UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SYMRISE AG

PETITIONER,

v.

INOLEX INVESTMENT CORPORATION,

PATENT OWNER.

Case IPR2023-01439
U.S. Patent No. 10,882,803

PETITION FOR *INTER PARTES* REVIEW

OF U.S. PATENT NO. 10,882,803

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Exhibit 1046	Isao Sakurada *et al*. "*Dichlorotin oxide-catalyzed new direct functionalization of olefins: synthesis of trans β–azidohydrins and 1,2-diols,*" TETRAHEDRON LETT. 41: 2415-2418, 2000 ("Sakurada")
Exhibit 1047	Chi-Ming Ho *et al*. "*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")
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Exhibit 1050	David R. Williams *et al.* "*Total Synthesis of (-)-Ratjadone,*" ORG. LETT. 3: 1383, 2001 ("Williams")

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I. INTRODUCTION

Symrise AG and Symrise Inc., (collectively "Petitioner"), hereby respectfully request *Inter Partes* Review pursuant to 35 U.S.C.§§ 311 *et seq.* and 37 C.F.R.§§ 42.100 *et seq*., of claims 1-7, 9-11, 24-26, 28, 29, 35 and 36 of U.S. Patent No. 10,882,803 ("the '803 Patent") filed on January 30, 2019, and issued on January 5, 2021, to Inolex Investment Corporation (hereinafter "Patent Owner", "PO", "Inolex," or "Applicant").

The '803 Patent claims an admittedly well-known chemical process for converting alkenes to 1,2-alkanediols. Namely, dehydrating 1-alcohols with a catalyst to produce 1-alkenes with high regioselectivity (*i.e.*, produce a high percentage of the 1-alkene isomer relative to other isomers of the alkene) which are then converted into a 1,2-alkanediol using known reactions. Indeed, Applicant acknowledged during prosecution that "[t]he chemical pathway to convert the alkene to the alkane may be carried out by any known chemical pathway." Ex.1004, 279.

The '803 Patent's allegedly distinguishing characteristic over the known conversion of 1-alkenes into 1,2-alkanediols is that the '803 Patent uses non-petroleum carbon source materials, such as plants, which it refers to as "bio" materials. Yet, the '803 Patent fails to explain why the well-known conversion of alkenes to 1,2-alkanediols would operate differently when using the same carbon

molecules from petroleum and non-petroleum sources. Rather, the inventors of the ’803 Patent acknowledge that the invention utilizes the same chemical reactions as petrochemically derived starting material. Ex.1001, 18:30-33 (“Various chemical reactions may be used for this conversion as are known for use in standard alkene to alkanediol conversions using petrochemically derived starting materials…”).

Nonetheless, “bio” 1-alkene feedstocks were well-known in the art. Le,[1] filed nearly a decade before the ’803 Patent, describes creating 1-alkenes with “starting materials of renewable origins.” Ex.1007, [0062]-[0063]. Additionally, one of the inventors of the ’803 Patent, Michael E. Wright, previously filed a patent application, assigned to the U.S. government, describing the well-known use of “bio-1-alkenes.” Ex.1009, [0018].[2] Moreover, Cheng[3] and Furyura[4] separately teach conversion of 1-alkenes to 1,2-alkanediols that reduces objectionable odors.

Cheng’s or Furuya’s conversion of 1-alkenes to 1,2-alkanediols using as starting material the bio-1-alkenes of Le or Wright ’788, renders the claims of the ’803 Patent obvious.

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[1] U.S. Patent Publication No. 2011/0196114A1 to Le, et. al. (“Le”).

[2] U.S. Patent Publication No. 2012/0238788 to Michael E. Wright (“Wright ’788”).

[3] U.S. Patent No. 6,528,665 to Cheng, et. al. (“Cheng”).

[4] U.S. Patent No. 8,173,850 to Furuya, et. al. (“Furuya”).

Therefore, the Board should institute this IPR proceeding and find claims 1-7, 9-11, 24-26, 28, 29, 35 and 36 unpatentable.

II. MANDATORY NOTICES UNDER 37 C.F.R.§42.8(a)(1)

Petitioner satisfies each requirement for *inter partes* Review of the '803 Patent pursuant to 37 C.F.R.§42.8(a)(1).

A. Real Party In Interest Under 37 C.F.R.§42.8(b)(1)

The real party in interest is Symrise AG and Symrise Inc.

Symrise AG's address is:

Mühlenfeldstrasse 1
37603 Holzminden
Germany

Symrise Inc.'s address is:

300 North Street
Teterboro, NJ 07608

B. Related Matters Under 37 C.F.R.§42.8(b)(2)

Petitioner is not aware of any judicial or administrative proceeding involving the '803 Patent.

C. Lead and Back-Up Counsel Under 37 C.F.R.§42.8(b)(3)

Petitioner is represented by the following counsel:

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Pursuant to 37 C.F.R.§42.10(b), Powers of Attorney have been filed with this Petition.

D. Service Information Under 37 C.F.R.§42.8(b)(4)

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E. Certification of Word Count under 37 C.F.R. §42.24(d)

Petitioner certifies that the word count in this Petition, including all footnotes and annotations, is 13,831 words as counted by the word-processing program used to generate this Petition, where such word count excludes the table of contents, mandatory notices, certificate of service, list of exhibits, and this certificate of word count. This Petition is in compliance with the 14,000 word limit set forth in 37 C.F.R. § 42.24(a)(1)(i).

III. FEES UNDER 37 C.F.R.§42.15

All required fees have been paid with the filing of this Petition. If there are any additional or outstanding fees, Petitioner further authorizes the U.S. Patent & Trademark Office to charge Deposit Account No. 50-1662 for these fees, including the fee set forth in 37 C.F.R.§42.15(a) for this Petition.

IV. REQUIREMENTS FOR IPR UNDER 37.C.F.R.§42.104

A. Grounds for Standing (37 C.F.R.§42.104(A))

Petitioner certifies that the ’803 Patent is available for *inter partes* review. Petitioner is not barred or estopped from requesting an *inter partes* review of the ’803 Patent’s claims on the grounds identified in this Petition. 37 C.F.R.§42.104(a).

B. Identification of Claims Being Challenged (37 C.F.R.§42.104(B))

Petitioner asserts that claims 1-7, 9-11, 24-26, 28, 29, 35 and 36 of the ’803 Patent are unpatentable based on the following grounds:

Ground	Prior Art	Basis	Claims Challenged
1	Cheng in view of Le	§103	1-7, 9-11, 24-26, 28 and 29
2	Cheng in view of Wright '788	§103	1-7, 9-11, 24-26, 28 and 29
3	Furuya in view of Le	§103	1-7, 9-11, 24-26, 28, 29, 35 and 36
4	Furuya in view of Wright '788	§103	1-7, 9-11, 24-26, 28, 29, 35 and 36

V. HOW THE CHALLENGED CLAIMS ARE TO BE CONSTRUED UNDER 37 C.F.R.§42.104(b)(3)

In an IPR, claim terms are construed according to the standard set forth in *Phillips v. A.W.H. Corp*., 415 F.3d 1303, 1312 (Fed. Cir. 2005) (*en banc*) (words of a claim are generally given their ordinary and customary meaning). Further, "claim terms need only be construed 'to the extent necessary to resolve the controversy.'" *Wellman, Inc. v. Eastman Chem. Co.,* 642 F.3d 1355, 1361 (Fed. Cir. 2011).

