least 95%, and has a bio-1-alkene regioselectivity of 92% to about 99%.

65. A POSITA would understand that Wright ’451 teaches a dehydration reaction of 1-alcohol that achieves a bio-1-alkene regioselectivity of 92% to about 99% and at least 95% conversion. Wright ’451 teaches a “bio-1-alkene” product that results from a dehydration reaction that takes place at 220-440 °C and achieves a “chemical conversion of greater than about 95%” and produces a “terminal olefin” “with about 90% to 99% regiochemical selectivity.” Wright ’451 at [0013], [0022] (< about 5% unreacted 1-alcohol is at least 95% conversion); [0082] (“In embodiments of the dehydration methods disclosed herein, the final product stream may contain about 5 wt% terminal alcohol or less, or less than about 0.5 wt% terminal alcohol. ... may produce the alkene product

with about 90% to about 98% or greater regioselectivity for the terminal alkene.”), [0083].

66. The 1-alcohols used in this process include a 1-alcohol “of general formula $\text{OH}(\text{CH}_2)_n(\text{CH}_3)$ with n being any integer from 1 to 22” which includes bio-1-octanol and specifically lists bio-1-hexanol as an example. Wright ’451 at [0078]. Accordingly, a POSITA would understand that the Wright ’451 includes carbon chains from 6 to 14 atoms. Wright ’451 at [0078].

67. Tables 1 and 2 provide conversion and regioselectivity results from different dehydration experiments running at different temperatures with different catalysts. There are multiple experimental results that use a base-treated and calcined γ -alumina catalyst, dehydrating alcohols at between 360-400 °C and achieving at least 95% conversion and 92 to 99% regioselectivity. *See e.g.*, Wright ’451 at Table 1 and Table 2 at Examples 1, 2, 3, 8, 9, 10, 12-19.

68. Accordingly, a POSITA would understand that Wright ’451 teaches dehydration reactions that achieve at least 95% conversion and at least 92% regioselectivity of bio-1-alkenes having a carbon chain between 2 and 23 atoms long.

30. The method of claim 29, wherein the bio-alkene has a carbon chain of 6 to 10 carbon atoms.

69. A POSITA would understand that the 1-alcohols used in this process include a 1-alcohol “of general formula $\text{OH}(\text{CH}_2)_n(\text{CH}_3)$ with n being any integer from 1 to 22” which includes bio-1-octanol and specifically lists bio-1-hexanol as an example. Wright ’451 at [0078]. The bio-1-alkene formed via the dehydration reaction of Wright ’451 will have the same carbon chain length as the bio-1-alcohol starting materials. Accordingly, Wright ’451 discloses the bio-alkene has a carbon chain of 6 to 10 carbon atoms.

31. The method according to claim 29, wherein the bio-alkene has a carbon chain of about 6 to 8 carbon atoms.

70. A POSITA would understand that the 1-alcohols used in this process include a 1-alcohol “of general formula $\text{OH}(\text{CH}_2)_n(\text{CH}_3)$ with n being any integer from 1 to 22” which includes bio-1-octanol and specifically lists bio-1-hexanol as an example. Wright ’451 at [0078]. The bio-1-alkene formed via the dehydration reaction of Wright ’451 will have the same carbon chain length as the bio-1-alcohol starting materials. Accordingly, Wright ’451 discloses the bio-alkene has a carbon chain of 6 to 8 carbon atoms.

32. The method according to claim 29, wherein the bio-alkene is bio-octene.

71. A POSITA would understand that the 1-alcohols used in this process include a 1-alcohol “of general formula $\text{OH}(\text{CH}_2)_n(\text{CH}_3)$ with n being any integer from 1 to 22” which includes bio-1-octanol and specifically lists bio-1-hexanol as

an example. Wright '451 at [0078]. The bio-1-alkene formed via the dehydration reaction of Wright '451 will have the same carbon chain length as the bio-1-alcohol starting materials. Accordingly, Wright '451 discloses the bio-alkene is bio-octene.

33. The method according to claim 29, wherein the reactor is heated at about 240 °C to about 360 °C.

72. A POSITA would understand that Wright '451 includes a product of “bio-1-alkene” that results from a dehydration reaction that takes place at 220-440 °C. Wright '451 at [0013], [0027], [0042]-[0046], [0049], [0077], [0082], [0097]; Tables 1 and 2; FIGs 9-13. For example, Example 2, the reaction temperature is 360 °C and the reaction achieves a 99.6% conversion and a 93.8% regioselectivity. Similarly, each of examples 12, 13, and 14 are dehydrated at 360 °C and each achieves at least 96% conversion and 93% regioselectivity to 1-alkene. It would be obvious to a person of ordinary skill in the art that the examples provided for butanol would be applicable to a longer chain 1-alcohol and a POSITA would expect to achieve similar results for those longer alcohols.

73. A POSITA would understand that the disclosed range includes the claimed 240 °C to 360 °C and would expect the reaction to achieve at least 95% conversion and 92-99% regioselectivity.