A. "about 5 to about 20 carbon atoms"

Independent claim 1 refers to "a carbon chain length of about 5 to about 20 carbon atoms." The term "about" in claims is a "term of degree" that is definite if the "specification provides examples or teachings that can be used to measure a degree even without precise numerical measurements." MPEP 2173.05(b) citing *Interval Licensing LLC v. AOL, Inc.,* 766 F.3d 1364, 1371-72, (Fed. Cir. 2014).

Furthermore, "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." MPEP 2143.03 citing *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970).

Patent Owner purposefully chose the phrase "about 5" to cover additional carbon chain lengths described in the '803 Patent. Ex.1001, Abstract and 29:24-31. A carbon chain length of 6 is already expressly covered by the range of "about 5 to about 20 carbon atoms." Ex.1001, 8:11-19. Therefore, the only additional scope for coverage by the phrase "about 5 to about 20 carbon atoms" is a carbon chain having a length of 4 carbon atoms to 21 carbon atoms. Ex.1001, 8:5-10. The specification supports this interpretation when disclosing it was known to dehydrate 1-butanol, which has a carbon chain length of 4 carbon atoms. Ex.1001, 7:1-45, 16:53-58.

Further, during the prosecution of a related application also owned by Inolex (U.S. App No 16/262,902, U.S. Patent No. 11,414,365), Patent Owner filed an amendment after allowance to replace the phrase "having a carbon chain length of about 8" with the phrase "having a carbon chain length of 7." Ex.1006, 334 (Amendment After Notice of Allowance filed April 21, 2020, in U.S. App No 16/262,902). The Office entered the amendment, finding it did not enlarge the scope of the claims, thereby confirming the term "about," in relation to the length of a carbon chain, covers one additional carbon atom. Ex.1006, 342.

Moreover, as a practical matter, the claimed phrase "about 5" necessarily includes 4 carbon atoms because carbon atoms are not divisible, *i.e.*, chemical compounds and reactions require entire carbon atoms, not partial carbon atoms. Ex.1001, 8:5-10. Similar language was construed in *Pieczenik v. Dyax Corp.*, 226 F.Supp.2d 314 (D. Mass. 2002). In its analysis, the court noted the word "about" is used in patent claims as a "warning," signaling that exactitude is not being claimed. *Id*. at 317. The court construed the claimed phrase "from about 4 to about 12 L-amino acid residues" to mean "a range of from 3 to 13 of such residues." *Id.* at 323. Like carbon atoms, L-amino acid residues are not divisible but exist in discrete units.

Finally, in related IPR2023-01035, Patent Owner filed a Patent Owner Preliminary Response ("the '035 POPR") on September 21, 2023 arguing this limitation should be construed to delete to the word "about" and add in a new limitation reciting "permitting trace impurities and minor undesired fractions." *See* '035 POPR at 11-12. Yet, even the case law quoted by Patent Owner states claims should not be construed to "revise or ignore the explicit language of the claims." *Id*. at 14 citing *Tubular Rollers, LLC v. Maximus Oilfield Prods., LLC*, Case No. 2021-2319, 2023 WL 4230371 at *11 (Fed. Circ. Jun 28, 2023) Thus, Patent Owner's construction improperly 1) ignores the explicit term "about" by removing it from the claim and 2) revises the claim to include an additional limitation reading "permitting

trace impurities and minor undesired fraction." Patent Owner's attempt to re-write the express words of the claim through its construction is not persuasive.

Accordingly, the claim limitation "a carbon chain length of about 5 to about 20 carbon atoms" should be construed to mean "a carbon chain length with a minimum of 4 carbon atoms and a maximum of 21 carbon atoms."

VI. OVERVIEW OF THE '803 PATENT

A. Summary of the Disclosure of the Claimed Subject Matter

The '803 Patent generally relates to sustainable antimicrobial compounds that use well-known natural and renewable preservation systems. Ex.1001, 1:20-26. More specifically, the specification discusses the "preparation of natural and renewable 1,2-alkanediols, methods for making natural and renewable 1,2-alkanediols and compositions," including 1,2-alkanediols derived from natural and renewable feedstocks. *Id.,* 1:26-30 and 3:14-20.

Thus, according to the '803 Patent, the process for synthesizing bio-1,2-alkanediols in the '803 Patent is "natural" because "preferably all of the carbons in the compound" are also "authentic natural compounds derived from plant sources (algae-, plant-, animal- or biomass-derived) and are non-petrochemically derived (*i.e.*, not derived from a non-renewable resource such as fossil fuel, petroleum or other "old" carbon source)." *Id.,* 7:65 and 12:45-50.

In the ’035 POPR, Patent Owner cites to a portion of the specification about known methods of making bio-1-butene, like Wright ’788, which are distinguishable from the invention because “salinization of the catalyst leads to a loss of regioselectivity” in those methods. Ex.1001 at 7:19-45; *see* ’035 POPR at 4-5. First, the claims of the ’803 Patent do not require the regioselectivity be maintained for any period of time. Second, both the specification of the ’803 Patent and Wright ’788 disclose that salinization of the catalyst “may” occur rather than required. Ex.1001 at 7:31-33 (“support **may** be further treated with an organosilane”)(emphasis added)[5]; Ex.1009, [0022]. Therefore, any loss in regioselectivity over time due to salinization of the catalyst is irrelevant to the claims and the arguments presented below.

B. Summary of the Prosecution of U.S. Patent No. 10,882,803

The ’803 Patent was filed on Jan. 30, 2019, as Application No. 16/262,898 (“the ’898 Application”). On August 6, 2019, the Examiner issued the only Office Action, which included rejections under 35 U.S.C.§§ 112(b) and 103. Ex.1004, 122.

The Examiner rejected claims 1-34 under 35 U.S.C.§ 112(b) as incomplete for omitting an “essential step” for converting the bio-alkene to a bio-1,2-alkanediol. *Id.*, 123. The Examiner identified a missing conversion procedure described in

[5] Emphasis always added unless otherwise noted.

Example 7 of the '898 Application, namely "where the initial reactants are formic acid and hydrogen peroxide an **additional reaction step** is needed before the possible use of hydrolysis in order to complete the formation of the diol." *Id.*, 124.

In response to the rejection under 35 U.S.C.§ 112, Applicant pointed to the alleged importance of their "unique starting material," the well-known bio-1-alkenes. With respect to the "essential step" of converting the bio-1-alkene into a bio-1,2-alkanediol, Applicant argued this reaction step is well-known in the art. Applicant explained, "the invention as claimed is focused on providing a process that uses a **unique starting material** that allows for formation of a unique end product upon chemical conversion." *Id*., 279. With respect to the chemical conversion, "[t]he chemical pathway to convert the alkene to the alkane may be carried out by **any known chemical pathway** for this purpose." *Id*. Applicant further explained, "the specific pathway for conversion of the **unique bio-alkene starting materials** of high regioselectivity **need not occur in a particular manner** so long as the bio-alkenes as claimed are processed chemically to result in the bio-1,2-alkanediols." *Id*. Accordingly, Applicant concluded, "[o]ne skilled in the art at the time of the invention would appreciate that the applicant's invention as claimed is focused on providing a process that uses a **unique starting material** that allows for formation of a unique end product upon chemical conversion." *Id*.

The Examiner rejected claims 35-41 under 35 U.S.C. §103 as obvious over Wright et al. (WO 2016/007196). Ex.1004, 127. The Office Action explained, "Wright discloses a method for treating a catalyst for use in the dehydration of alcohols to diene products." *Id*., 126. Therefore, "Wright teaches the elements of the claimed invention with sufficient guidance, particularity, and with a reasonable expectation of success, that the invention would be prima facie obvious to one of ordinary skill before the effective filing date of the claimed invention." *Id*.

Applicant failed to overcome the rejection, and instead responded by simply canceling the rejected claims (claims 35-41). *Id.*, 278.

Following Applicant's response, the Examiner allowed the '898 Application. *Id.*, 287-294. The Examiner's Reason for Allowance identifies U.S. Patent No. 7,385,092 to Osterhold et al. ("Osterhold") as the closest prior art. *Id.*, 293. Rather than relying on the "unique starting material" highlighted by Applicant, the Examiner found that Osterhold, the "closest prior art," failed to teach the "additional base hydrolysis to obtain the final 1,2-alkanediol." *Id.*, 293.

Yet, the claims do not recite "base hydrolysis" or any other specific process to convert a bio-1-alkene to a bio-1,2-alkanediol. Moreover, the Examiner's reason for allowance contradicts Applicant's admission that "convert[ing] the alkene to the alkane may be carried out by any known chemical pathway" and not just via "base

hydrolysis." *Id.*, 279. Nonetheless, the prior art cited in this IPR teach the claimed processes for the reasons provided below.

VII. OVERVIEW OF THE PRIOR ART

A. Summary of Cheng

Cheng was filed on April 3, 2002 and published on Mar. 4, 2003. Cheng is prior art to the '803 Patent under at least 35 U.S.C.§102(a)(1) since it issued prior to the effective filing date of the '803 Patent.

Cheng describes forming an intermediate epoxyalkane from an alkene mixed with hydrogen peroxide, in the presence of a heavy metal catalyst. Ex 1010, 1:11-14. The epoxyalkane is converted to an alkanediol, "especially vicinal alkanediols" by hydrolysis of the epoxyalkane. *Id.*, 1:6-10. The resulting alkanediol exhibits "reduced odor." *Id.*, 1:23-30. Cheng's method therefore provides a commercially viable mechanism for generating clean (odor-free) vicinal alkanediols without requiring further additional procedures to remove byproducts. *Id.*, 1:23-30.

Example 1 of Cheng feeds "1-hexene and 70% H_2O_2" into an epoxidation reactor. *Id.*, 13:61-66. Once reaction conditions are stabilized, $Na_2WO_4H_2O$ and H_2SO_4 are added, followed by addition of a peroxotungstate solution. *Id.*, 14:4-31. As the temperature begins to rise, "1,2-epoxyhexane is formed." *Id.*, 14:31 (describing four different methods for hydrolysis, each producing different percentage of 1,2- hexanediol).

Cheng highlights a method for chemically treating epoxyalkanes to form alkanediols without "adversely affecting the product or materially reducing the yield." *Id*., 1:23-35. Cheng's examples create 1,2-alkanediols with yields of 99.2% in Example 2, 99.1% in Example 3, 98.2% in Example 4, and 98.4% in Example 5. *Id*., 15:64, 16:38, 17:11, and 17:57.

B. Summary of Furuya

Furuya was filed on August 19, 2011 and published on December 8, 2011. Furuya is prior art to the '803 Patent under at least 35 U.S.C.§102(a)(1).

Furuya relates to the production of alkanediols with a process that reduces by-products responsible for objectionable odors, making the alkanediols more appropriate for cosmetic use. Ex.1013, 1:17-22.

Furuya explains that an "alkanediol composition may be produced by oxidizing an olefin into an epoxy compound and subsequently hydrolyzing the epoxy compound." *Id.,* 3:41-44. More specifically, Furuya teaches that an olefin may be oxidized with hydrogen peroxide, a peroxide compound, or an inorganic oxidizing agent. *Id.,* 3:44-46. Furuya also explains that the alkanediols made with its process have "at least four carbon atoms." *Id.,* 2:65-66. Furuya provides several examples creating alkanediols, each with varying carbon chain lengths, including 8, i.e., 1,2-octanediol. *Id.,* 8:6-31; *see also* 8:33-46 (describing producing 1,2-decanediol and a 1,2-dodecanediol from alpha-olefins).

C. Summary of Le

Le was filed as a PCT application with the U.S. Patent and Trademark Office on September 22, 2009, and published on August 11, 2011, as US 2011/0196114. Le is prior art to the ’048 Patent under at least 35 U.S.C.§102(a)(1) since it was published prior to the effective filing date of the ’803 Patent. *See, e.g.,* Ex.1007.

Le describes a process of polymerizing an olefin having 6 to 9 carbon atoms from “renewable materials” to produce a polymer. *Id*., [0002]. Le uses olefins derived from renewable sources. *Id*., [0007], [0008], [0019] and [0021].

The first step of creating the polymer is to form an olefin. *Id*., [0062]-[0063]. The olefin is formed using renewable material, a natural resource derived from an animal or plant, which can be “renewed as quickly as it is consumed.” *Id*., [0037]; *see also* [0050]-[0052]. The renewable materials include an unsaturated fatty acid with “an unsaturation of C=C type.” *Id*., [0055]. For example, one embodiment of the invention advantageously uses plant oil, preferably ricinoleic acid. *Id*., [0056].

Le describes obtaining and dehydrating an alpha-alcohol. *Id*., [0094]-[0100]. The dehydration process is carried out in the presence of a dehydration catalyst, *e.g.*, a gamma-alumina-based catalyst, “in a reactor so as to form a mixture of alkene and water.” *Id*., [0062]-[0063]. The temperature, *e.g.*, between 250 to 400 °C, and pressure, *e.g.*, partial vacuum, are chosen “such that the alcohol is in vaporized form”

during the reaction. The bio-1-alkene is created by dehydrating the alcohol in the alpha position, creating "a single isomer (an alpha-olefin)." *Id*., [0068].

D. Summary of Wright '788

Wright '788 was filed on March 29, 2012, and published on September 20, 2012, as US 2012/0238788. Wright '788 is prior art to the '803 Patent under at least 35 U.S.C.§102(a)(1) since it was published prior to the effective filing date of the '803 Patent.

Wright '788 relates to conversion of terminal alcohols to corresponding terminal alkenes with high regioselectivity and chemical yields. Ex 1009, [0003]. Note that high regioselectivity is different from high chemical yields. Wright '788 discloses a catalyst system and process for converting a feed of terminal bio-alcohol in water and producing a corresponding alpha-olefin with 92-99% regioselectivity. Further, the reaction can occur in a single pass over the catalyst system with a chemical conversion of greater than 95%. *Id*., [0008].

Particularly, Wright '788 describes a method for dehydrating bio-1-alcohol with a catalyst to produce bio-1-alkene with high regioselectivity (>95%). *Id*., [0018].

Wright '788's catalyst can be $ZnAl_2O_4$ or "an alumina-based catalyst specifically washed with base solutions. In other embodiments, the catalyst is an alumina-based catalyst modified with an organosilane." *Id*., [0020] and [0022]. In

some embodiments, the heating step "ranges from temperatures of about 300 °C. to 420 °C." *Id*., [0022].

VIII. HOW THE CONSTRUED CLAIMS ARE UNPATENTABLE UNDER 37 C.F.R.§42.104(b)(4)

A. Level of Skill in the Art

In view of the subject matter of the '803 Patent, a person of ordinary skill in the art ("POSITA") would have 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*. Ex.1002, ¶¶15-16. In support of the Petition, Petitioner has submitted the declaration of Douglass Taber who is well qualified to opine on the knowledge of a POSITA with respect to the issues raised in this petition. Ex.1002, ¶¶2-4.