34. The method according to claim 33, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

74. A POSITA would understand that Wright '451 discloses that the catalyst is calcined prior to the dehydration reaction, including at temperature ranges that include 400 °C to 480 °C. Wright '451 at [0014], [0015], [0035], [0042], [0043], [0045], [0067] (“IWP [incipient wetness impregnation] **is typically followed** by a drying or calcination process for some time....”)(emphasis added), [0093]-[0095], [0098], [0100], [0102]-[0104], [0107]-[0111]; FIG. 2.

75. In one specific embodiment, Wright '451 states that “This material 204 can be further heated in a second apparatus (205) to provide drying or calcination of the catalyst. The drying or calcination can be carried out in vessel 203 or 205 at temperatures of about 100 °C to about 900 °C, or about 200 °C to 600 °C for a time period of about 1 h to about 8 h, or about 2 h to 6 h. The removal of the solvent can be done in air or under an inert atmosphere.” Wright '451 at [0067]. It would be obvious to a person of ordinary skill in the art that calcination can take place at 200 °C to 600 °C, including at a temperature between 400 °C and 480 °C.

76. Accordingly, a POSITA would understand that Wright '451 discloses that prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

35. The method according to claim 34, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

77. A POSITA would understand that Wright '451 discloses a method for producing a bio-1-alkene at 95% to about 99% regioselectivity from a reaction that was run at about 240 °C to about 360 °C and was calcined at 400 °C to about 480 °C prior to the dehydration reaction. More specifically, Wright '451 states that the reaction achieves a yield of bio-1-butene of greater than 98%. A yield this high requires high regioselectivity and high conversion, as the chemical yield is the product of the conversion and regioselectivity. Wright '451 at [0004] and [0013]. The dehydration reaction of Wright can achieve “the alkene product with about 90% to about 98% or greater regioselectivity for the terminal alkene.” Wright '451 at [0082]; *see also* [0042]-[0046]; [0050], [0059]; Tables 1 and 2; FIG. 9-13. Accordingly, after calcining the catalyst at 400 °C to about 480 °C and then running the reaction at 240 °C to about 360 °C, Wright '451 teaches a regioselectivity of 95% to 99% and a conversion of at least 95%. *See e.g.*, Wright '451 at Table 2, Example 13.

36. The method according to claim 30, wherein the reactor is heated at about 240 °C to about 360 °C.

78. A POSITA would understand that Wright '451 includes a product of "bio-1-alkene" that results from a dehydration reaction that takes place at 220-440 °C. Wright '451 at [0013], [0027], [0042]-[0046], [0049], [0077], [0082], [0097]; Tables 1 and 2; FIGs 9-13. For example, Example 2, the reaction temperature is 360 °C and the reaction achieves a 99.6% conversion and a 93.8% regioselectivity. Similarly, each of examples 12, 13, and 14 are dehydrations at 360 °C and each achieves at least 96% conversion and 93% regioselectivity to 1-alkene. It would be obvious to a person of ordinary skill in the art, and as stated in Wright '451, that the examples provided for butanol would be applicable to a longer chain 1-alcohol. Wright '451 at [0078]. A POSITA would thus expect to achieve similar results for those longer alcohols, producing bio-1-alkenes having a carbon chain from 6 to 10 carbon atoms.

79. A POSITA would understand that the disclosed range includes the claimed 240 °C to 360 °C and would expect the reaction to achieve at least 95% conversion and 92-99% regioselectivity to the bio-1-alkenes, including bio-alkenes with 6 to 10 carbon atoms.

37. The method according to claim 36, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C

80. Wright '451 discloses that the catalyst is calcined prior to the dehydration reaction, including at temperature ranges that include 400 °C to 480

°C. Wright '451 at [0014], [0015], [0035], [0042], [0043], [0045], [0067] (“IWP [incipient wetness impregnation] **is typically followed** by a drying or calcination process for some time....”)(emphasis added), [0093]-[0095], [0098], [0100], [0102]-[0104], [0107]-[0111]; FIG. 2.

81. In one specific embodiment, Wright '451 states that “This material 204 can be further heated in a second apparatus (205) to provide drying or calcination of the catalyst. The drying or calcination can be carried out in vessel 203 or 205 at temperatures of about 100 °C to about 900 °C, or about 200 °C to 600 °C for a time period of about 1 h to about 8 h, or about 2 h to 6 h. The removal of the solvent can be done in air or under an inert atmosphere.” Wright '451 at [0067]. It would be obvious to a person of ordinary skill in the art that calcination can take place at 200 °C to 600 °C, including at a temperature between 400 °C and 480 °C.

82. Accordingly, in my opinion, Wright '451 discloses prior to producing bio-1-alkenes having a carbon chain from 6 to 10 carbon atoms, the catalyst would have been calcined at a temperature of about 400 °C to about 480 °C.