B. Summary of Arguments

The '803 Patent claims a process for synthesizing bio-1,2-alkanediols having a carbon chain length between about 5 and about 20 atoms.

This process is not new and is both in the prior art and PO has admitted that the process was known. For example, both Cheng and Furuya teach using alkenes as a starting material and producing alkanediols having reduced odors. Ex.1002, ¶27. In both Cheng's and Furuya's processes, a 1-alkene produces a 1,2-alkanediol. *Id*.

This process of Cheng or Furuya is illustrated below:

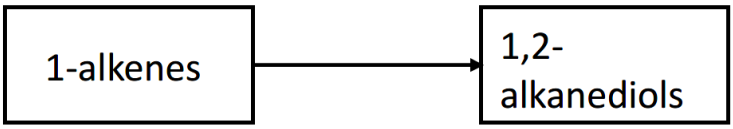


Illustration of Cheng or Furuya teachings

Further, plant-derived precursors were known to produce 1,2-alkanediols in the claimed percentages using chemical reactions that a POSITA routinely implemented. Ex.1002, ¶¶22-25 and 57. For instance, as set out in the Le and Wright '788 references, plants are processed into bio-alcohols with chain lengths of four or more carbons. Ex.1002, ¶26. These bio-alcohols are converted into bio-1-alkenes with the same carbon chain length via highly-regioselective dehydration. *Id*. The high regioselective dehydration reactions set out in Le or Wright '788 result in greater than 95% bio-1-alkene. *Id*.

Compounds formed from new carbon atoms, such as Le or Wright '788, will have the same properties and chemical reactivity as compounds formed from fossil carbon atoms. Ex.1002, ¶¶30-32. The choice of new carbon versus fossil carbon starting materials might be driven by other considerations but would not be based on any fundamental differences in the chemistry. Ex.1002, ¶33; *see also* Ex.1031 and 1032. An important class of known bio-compounds is bio-alcohols, which were widely used before the priority date

of the ’803 Patent. Ex.1002, ¶¶34-38; *see also* Ex.1020, 1021, 2022, 1023, 1027 and 1036.

The relevant source and outputs of Le or Wright ’788 processes are illustrated below:

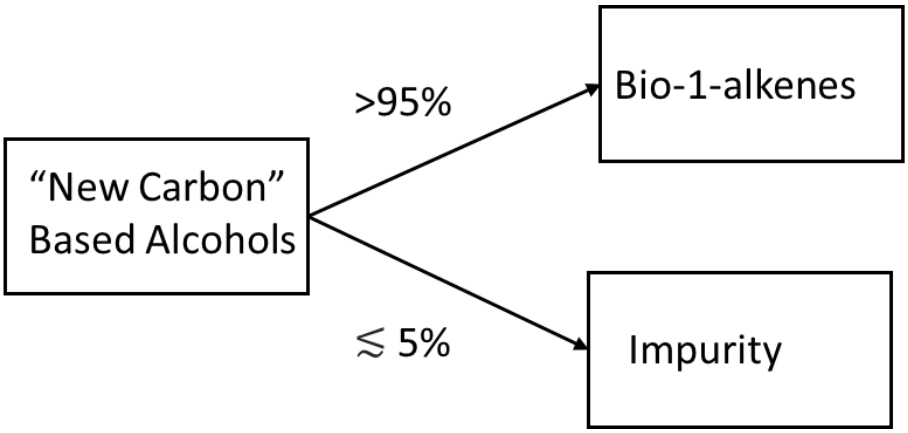


Illustration of Le or Wright ’788 teachings

When using the Le or Wright ’788 bio-1-alkene as the starting material, the result of Cheng or Furuya’s process would be a plant-derived bio-1,2-alkanediol with reduced odor. Ex.1002, ¶28. Moreover, since the starting material from Le or Wright ’788 is highly selective, it contains more than 95% bio-1-alkene, the resulting material would likewise contain more than 95% bio-1,2-alkanediol and less than 5% impurity. Ex.1002, ¶28; *see also* Ex.1006, 579 (arguing to the Examiner in related application that “the conversion of the bio-1-alkene to the corresponding claims bio-1,2-alkanediol occurs near unity yield, and therefore, the bio-1-alkene regioselectivity is largely responsible for providing the purity of the resulting claims bio-1,2-alkanediol composition.”).

When these teachings are viewed together, the processes claimed in the ’803 Patent are obvious, as illustrated below.

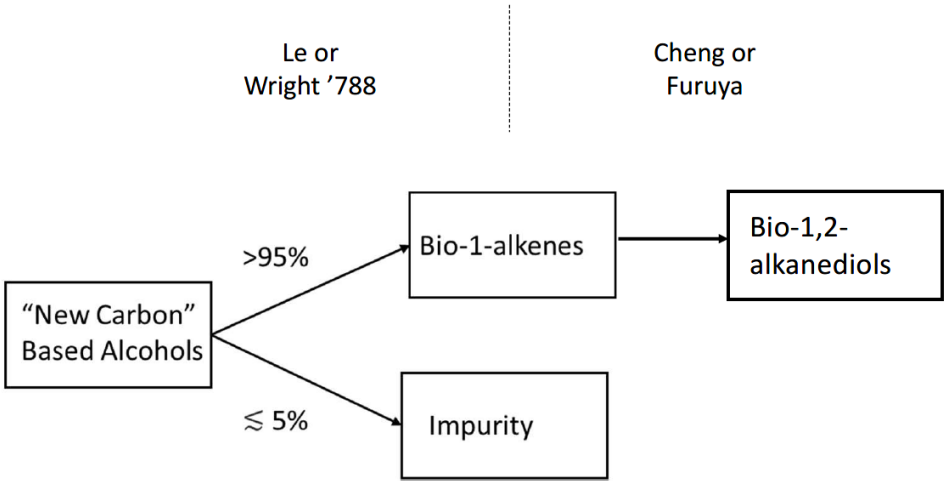


Illustration of combined teachings of prior art

As such, a POSITA looking to improve environmental impact while reducing reliance on petroleum for this conversion would look to Le or Wright ’788, which teach a process to make 1-alkenes from plant-derived sources. Ex.1002, ¶¶28-29.

Finally, a POSITA would have understood that all the chemical products and reactions claimed in the ’803 Patent had been well-known for decades. Ex.1002, ¶¶39-40. The dehydration of a 1-alcohol to a 1-alkene is a well-known and widely studied chemical reaction that appeared in entry-level organic chemistry textbooks prior to the ’803 Patent. Ex.1002, ¶¶41-48; *see e.g.,* Ex.1024, 1029, 1030, 1034, 1035 and 1037. This dehydration reaction has been commercialized for decades and practiced on metric ton scale. Ex.1002, ¶47 and ¶53. Further, it was known to optimize this reaction to

produce 1-alkenes, for example, by adjusting reaction temperatures, modifying catalysts, changing flow rates. Ex.1002, ¶¶49-52; *see e.g.*, Ex.1025, 1026 and 1028.

Likewise the conversion of 1-alkene to a 1,2-alkanediols was a well-known reaction described in numerous papers prior to the '803 Patent. Ex.1002, ¶¶54; *see e.g.,* Exs. 1030 and 1041-1050. In addition, a POSITA would understand that as part of this process it was known to add a hydroxide to maximize yield then epoxidizing the 1-alkene and opening the epoxide with water or carboxylic acid to form the corresponding 1,2-alkanediol. Ex.1002, ¶¶55-56; *see e.g.,* Exs. 1030, 1040, and 1041.

C. Claims 1-7, 9-11, 24-26, 28 and 29 are rendered obvious under 35 U.S.C.§ 103 by Cheng in view of Le

Cheng describes a "commercially attractive way" for generating 1,2-alkanediols from 1-alkenes. Ex.1010, 1:40-45. A POSITA understands that Cheng's conversion process can use Le's bio-1-alkenes having 6 to 9 carbon atoms derived from "renewable materials". Ex.1007, [0002]; Ex.1002, ¶58. A POSITA would be motivated to convert the bio-alkenes of Le into 1,2-bio-alkanediols according to Cheng's process because "…vicinal alkanediols, such as 1,2-alkane diols…" are useful in commercial applications; and Cheng's method is a "commercially attractive way[]" for carrying out the conversion without objectionable odors

commonly associated with the 1,2-alkanediols. Ex.1010, 1:6-10 and 1:40-48; Ex.1002, ¶58.

A POSITA would also understand that an alcohol, regardless of whether it is from a natural source or a petroleum source, predictably dehydrates to a corresponding alkene that predictably converts to a corresponding 1,2-alkanediol. Ex.1002, ¶60. Further, a POSITA understands that the choice of bio-based versus petroleum starting materials would likely be driven by many considerations, *e.g.*, marketing, cost, and availability. Ex.1002, ¶58. In addition, a POSITA would be motivated to use bio-1-alkenes of Le (derived from natural feedstocks) instead of petrochemically derived 1-alkenes to reduce environmental impacts associated with fossil fuels. Ex.1007, [0009]-[0013]; Ex.1002, ¶59. In fact, Patent Owner admits that there is no fundamental difference in how reactions take place between "new" carbon (e.g., plant derived) and "old" carbon (e.g., petroleum derived). Ex.1001, 18:30-43 (admitting that new and old carbon reactions are interchangeable). Accordingly, it would be obvious to a person of skill in the art to use the bio-1-alkenes of Le to produce bio-1,2-alkanediols according to the procedures outlined by Cheng. Ex.1002, ¶61.

1. Claim 1

[1.1] A process for the synthesis of bio-1,2-alkanediols, comprising: providing a bio-alkene having a carbon chain of about 5 to about 20 carbon atoms and a bio-1-alkene regioselectivity of at least about 80%[6]; and

Cheng teaches how to convert alkenes having carbon chain length of 2 to 12 carbon atoms to corresponding 1,2-alkanediols. Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:35-41, 11:20-41 and 13:40-50, *see also* 13:58-18:59 (providing Example 1 converts 1-hexane to an intermediate 1,2-epoxyhexane and Examples 2-6 convert the intermediate 1,2-epoxyhexane into 1,2-hexanediol). The corresponding 1,2-alkanediols have a carbon chain length of 2 to 12 carbon atoms because the starting 1-alkenes have a carbon chain length of 2 to 12 carbon atoms. Ex 1002 ¶62. A carbon chain length of 2 to 12 carbon atoms overlaps with the claimed carbon chain length of about 5 to about 20 carbon atoms.

To the extent that Cheng does not specifically characterize its 1-alkenes as "bio"-1-alkenes or as the 1-alkenes having a "regioselectivity of at least about 80%," this is remedied by Le. *See, e.g.,* Ex.1007. Le describes alkenes (olefins) "obtained

[6] Because arguments under 35 U.S.C. §112 are not considered in IPR proceedings, Petitioner will note that to the extent that the specification supports providing a bio-alkene having a regioselectivity, the prior art provides equivalent disclosure. Petitioner reserves the right to raise invalidity based on 35 U.S.C. §112 in an appropriate proceeding because reactions have regioselectivity, not chemicals in isolation.

from a fatty substance consisting of a plant oil…extracted from renewable resources." *Id*., [0023]; *see also* [0027]-[0028], [0036]-[0037], [0053]-[0057], [0062]-[0063], [0086]-[0089] and [0094]-[0117]. Le explains, "oil comprising ricinoleic acid, preferably castor oil" is processed to obtain heptan-1-ol (1-heptanol), which is dehydrated "to form 1-heptene." *Id.,* [0101]-[0105].

A POSITA understands the alcohol (*e.g.*, 1-heptanol) and the alkene (*e.g.*, 1-heptene) in Le's method are a bio-1-alcohol and a bio-1-alkene because they are derived from renewable plant oils, rather than petroleum or other fossil fuel sources. Ex.1002, ¶¶63-64; *see also* Ex.1001, 13:53-55 ("bio-alkenes may be bio-1-pentene, bio-1-iso-pentene, bio-1-hexene, bio-1-heptene, …"). Indeed, the '803 Patent expressly notes that non-petrochemically derived products are known in the art as "bio" products, such as products "derived from the carbon of plant sources." *Id*., 3:26-56.

Le describes "an olefin[/alkene], derived from renewable materials, having a number of carbon atoms included in the range of from 6 to 9." Ex.1007, [0002]; *see also* [0007], [0019]-[0020], [0059], and [0117]. Le provides specific examples teaching a POSITA how to dehydrate C_6-C_9 alcohols to their respective alkenes. *Id*., [0094]-[0105], [0110]-[0114] and [0117]; *see also,* [0168]-[0174] (describing dehydrating bio-1-heptanol derived from castor oil to produce bio-1-heptene);

Ex.1002, ¶65. The chain lengths of bio-1-hexene, bio-1-heptene, and bio-1-nonene are respectively 6, 7 and 9 carbon atoms. Ex.1002, ¶65.

While Le does not use the word "regioselectivity," regioselectivity merely describes the preference of a process to form one specific regioisomer over another regioisomer. Ex.1002, ¶¶66 and 68. Le discloses a process that "makes it possible to produce predominantly one olefin with a very limited number of isomers." Ex.1007, [0012] and [0021]; Ex.1002, ¶67. Le also teaches that when a bio-1-alcohol is dehydrated, "a single isomer (an alpha-olefin) is obtained" contrasted to "when the saturated alcohol is not in the alpha-position, a mixture of two isomers is formed." Ex.1007, [0068]; Ex.1002, ¶¶67-69. As previously discussed, alpha-olefin is another term for a 1-alkene. Ex.,1002 at ¶67. Finally, Le provides at least one example where the bio-1-alcohol was purified prior to dehydrating the pure bio-1-alcohol to form a corresponding bio-1-alkene. Ex.1007, [0171] ("After separation of 1-heptanol from the other compounds, the 1-heptanol is injected, in order to dehydrate it, …"), and [0172] ("the mixture of water and 1-heptene produced"); Ex.1002, ¶67.

Therefore, a POSITA understands that even though Le does not use the term regioselectivity, Le's method of obtaining a single isomer of the bio-1-alkene results in a bio-1-alkene regioselectivity of greater than 95%, which is "at least about 80%." Ex.1002, ¶69.

[1.2] converting the bio-alkene to a bio-1,2-alkanediol having a carbon chain length of about 5 to about 20 carbon atoms.