38. The method according to claim 37, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

83. A POSITA would understand that Wright '451 discloses a method for producing a bio-1-alkene at 95% to about 99% regioselectivity from a reaction that was run at about 240 °C to about 360 °C using a catalyst that was calcined at 400 °C to about 480 °C prior to the dehydration reaction. Furthermore, Wright '451 states that the reaction achieves a yield of bio-1-butene of greater than 98%. A yield this high requires high regioselectivity and high conversion, as the chemical yield is the product of the conversion and regioselectivity. Wright '451 at [0004] and [0013]. The dehydration reaction of Wright '451 can achieve “the alkene product with about 90% to about 98% or greater regioselectivity for the terminal alkene.” Wright '451 at [0082]; see also [0042]-[0046]; [0050], [0059]; Tables 1 and 2; FIG. 9-13. Accordingly, after calcining the catalyst at 400 °C to about 480 °C and then running the dehydration reaction of bio-1-alcohols having a carbon chain from 6 to 10 carbon atoms at 240 °C to about 360 °C, Wright '451 teaches achieving a regioselectivity of 98% or greater of the bio-1-alkene. See *e.g.*, Wright '451 at Table 2, Example 13.

39. The method according to claim 31, wherein the reactor is heated at about 240 °C to about 360 °C.

84. A POSITA would understand that Wright '451 includes a product “bio-1-alkene” that results from a dehydration reaction that takes place at 220-440 °C. Wright '451 at [0013], [0027], [0042]-[0046], [0049], [0077], [0082],

[0097]; Tables 1 and 2; FIGs 9-13. For example, in Example 2, the reaction temperature is 360 °C and the reaction achieves a 99.6% conversion and a 93.8% regioselectivity. Similarly, each of examples 12, 13, and 14 dehydrate at 360 °C and each achieves at least 96% conversion and 93% regioselectivity to 1-alkene. Wright '451 states it would be obvious to a person of ordinary skill in the art that the examples provided for 1-butanol would be applicable to a longer chain 1-alcohol. A POSITA would therefore expect to achieve similar results when dehydrating longer alcohols, including creating bio-1-alkenes having a carbon chain from 6 to 8 carbon atoms.

85. A POSITA would understand that the disclosed range includes the claimed 240 °C to 360 °C and would expect the reaction to achieve at least 95% conversion and 92-99% regioselectivity to the bio-1-alkenes, including bio-alkenes with 6 to 8 carbon atoms.

40. The method according to claim 39, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

86. A POSITA would understand that Wright '451 discloses that the catalyst is calcined prior to the dehydration reaction, including at temperature ranges that include 400 °C to 480 °C. Wright '451 at [0014], [0015], [0035], [0042], [0043], [0045], [0067] (“IWP [incipient wetness impregnation] is typically followed by a drying or calcination process for some

time....”)(emphasis added), [0093]-[0095], [0098], [0100], [0102]-[0104], [0107]-[0111]; FIG. 2.

87. In one specific embodiment, Wright '451 states that “This material 204 can be further heated in a second apparatus (205) to provide drying or calcination of the catalyst. The drying or calcination can be carried out in vessel 203 or 205 at temperatures of about 100 °C to about 900 °C, or about 200 °C to 600 °C for a time period of about 1 h to about 8 h, or about 2 h to 6 h. The removal of the solvent can be done in air or under an inert atmosphere.” Wright '451 at [0067]. It would be obvious to a person of ordinary skill in the art that calcination can take place at 200 °C to 600 °C, including at a temperature between 400 °C and 480 °C.

88. Accordingly, in my opinion Wright '451 discloses prior to dehydrating bio-alkenes having a carbon chain from 6 to 8 carbon atoms, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

41. The method according to claim 40, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

89. A POSITA would understand that Wright '451 discloses a method for producing a bio-1-alkene at 95% to about 99% regioselectivity from a reaction that was run at about 240 °C to about 360 °C and was calcined at 400 °C to about 480 °C prior to the dehydration reaction. Furthermore, Wright '451 states that the

reaction achieves a yield of bio-1-butene of greater than 98%. A yield this high requires high regioselectivity and high conversion, as the chemical yield is the product of the conversion and regioselectivity. Wright '451 at [0004] and [0013]. The dehydration reaction of Wright '451 can achieve "the alkene product with about 90% to about 98% or greater regioselectivity for the terminal alkene." Wright '451 at [0082]; *see also* [0042]-[0046]; [0050], [0059]; Tables 1 and 2; FIG. 9-13.

90. Accordingly, after calcining the catalyst at 400 °C to about 480 °C and while running the dehydration reaction of bio-1-alcohols having a carbon chain from 6 to 8 carbon atoms at 240 °C to about 360 °C, Wright '451 teaches a regioselectivity of 98% or greater. *See e.g.*, Wright '451 at Table 2, Example 13.

42. The method according to claim 32, wherein the reactor is heated at about 240 °C to about 360 °C.

91. A POSITA would understand that Wright '451 includes a product "bio-1-alkene" that results from a dehydration reaction that takes place at 220-440 °C. Wright '451 at [0013], [0027], [0042]-[0046], [0049], [0077], [0082], [0097]; Tables 1 and 2; FIGs 9-13. For example, Example 2, the reaction temperature is 360 °C and the reaction achieves a 99.6% conversion and a 93.8% regioselectivity. Similarly, each of examples 12, 13, and 14 are dehydrations at 360 °C and each achieves at least 96% conversion and 93% regioselectivity to 1-

alkene. Wright states it would be obvious to a person of ordinary skill in the art that the examples provided for butanol would be applicable to a longer chain 1-alcohol. Wright '451 at [0078]. A POSITA would therefore expect to achieve similar results for those longer alcohols, including for bio-1-alcohols having a carbon chain of 8 carbon atoms.

92. A POSITA would understand that the disclosed range includes the claimed 240 °C to 360 °C and would expect the reaction to achieve at least 95% conversion and 92-99% regioselectivity to the bio-1-alkenes, including bio-alkenes with 6 to 8 carbon atoms.

43. The method according to claim 42, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C

93. A POSITA would understand that Wright '451 discloses that the catalyst is calcined prior to the dehydration reaction, including at temperature ranges that include 400 °C to 480 °C. Wright '451 at [0014], [0015], [0035], [0042], [0043], [0045], [0067] (“IWP [incipient wetness impregnation] **is typically followed** by a drying or calcination process for some time....”)(emphasis added), [0093]-[0095], [0098], [0100], [0102]-[0104], [0107]-[0111]; FIG. 2.

94. In one specific embodiment, Wright '451 states that “This material 204 can be further heated in a second apparatus (205) to provide drying or

calcination of the catalyst. The drying or calcination can be carried out in vessel 203 or 205 at temperatures of about 100 °C to about 900 °C, or about 200 °C to 600 °C for a time period of about 1 h to about 8 h, or about 2 h to 6 h. The removal of the solvent can be done in air or under an inert atmosphere.” Wright ’451 at [0067]. It would be obvious to a person of ordinary skill in the art that calcination can take place at 200 °C to 600 °C, including at a temperature between 400 °C and 480 °C.

95. Accordingly, in my opinion Wright ’451 discloses prior to dehydrating bio-1-alcohols having a carbon chain of 8 carbon atoms, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

44. The method bio-alkene according to claim 2643, wherein the resulting bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%

96. A POSITA would understand that Wright ’451 discloses a method for producing a bio-1-alkene at 95% to about 99% regioselectivity from a reaction that was run at about 240 °C to about 360 °C using a catalyst that was calcined at 400 °C to about 480 °C prior to the dehydration reaction. Furthermore, Wright ’451 states that the reaction achieves a yield of bio-1-butene of greater than 98%. A yield this high requires high regioselectivity and high conversion, as the chemical yield is the product of the conversion and regioselectivity. Wright ’451 at [0004] and [0013]. The dehydration reaction of Wright ’451 can achieve “the

alkene product with about 90% to about 98% or greater regioselectivity for the terminal alkene.” Wright ’451 at [0082]; *see also* [0042]-[0046]; [0050], [0059]; Tables 1 and 2; FIG. 9-13.

97. Accordingly, after calcining the catalyst at 400 °C to about 480 °C and while running the dehydration reaction of bio-1-alcohols having a carbon chain of 8 carbon atoms at 240 °C to about 360 °C, Wright ’451 teaches achieving a regioselectivity of 98% or greater for the bio-1-alkene. *See e.g.*, Wright ’451, Table 2, Example 13.

B. Claims 29-44 are Obvious over Wu in view of Chokkaram

1. Motivation to Combine

98. A POSITA would be motivated to combine Wu with Chokkaram because Wu provides a roadmap for base treatment that delivers a catalyst that achieves dehydration of the starting alcohol to give the 1-alkene with a regioselectivity in excess of 97%. However, the conversion using the modified catalysts was not mentioned. The POSITA would therefore turn to Chokkaram. Chokkaram provides the needed details to take advantage of the catalysts taught by Wu. For example, Chokkaram teaches that the “activity and selectivity of these catalysts for 2-octanol conversion are dependent on reaction temperature, liquid hour space velocity (LHSV) as well as on the calcination temperature.” Chokkaram at Abstract. A POSITA would be motivated to combine the

calcination steps taught by Chokkaram with the base treatment taught by Wu to achieve high conversion while maintaining high selectivity for the dehydration of longer straight-chain alcohols. Chokkaram provides details as experimental results that would make it easier to implement the full scope of Wu's process while achieving the desired high conversion and selectivity. Chokkaram teaches that calcining a γ -alumina catalyst at 673k (400 °C) and then dehydrating an octanol at 270-280 °C achieves conversions of 95-97% while maintaining high regioselectivity. Chokkaram at p 165, Table 3. Therefore, a POSITA would understand that calcination leads to a catalyst that effects dehydration with high conversion while maintaining high regioselectivity. A POSITA would therefore be motivated to combine Chokkarams' implementation details with Wu's highly regioselective dehydration of longer chain alcohols, including n-octanol.