Patent Owner conceded that converting a bio-1-alkene to a corresponding bio-1,2-alkanediol having a carbon chain length of about 5 to about 20 carbon atoms was well-known prior to filing the '803 Patent. Ex.1001, 18:30-43; Ex.1002, ¶70. Indeed, Applicant acknowledged that "[t]he chemical pathway to convert the alkene to the alkane may be carried out by any known chemical pathway" and "need not occur in a particular manner." Ex.1004, 279. The '803 specification further acknowledges that:

> Various chemical reactions may be used for this conversion as are known for use in standard alkene to alkanediol conversions using petrochemically derived starting materials and/or that are used for smaller chain bio-alkanes.

Ex.1001, 18:30-33.

Cheng discloses a "known chemical pathway" for the claimed conversion when it describes converting 1-alkenes having carbon chain lengths of 2 to 12 into corresponding 1,2-alkanediols. Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:20-41 and 13:40-50; *see also* 13:58-18:59 (providing Example 1 converts 1-hexane to intermediate 1,2-epoxyhexane and Examples 2-6 convert the intermediate 1,2-epoxyhexane into 1,2-hexanediol); Ex.1002, ¶71. Cheng states, "[i]n Examples 3-5, 1,2-hexanediol is produced by hydrolysis from 1,2-epoxyhexane which in turn was produced in Example 1 by oxidation of 1-hexene with hydrogen peroxide using a

peroxotungstate catalyst." *Id.,* 13:40-43. Cheng also provides that "various epoxidizable olefinic compounds can be epoxidized and purified in the practice of this invention." *Id.,* 11:29-30; *see also* 11:35-41 (providing 1-alkenes having 2 to 12 carbon atoms are used in the conversion reaction).

A POSITA understands Cheng's process for converting 1-hexene to 1,2-hexanediol refers to a starting and final product having a chain length of 6 carbon atoms. Ex.1002, ¶72. Likewise, a POSITA would appreciate that because Cheng explicitly refers to 1-alkenes having carbon chain lengths of 2 to 12 atoms, the process for creating 1,2-alkanediols would predictably yield 1,2-alkanediols having chain lengths of 2 to 12 carbon atoms. Ex.1002, ¶72; *see also* Ex.1010, 11:35-41.

Accordingly, a POSITA would recognize Cheng's process forms 1,2-alkanediols with carbon chain lengths of 2 to 12 carbon atoms, overlapping the claimed carbon chain length of about 5 to about 20. Ex.1010, 11:35-41; Ex.1002, ¶72.When combined with Le's teaching of bio-1-alcohols having carbon chain lengths of 6 to 9 atoms, Cheng teaches a process to convert Le's bio-1-alcohols to bio-1,2-alkanediols having a carbon chain length of at least 6 to 9 carbon atoms. Ex.1002, ¶72.

2. Claims 2-5

> **Claim 2[/3/4]. The process of claim 1[/2/3], wherein the bio-alkene and the bio-1,2-alkanediol each have a carbon chain of about 6 to about 14[/10/8] carbon atoms.**
>
> **Claim 5. The process according to claim 1, wherein the bio-alkene is bio-octene and the bio-1,2-alkane diol is bio-1,2-octanediol.**

Le teaches "an olefin[/alkene], derived from a renewable source, "having a number of carbon atoms included in the range of from 6 to 9." Ex.1007, [0002]; *see also* [0007], [0019-0020], [0059] and [0117] (describing Le's invention producing alkenes with 6 to 9 carbon atoms); Ex.1002, ¶73.

As discussed above, in addition to teaching bio-alkenes of 6 to 9 carbon atoms, Le also teaches specific examples for dehydrating bio-1-hexanol, bio-1-heptanol, and bio-1-nonanol into bio-1-hexene, bio-1-heptene, and bio-1-nonene. Ex.1007, [0094]-[0105]; *see also* [0168]-[0174] (providing an example involving dehydrating bio-1-heptanol derived from castor oil to make bio-1-heptene); *see also* Ex.1002, ¶74. Carbon chains of 6 to 9 carbon atoms are within the ranges of 6 to 14 (claim 2), 6 to 10 (claim 3), 6 to 8 (claim 4), and 8 carbon (claim 5). Ex.1002, ¶74.

Le gives an example of dehydrating bio-2-octanol into a mixture of bio-1-octene and bio-2-octene. Ex.1007, [0106]-[0109]. While this specific example of Le uses bio-2-octanol instead of bio-1-octanol, Le's teachings are not so limited. Ex.1002, ¶75. A POSITA would expect a bio-2-octanol to have greater isomerization

during dehydration than a bio-1-octanol, and would also understand that Le chose bio-2-octanol for its easy availability, not because of any technical issue with using bio-1-octanol. Ex.1007, [0068]; Ex.1002, ¶75. A POSITA would expect a bio-1-octanol used in the process above to produce "a single isomer (an alpha-olefin)," bio-1-octene. Ex.1007, [0068]; Ex.1002, ¶75. Therefore, a POSITA would recognize that if the desired end-product were bio-1-octene (instead of a mixture of bio-1-octene and bio-2-octene), starting with bio-1-octanol would result in the formation of primarily bio-1-octene. Ex.1002, ¶75.

Likewise, as discussed above, Cheng teaches "[i]n Examples 3-5, 1,2-hexanediol is produced by hydrolysis from 1,2-epoxyhexane which in turn was produced in Example 1 by oxidation of 1-hexene with hydrogen peroxide using a peroxotungstate catalyst." Ex.1010, 13:40-43. A POSITA understands that Cheng's disclosure of a process for converting 1-hexene to 1,2-hexanediol refers to a carbon chain length of 6 carbon atoms. Ex.1002, ¶76. Cheng also explicitly discloses the conversion of 1-octene to 1,2-octanediol, which both have carbon chain lengths of 8 carbon atoms. Ex.1010, 11:35-41 (starting alkenes include 1-octene). A carbon chain of 6 carbon atoms is within the ranges of 6 to 14, 6 to 10 and 6 to 8 carbon atoms recited in claims 2, 3, and 4 respectively. Ex.1002, ¶76.

Finally, a POSITA understands that the process for synthesizing 1,2-alkanediols provided by Cheng would predictably yield 1,2-alkanediols having

various chain lengths from 2 to 12 because Cheng explicitly refers to 1-alkenes having a carbon chain length of 2 to 12 carbon atoms, such as 1-octene. Ex.1002, ¶77; *see also* Ex.1010, 11:35-41. A POSITA would likewise appreciate that using Le's bio-1-octene in Cheng's conversion process would result in bio-1,2-octanediol. Ex.1002, ¶77.

In sum, a POSITA would recognize the combination of Cheng and Le forms bio-1,2-alkanediols with carbon chain lengths of 2 to 12 atoms, thereby teaching the subject matter of each claim, for claims 2, 3, 4, and 5. Ex.1002, ¶77.

3. Claim 6

> **The process according to claim 1, wherein the bio-alkene results from a process wherein a bio-1-alcohol is dehydrated by heating the bio-1-alcohol in a reactor with a catalyst.**

Le teaches a process for dehydrating a bio-1-alcohol into a bio-1-alkene/olefin. Ex.1007, [0023]; *see also* [0036]-[0037], [0053]-[0057], [0062]-[0063], [0086]-[0089] and [0101]-[0105]; Ex.1002, ¶¶78-81

With regards to dehydrating the bio-alcohol, Le teaches:

> In order to form the olefin (a) according to the process of the invention, a dehydration step is carried out in a reactor so as to form a mixture of alkene and water. This dehydration step can be carried out in the presence of a dehydration catalyst, for example a γ-alumina-based catalyst, which may be acidic or basic, in the presence of the alcohols obtained from the starting materials of renewable origin.

Ex.1007, [0062]-[0063]; *see also* Ex.1002, ¶¶79-82; Ex.1007, [0066], [0119] and [0171]. The alcohol is dehydrated in the reactor by heating it at least within the exemplary temperature range of 250 to 400 °C. Ex.1007, [0065] and [0171] Ex.1002, ¶79.

Therefore, a POSITA understands that Le teaches dehydrating a bio-1-alcohol (*e.g.*, bio-1-hexanol to bio-1-nonanol derived from plant oil) by heating the bio-1-alcohol in a reactor (*e.g.*, at 250 to 400 °C) with a catalyst (*e.g.*, a γ-alumina catalyst) to form a bio-1-alkene (*e.g.*, bio-1-hexene to bio-1-nonene). Ex.1002, ¶82.

4. Claim 7

The process according to claim 6, wherein the reactor is a fixed bed reactor.

Le teaches an example using a tubular reactor with a catalytic bed to dehydrate bio-1-heptanol to bio-1-heptene. Ex.1007,[0171]. This reactor would be a fixed bed reactor because the catalytic bed is a fixed layer of "ESM110® alumina" within the tubular reactor that promotes the dehydration of the 1-heptanol. Ex.1007, [0171]; Ex.1002, at ¶83.

5. Claim 9

The process according to claim 6, wherein the catalyst is selected from $ZnAl_2O_4$ and a γ-alumina catalyst.

Le teaches the catalyst used in the dehydration reaction can be γ-alumina with varying parameters, such as the catalyst being acidic, basic, doped, powder,

granules, and having various pore sizes. Ex.1007, [0062]-[0064], [0066], [0119] and [0171]; Ex.1002, ¶84. Specific examples of commercially available catalysts used in Le are "ESM 110®" produced by Eurosupport and "Pural® KR1" produced by Sasol®. Ex.1007, [0064] and [0066]; Ex.1002, ¶84.

6. Claims 10-11

> **10. The process according to claim 9, wherein the bio-alkene has a bio-1-alkene regioselectivity of about 92% to about 99%.**
>
> **11. The process according to claim 10, wherein the bio-alkene have a bio-1-alkene regioselectivity of about 95% to about 99%.**

As discussed above with respect to Claim 1, a POSITA would understand that Le's method obtains a single isomer of a bio-1-alkene that comprises a regioselectivity greater than 95% to about 99%. Ex.1002,¶¶85-91.

Therefore, a POSITA would understand that even though Le does not use the term regioselectivity, Le's method of obtaining a single isomer of the bio-1-alkene results in a bio-1-alkene regioselectivity greater than 95%, which is at least about 92% to 99%. Ex.1002, ¶¶85 and 92. Accordingly, claims 10 and 11 are rendered obvious.

7. Claim 24

> **The process according to claim 6, wherein the bio-alkene undergoes a distillation step to refine the bio-alkene prior to converting the bio-alkene to the bio-1,2-alkanediol.**

Le teaches the bio-1-alkene can be purified using known techniques, including "a distillation step." Ex.1007, [0067]; *see also* [0173] (describing an example with

the step of purifying 1-heptene); Ex.1002, ¶93. A POSITA would have refined the bio-1-alkene from Le prior to converting it to a bio-1,2-alkanediol in order to purify the input material to Cheng's process thereby improving the efficiency and yield of Cheng's process. Ex.1002, ¶94.

8. Claim 25

> **The process according to claim 6, wherein the bio-1,2-alkanediol formed from the bio-alkene undergoes a final distillation step to refine the bio-1,2-alkanediol.**

Cheng describes a distillation step for the 1,2-alkanediol. *See, e.g.,* Ex.1010, Examples 2-5, *see also* 14:61-17:63. In particular, in Example 2, part (c) "[a] batch distillation column" is used to refine the 1,2-hexanediol. *Id*, 15:25-36 ("1,2-[hexanediol] was then recovered in the distillate" and analyzed to be 98.9% of the distillate). A POSITA would likewise utilize this distillation step in the combination of Le and Cheng to refine the bio-1,2-alkanediol into a purer 1,2-alkanediol product for use as a more efficient input into additional chemical processes. Ex.1002, ¶95.

9. Claim 26

> **The process according to claim 1, wherein the bio-alkene results from a process wherein the bio-1-alcohol in water is dehydrated by heating the bio-1-alcohol with a catalyst under a purge gas.**

Claim 26 is similar to claim 6 but adds in limitations for "in water" and "under a purge gas." Le teaches claim 6 as described above. In addition, Le teaches dehydrating a bio-alcohol in the presence of a catalyst under an inert purge gas such

as "nitrogen, helium, argon, water, methane, propane, butane, and the other aliphatic or aromatic hydrocarbons." Ex.1007, [0065]-[0066]; Ex.1002, ¶96. Further, water was used earlier in the process, *e.g.*, during the cracking step. Ex.1007, [0169]-[0171]. A POSITA understands that without an explicit drying step, some water would be present in the starting bio-1-alcohol, and Le does not explicitly dry the starting bio-1-alcohol. Ex.1002, ¶96. In addition, the bio-1-alcohol will also be in water, at least because the dehydration process generates water in the mixture being dehydrated. Ex.1007, [0062] ("a dehydration step is carried out in a reactor so as to form a mixture of alkene and water."); Ex.1002, ¶96.

10. Claims 28-29

> **Claim 28[/29]: The process according to claim 1, wherein the process yields at least about 60%[/72%] to about 99% of the bio-1,2-alkanediol.**

Cheng calculated an 83% yield for its epoxidation reaction. Ex.1010, 14:52-53. Following Example 2 of Cheng, 318 g of epoxyhexane is 3.18 mols, and the distilled product, 1,2-hexanediol, weighed 316.5 g, which is 2.68 mols representing an 84.3% yield. *Id*., 14:59-15:67. However, the product was 96.8% pure resulting in a yield for the hydrolysis reaction of 81.6%. Ex.1002, ¶97. Thus, the total yield for the reaction from alkene to alkanediol is 69%, which is within the range of about 60% to about 99% recited in claim 28. Ex.1002, ¶97.

With respect to claim 29, a POSITA would consider Cheng's 69% yield to be "about" 72% since there is little, if any, substantive difference between 69% and 72%. In addition, a POSITA appreciates Cheng's process can be optimized for higher yields as desired. Ex.1002, ¶98. Based on the type of wash undertaken, it appears as though Cheng was seeking to optimize purity rather than yield. Ex.1002, ¶98. However, a POSITA could seek to optimize yield over purity by, for example, increasing the salt concentration of the aqueous washes. Ex.1002, ¶98. Therefore, based on the teachings of Cheng and the benefits of increasing yield, a POSITA would have achieved 72% to 99% yield in the combination. Ex.1002, ¶98.

D. Claims 1-7, 9-11, 24-26, 28 and 29 are rendered obvious under 35 U.S.C.§ 103 by Cheng in view of Wright '788

Wright '788 is prior art to the '803 Patent under at least 35 USC §102(a)(1). Wright '788 is a printed publication that was published on September 20, 2012, well before the '803 Patent's earliest priority claim of January 30, 2018. Ex.1009, 1 ("Pub. Date: Sep. 20, 2012"). Moreover, because Wright '788 was published more than a year before the earliest priority date to the '803 Patent there is no exception to Wright '788 as prior art under 35 USC §102(b)(1).