29. A method for making a bio-alkene, comprising: dehydrating a bio-1-alcohol by heating the bio-1-alcohol in a reactor with a base-treated and calcined γ -alumina catalyst, wherein the catalyst has not been silanized, and

99. A POSITA would understand that Wu teaches a dehydration process in a reactor using "straight chain" alcohols which "can contain from 2 to about 20 carbon atoms per molecule" including "n-octanol". Wu at 1:59-2:4. The dehydration is "in the presence of gamma-alumina which may be base treated." Wu at Abstract. Wu teaches that the acidic sites of the catalyst can be "neutralized

by treatment of the alumina with aqueous potassium hydroxide or aqueous sodium hydroxide, followed by washing with water and subsequent drying, or otherwise altered.” Wu at 2:23-36. After treating the catalyst with a base but prior to the reaction, the reactor was “packed with 10 kg of base-treated gamma-alumina” which was “maintained at 350 °C.” Wu at 4:5-7. Wu does not silanize the catalyst.

100. Accordingly, in my opinion, Wu teaches a POSITA a base treated and dried γ -alumina catalyst for use in the dehydration of a bio-1-alcohol to a bio-1-alkene.

101. Wu can be combined with Chokkaram, which teaches that calcination can be used to optimize dehydration catalysts, including metal salt promoted catalysts. Chokkaram at 157, Col. 1 and 2. Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, catalyst calcination temperature and the reaction temperature.” Chokkaram at 164 col. 2. Chokkaram also teaches that calcining the treated γ -alumina leads to a catalyst that effects dehydration of the 1-alcohol in high conversion and with high regioselectivity. Chokkaram at p 165, Table 3.

102. Accordingly, Wu in view of Chokkaram teaches a POSITA to use calcination with metal oxide catalysts, e.g., γ -alumina treated with a metal salt, to achieve increased selectivity and conversion.

wherein the resulting bio-alkene has a carbon chain of 6 to 14 carbon atoms and is produced in a conversion of at least 95%, and has a bio-1-alkene regioselectivity of 92% to about 99%.

103. A POSITA would understand that Wu teaches a dehydration process involves “straight chain” alcohols which “can contain from 2 to about 20 carbon atoms per molecule” including “n-octanol”. Wu at 1:59-2:4. The bio-1-alkene formed via the dehydration reaction of Wu will have the same carbon chain length as the bio-1-alcohol starting materials. The reactions achieve yields “well in excess of 90%”. Wu at Abstract. The Examples explain that the untreated γ -alumina catalyst, after fractional distillation of the product, yields the desired 1-alkene at 96.4% selectivity and a 93.4% conversion. Wu at 3:9-27. Wu then teaches that an improved catalyst that is “base-treated” achieves an improved regioselectivity of 97.7% and that the process achieves “high conversion”. Wu at 4:5-21. A POSITA would understand that base-treating the γ -alumina catalyst improves regioselectivity and conversion, and that the dehydration process at the proposed temperatures proceeds towards 100% conversion. Wu at 2:24-36; 4:11-13 and Abstract.

104. Further, Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, catalyst calcination temperature and the reaction temperature.” Chokkaram at 164 col. 2. Chokkaram also teaches that calcining the γ -alumina

leads to a catalyst that effects dehydration of n-octanol with conversion of at least 95% when the reaction is run at 270 °C to 280 °C. Chokkaram at p 165, Table 3. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of 97.4% at a reaction temperature of 553K (280 °C). Chokkaram at Table 3. Chokkaram Table 3 also teaches that at a reaction temperature of 280 °C, the byproduct formation, e.g., alkene migration and ether formation, sums to less than 1%. Chokkaram at p 165, Table 3; *see also* Berteau at 133. Accordingly, a POSITA combining Wu with Chokkaram would expect to achieve at least 95% conversion of the bio-1-alcohol and at least 97.7% regioselectivity for the desired bio-1-alkene.

105. Accordingly, a POSITA would be motivated and expect to succeed in running a dehydration reaction that achieves at least 95% conversion while maintaining the 97.7% regioselectivity taught by Wu. For example, when the teachings are combined, a POSITA would understand that by adding a calcining step at about 400 °C after the drying step of the base-treated catalyst taught by Wu, the POSITA would expect to achieve about 97% conversion with about 97% regioselectivity by running a dehydration reaction with the base-treated and calcined γ -alumina catalyst within the temperature range of 200 °C to 500 °C. When the teachings of Chokkaram are combined with the teachings of Wu, a

POSITA would understand that a 1-alcohol can be converted to a 1-alkene at a conversion of at least 95% while maintaining a regioselectivity above 95%.

30. The method of claim 29, wherein the bio-alkene has a carbon chain of 6 to 10 carbon atoms.

106. A POSITA would understand that Wu in view of Chokkaram teaches a dehydration process that involves “straight chain” alcohols which “can contain from 2 to about 20 carbon atoms per molecule” including “n-octanol”. Wu at 1:59-2:4. Wu at 1:59-63. Further, Chokkaram specifically teaches the dehydration of an n-octanol. Chokkaram at p 165, Table 3. Therefore, Wu in view of Chokkaram teaches dehydration reactions including carbon chains of 6 to 10 atoms. Wu at 4:5-14. Wu at Abstract; Chokkaram at p 165, Table 3. The bio-1-alkene formed via the dehydration reaction of Wu in view of Chokkaram will have the same carbon chain length as the bio-1-alcohol starting materials.

31. The method according to claim 29, wherein the bio-alkene has a carbon chain of about 6 to 8 carbon atoms.

107. A POSITA would understand that Wu in view of Chokkaram teaches a dehydration process that involves “straight chain” alcohols which “can contain from 2 to about 20 carbon atoms per molecule” including “n-octanol”. Wu at 1:59-2:4. Wu at 1:59-63. Further, Chokkaram specifically teaches the dehydration of an n-octanol. Chokkaram at p 165, Table 3. Therefore, Wu in view of Chokkaram teaches dehydration reactions including carbon chains of 6 to 8 atoms. Wu at 4:5-

14. Wu at Abstract; Chokkaram at p 165, Table 3. The bio-1-alkene formed via the dehydration reaction of Wu in view of Chokkaram will have the same carbon chain length as the bio-1-alcohol starting materials.

32. The method according to claim 29, wherein the bio-alkene is bio-octene.

108. A POSITA would understand that Wu in view of Chokkaram teaches a dehydration process that involves “straight chain” alcohols which “can contain from 2 to about 20 carbon atoms per molecule” including “n-octanol”. Wu at 1:59-2:4. Wu at 1:59-63. Further, Chokkaram specifically teaches the dehydration of an n-octanol. Chokkaram at p 165, Table 3. Therefore, Wu in view of Chokkaram teaches dehydration reactions including wherein the bio-alkene is octene. Wu at 4:5-14. Wu at Abstract; Chokkaram at p 165, Table 3. The bio-1-alkene formed via the dehydration reaction of Wu in view of Chokkaram will have the same carbon chain length as the bio-1-alcohol starting materials.

33. The method according to claim 29, wherein the reactor is heated at about 240 °C to about 360 °C.

109. A POSITA would understand that Wu in view of Chokkaram teaches that the “temperatures in the range of from about 200 °C to 500 °C are suitable for the desired dehydration reaction to occur. It is currently preferable, however, to employ temperatures in the range of 300 °C - 450 °C.” Wu at 2:51-54; *see also* 3:14-6, 4:6-7. Further, Chokkaram teaches that calcining a γ -alumina catalyst,

allows a dehydration reaction of n-octanol to achieve a conversion of at least 95% when the reaction is run at 270 °C to 280 °C. Chokkaram at p 165, Table 3. Accordingly, Wu in view of Chokkaram teaches the dehydration reaction of the bio-1-alcohol that has a carbon chain of 6 to 14 carbon atoms can take place at temperatures including about 240 °C to about 360 °C.

34. The method according to claim 33, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

110. A POSITA would understand that Wu in view of Chokkaram teaches calcination temperatures from 473 K to 1173 K. Wu at 3:43-4:7; Chokkaram at 158, 2.1. Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, **catalyst calcination temperature** and the reaction temperature.” Chokkaram at 164 col. 2 (emphasis added). Chokkaram specifically teaches that BET surface areas are at their maximum when calcination takes place at 673 K (about 400 °C). Chokkaram at 160, 1st col. and Table 1. A POSITA wanting to increase selectivity and conversion of the dehydration reaction of longer chain alcohols based on the teachings of Wu in view of Chokkaram would be motivated to run the dehydration reaction with a base-treated γ -alumina catalyst calcined at 400 °C.

111. The POSITA contemplating the dehydration of bio-1-octanol to bio-1-octene would have learned about calcination and would be motivated to learn

the appropriate calcination time and temperature. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of n-octanol of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

112. In my opinion the combination of Wu with Chokkaram would teach a POSITA to run the dehydration reaction of bio-1-alcohol with a base-treated γ -alumina catalyst calcined within the range of 400-550 °C, including a specific example at 400 °C. Wu in view of Chokkaram teaches a POSITA to expect high conversion (i.e., at least 95%) and high regioselectivity (i.e., greater than 92%).

35. The method according to claim 34, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

113. A POSITA would understand that Wu in view of Chokkaram teaches that an untreated γ -alumina catalyst achieved 96.4% selectivity, while a “base-treated” catalyst achieves an improved regioselectivity of 97.7%”. Wu at 3:9-27, 4:5-21. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining

the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of n-octanol of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

114. Accordingly, a POSITA would understand from the teachings of Wu in view of Chokkaram that after calcining the catalyst at 400 °C to about 480 °C and while running the reaction at 240 °C to about 360 °C, a dehydration reaction can achieve at least 95% conversion and a regioselectivity of 95% to about 99%.

36. The method according to claim 30, wherein the reactor is heated at about 240 °C to about 360 °C.

115. A POSITA would understand that Wu in view of Chokkaram teaches that the “temperatures in the range of from about 200 °C to 500 °C are suitable for the desired dehydration reaction to occur. It is currently preferable, however, to employ temperatures in the range of 300 °C- 450 °C.” Wu at 2:51-54; see also 3:14-6, 4:6-7. Further, Chokkaram teaches that calcining a γ -alumina catalyst, allows a dehydration reaction to achieve a conversion of at least 95% when the reaction is run at 270 °C to 280 °C. Chokkaram at p 165, Table 3.

116. Accordingly, Wu in view of Chokkaram teaches the dehydration reaction of the bio-1-alcohol that has a carbon chain of 6 to 10 carbon atoms can take place at temperatures including about 240 °C to about 360 °C.

37. The method according to claim 36, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C

117. A POSITA would understand that Wu in view of Chokkaram teaches calcination temperatures from 473 K to 1173 K. Wu at 3:43-4:7; Chokkaram at 158, 2.1. Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, **catalyst calcination temperature** and the reaction temperature.” Chokkaram at 164 col. 2 (emphasis added). Chokkaram specifically teaches that BET surface areas are at their maximum when calcination takes place at 673 K (about 400 °C). Chokkaram at 160, 1st col. and Table 1. A POSITA wanting to increase selectivity and conversion of the dehydration reaction of longer chain alcohols based on the teachings of Wu in view of Chokkaram would be motivated to run the dehydration reaction with a base-treated γ -alumina catalyst calcined at 400 °C.

118. The POSITA contemplating the dehydration of bio-1-octanol to bio-1-octene would have learned about calcination and would be motivated to learn the appropriate calcination time and temperature. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of 97.4% at a reaction temperature

of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

119. The combination of Wu with Chokkaram would teach a POSITA to run the dehydration reaction of bio-1-alcohol that has a carbon chain of 6 to 10 carbon atoms with a base-treated γ -alumina catalyst calcined at 400 °C. Wu in view of Chokkaram teaches a POSITA to expect high conversion (i.e., at least 95%) and high regioselectivity (i.e., greater than 92%).

38. The method according to claim 37, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

120. A POSITA would understand that Wu in view of Chokkaram teaches the recited calcination and reaction temperatures. Further, Wu teaches that an untreated γ -alumina catalyst achieved 96.4% selectivity, while a “base-treated” catalyst achieves an improved regioselectivity of 97.7%”. Wu at 3:9-27, 4:5-21. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

121. Accordingly, a POSITA would understand from the teachings of Wu in view of Chokkaram that a dehydration reaction of a bio-1-alcohol that has a carbon chain of 6 to 10 carbon atoms can achieve at least 95% conversion and a regioselectivity of 95% to about 99%.

39. The method according to claim 31, wherein the reactor is heated at about 240 °C to about 360 °C.

122. A POSITA would understand Wu in view of Chokkaram teaches that the “temperatures in the range of from about 200 °C to 500 °C are suitable for the desired dehydration reaction to occur. It is currently preferable, however, to employ temperatures in the range of 300 ° - 450 °C.” Wu at 2:51-54; see also 3:14-6, 4:6-7. Further, Chokkaram teaches that calcining a γ -alumina catalyst, allows a dehydration reaction to achieve a conversion of at least 95% when the reaction is run at 270 °C to 280 °C. Chokkaram at p 165, Table 3.

123. Accordingly, Wu in view of Chokkaram teaches the dehydration reaction of the bio-1-alcohol that has a carbon chain of 6 to 8 carbon atoms can take place at temperatures including about 240 °C to about 360 °C.

40. The method according to claim 39, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C.

124. A POSITA would understand that Wu in view of Chokkaram teaches calcination temperatures from 473 K to 1173 K. Wu at 3:43-4:7; Chokkaram at

158, 2.1. Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, **catalyst calcination temperature** and the reaction temperature.” Chokkaram at 164 col. 2 (emphasis added). Chokkaram specifically teaches that BET surface areas are at their maximum when calcination takes place at 673 K (about 400 °C). Chokkaram at 160, 1st col. and Table 1. A POSITA wanting to increase selectivity and conversion of the dehydration reaction of longer chain alcohols based on the teachings of Wu in view of Chokkaram would be motivated to run the dehydration reaction with a base-treated γ -alumina catalyst calcined at 400 °C.

125. The POSITA contemplating the dehydration of bio-1-octanol to bio-1-octene would have learned about calcination and would be motivated to learn the appropriate calcination time and temperature. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

126. The combination of Wu with Chokkaram would teach a POSITA to run the dehydration reaction of bio-1-alcohol that has a carbon chain of 6 to 8

carbon atoms with a base-treated γ -alumina catalyst calcined at 400 °C. Wu in view of Chokkaram teaches a POSITA to expect high conversion (i.e., at least 95%) and high regioselectivity (i.e., greater than 92%).

41. The method according to claim 40, wherein the bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%.

127. A POSITA would understand that Wu in view of Chokkaram teaches that an untreated γ -alumina catalyst achieved 96.4% selectivity, while a “base-treated” catalyst achieves an improved regioselectivity of 97.7%. Wu at 3:9-27, 4:5-21. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of n-octanol of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

128. Accordingly, a POSITA would understand from the teachings of Wu in view of Chokkaram that a dehydration reaction of a bio-1-alcohol that has a carbon chain of 6 to 8 carbon atoms can achieve at least 95% conversion and a regioselectivity of 95% to about 99%.

42. The method according to claim 32, wherein the reactor is heated at about 240 °C to about 360 °C.

129. A POSITA would understand that Wu in view of Chokkaram teaches that the “temperatures in the range of from about 200 °C to 500 °C are suitable for the desired dehydration reaction to occur. It is currently preferable, however, to employ temperatures in the range of 300 °C- 450 °C.” Wu at 2:51-54; see also 3:14-6, 4:6-7. Further, Chokkaram teaches that calcining a γ -alumina catalyst, allows a dehydration reaction to achieve a conversion of n-octanol of at least 95% when the reaction is run at 270 °C to 280 °C. Chokkaram at p 165, Table 3.

130. Accordingly, Wu in view of Chokkaram teaches the dehydration reaction of the bio-1-alcohol that has a chain of 8 carbon atoms can take place at temperatures including about 240 °C to about 360 °C.

43. The method according to claim 42, wherein prior to the dehydrating, the catalyst has been calcined at a temperature of about 400 °C to about 480 °C

131. A POSITA would understand that Wu in view of Chokkaram teaches calcination temperatures from 473 K to 1173 K. Wu at 3:43-4:7; Chokkaram at 158, 2.1. Chokkaram teaches a POSITA that “the selectivity for dehydrogenation, dehydration, and isomerization depend on the type of catalyst, LHSV, **catalyst calcination temperature** and the reaction temperature.” Chokkaram at 164 col. 2 (emphasis added). Chokkaram specifically teaches that BET surface areas are at their maximum when calcination takes place at 673 K (about 400 °C). Chokkaram at 160, 1st col. and Table 1. A POSITA wanting to increase selectivity

and conversion of the dehydration reaction of longer chain alcohols based on the teachings of Wu in view of Chokkaram would be motivated to run the dehydration reaction with a base-treated γ -alumina catalyst calcined at 400 °C.

132. The POSITA contemplating the dehydration of bio-1-octanol to bio-1-octene would have learned about calcination and would be motivated to learn the appropriate calcination time and temperature. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of n-octanol of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

133. The combination of Wu with Chokkaram would teach a POSITA to run the dehydration reaction of bio-1-alcohol that has a carbon chain of 8 carbon atoms with a base-treated γ -alumina catalyst calcined at 400 °C. Wu in view of Chokkaram teaches a POSITA to expect high conversion (i.e., at least 95%) and high regioselectivity (i.e., greater than 92%).

44. The method bio-alkene according to claim 2643, wherein the resulting bio-alkene has a bio-1-alkene regioselectivity of 95% to about 99%

134. A POSITA would understand Wu in view of Chokkaram teaches that an untreated γ -alumina catalyst achieved 96.4% selectivity, while a “base-treated” catalyst achieves an improved regioselectivity of 97.7%”. Wu at 3:9-27, 4:5-21. Chokkaram teaches that calcining the treated γ -alumina at 400 °C for four hours yields an effective catalyst for dehydration. Chokkaram at 158 at 2.1. In one specific example, after drying the catalyst at 373K (about 100 °C) and calcining the γ -alumina catalyst at 673 K (400 °C), Chokkaram achieves a conversion of n-octanol of 97.4% at a reaction temperature of 553k (280 °C) with less than 1% alkene migration. Chokkaram at 165, Table 3.

135. Accordingly, a POSITA would understand from the teachings of Wu in view of Chokkaram that a dehydration reaction of a bio-1-alcohol that has a carbon chain of 8 carbon atoms can achieve at least 95% conversion and a regioselectivity of 95% to about 99%.

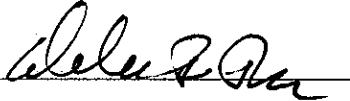
IX. CONCLUSION

136. In my opinion, and in view of the foregoing, a POSITA would view Substitute Claims 29-44 of U.S. Patent No. 10,995,048 as obvious in light of the combinations of prior art references discussed above.

X. OATH

137. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: *May 1, 2024*

By: 

Douglass F. Taber