Cheng describes a process of creating 1,2-alkanediols in a commercially attractive way from 1-alkenes. Ex.1002, ¶99. Wright '788 describes a method for dehydrating bio-1-alcohol to produce bio-1-alkene with high selectivity (>95%).

Ex.1009, [0018]; *see also* [0003] (producing α-olefin with 92-99% regiochemical selectivity). Ex.1002, ¶99.

A POSITA would be motivated to combine Wright '788 with Cheng because "…vicinal alkanediols, such as 1,2-alkane diols…" taught by Cheng have known commercial applications. Ex.1010, 1:6-10; Ex.1002, ¶¶99-100. Further, a POSITA understands that bio-1-alkenes are known chemical precursors to commercial products and that Cheng describes a "commercially attractive way[]" of using the bio-1-alkene products of Wright '788 to prepare vicinal alkanediols. Ex.1010, 1:6-10 and 1:40-48; Ex.1002, ¶99. For example, a POSITA would have understood that Wright '788 can be combined with Cheng to provide an example of converting 1-hexene to 1,2-epoxyhexane, which is then converted to 1,2-hexanediol. Ex.1010, 13:55-14:58 and 16:1-40; Ex.1002, ¶103. Using a known product, *e.g.*, bio-1-alkene, in a known way, *e.g.*, converting to vicinal diols, for known commercial applications would have motivated a POSITA to combine Wright '788 with Cheng. Ex.1002, ¶100.

A POSITA understands the advantages of using the natural feedstocks taught by Wright '788 with the 1,2-alkanediol process conducted by Cheng. *See, e.g.*, Ex.1009; *see also* Ex.1002, ¶¶100-101. A POSITA would also understand that using an alkene from a natural source would predictably create a bio-1,2-alkanediol, e.g., bio-1,2-hexanediol or bio-1,2-octanediol, when processed according to the method

provided in Cheng. Ex.1002, ¶100. Further, a POSITA would be motivated to use the natural feedstocks given the perceived environmental impacts associated with using petroleum derived starting materials. Ex.1002, ¶102. A POSITA would understand that the choice of bio-based versus petroleum starting materials might be driven by many considerations, e.g., marketing, cost, availability. Ex.1002, ¶100.

Further, Patent Owner admits that there is no fundamental difference in how reactions take place between "new" carbon (e.g., plant derived) and "old" carbon (e.g., petroleum derived). Ex.1001, 18:30-43 (admitting that new and old carbon reactions are interchangeable). Accordingly, it would be obvious to a POSITA to form a bio-1-alkene using the bio-alcohols of Wright and use those bio-1-alkenes as the starting materials in Cheng to form bio-1,2-alkanediols. Ex.1002, ¶¶100-102.

1. Differences in Grounds 1 and 2

Ground 2 relies on the same conversion of 1-alkene to 1,2-alkanediol taught by Cheng as discussed above in Ground 1. As such, the arguments for Ground 2 relies on the prior analysis in Ground 1 regarding Cheng's conversion of 1-alkene to 1,2-alkanediol.

The difference for Ground 2 is that the bio-1-alkene taught by Wright '788 is used in Cheng's conversion process instead of the bio-1-alkene taught by Le. Thus, the relevant teachings from Wright '788 and how they are combined with Cheng's previously discussed teachings are provided below.

2. Claim 1

Limitation 1.1[7]

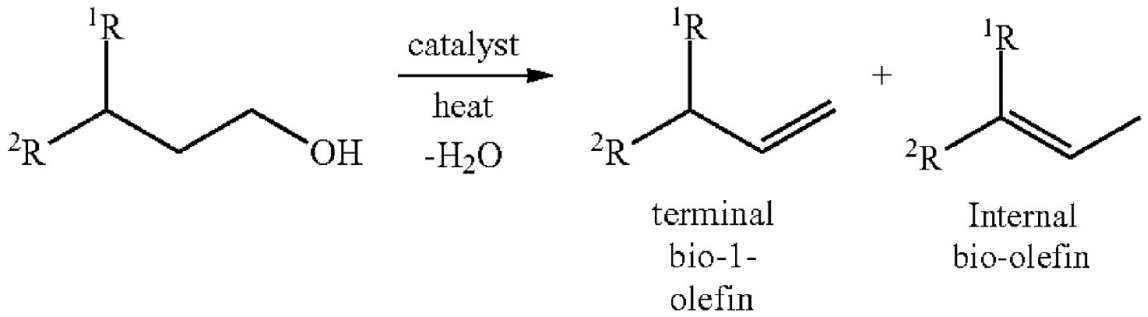
The relevant teachings of Cheng for this limitation were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(1); *see also* Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:35-41, 11:20-41, 13:40-50 and 13:58-18:59; Ex.1002, ¶¶103-104.

To the extent that Cheng does not discuss whether or not the 1-alkene is a "bio"-1-alkene with the bio-1-alkene having a "regioselectivity of at least about 80%," Wright provides such explicit disclosure. For example, it has been found by the EPO, via a Written Opinion of the PCT International Searching Authority that "Wright ['778] discloses a method for dehydrating a 1-alcohol to a 1-alkene (a method for dehydrating bio-1-alcohol to a bio-l-alkene product; paragraph [0018])… thereby producing the corresponding 1-alkene with greater than about 90 percent regioselectivity (produce bio-l-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034])." Ex.1011, 1.

In addition to the analysis and citations provided by the International Searching Authority, Wright '788 characterizes its invention as "a catalyst system and approach that lead to high regiochemical dehydration of 1-bioalcohols" in a

[7] For Grounds 2-4, Petitioner refers back to the claim limitations set out in Ground 1 rather than repeat the limitations of each claim for every Ground.

reactor chamber to "optimize bio-1-alkene production." Ex.1009, [0027] and [0030]; Ex.1002, ¶105. Wright '788 describes creating bio-1-alkenes having a chain length of 4 to 23 carbon atoms, as shown below, where ^{1}R and ^{2}R can be "hydrogen, an alkyl radical of C1 to C20, and any combination thereof." *Id*., [0003] and [0016]-[0017]; Ex.1002, ¶106.



Wright '788, [0016]

The primary example in Wright '788 dehydrates bio-1-butanol to bio-1-butene, which has a chain length of 4 carbon atoms. Ex.1009, [0027], [0034] and claim 2; Ex.1002, ¶107. A chain length of 4 carbon atoms falls within the scope of "about 5" carbon atoms under the proper construction of the claims. *See* supra, Section V.

Furthermore, Wright '788 includes embodiments producing bio-1-alkenes having carbon chain lengths of 5 carbon atoms up to carbon chains lengths of 16 carbon atoms. Ex.1009, [0022] and claims 11-12 (disclosing bio-1-alkenes produced from bio-1-pentanol, bio-1-hexanol, and bio-1-hexadecanol). Ex.1002, ¶108. A POSITA understands the corresponding terminal alkene for 1-hexanol is 1-hexene

because both have a chain length of 6 carbon atoms. Ex.1002, ¶108. Wright '788 also teaches "produc[ing] the respective α-olefin with 92-99% regiochemical selectivity." Ex.1009, [0008]; *see also* [0016] ("high selectivity (>92%)") and [0018] ("high selectivity (>95%)"); Ex.1002, ¶108. A POSITA would understand that dehydration of longer chain bio-1-alcohols of Wright '788 would give the same regioselectivity as that observed for the dehydration of bio-1-butanol. Ex.1002, ¶124; *see also* Ex.1029.

Limitation 1.2

The relevant teachings of Cheng for this limitation were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(1); *see also* Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:20-41, 13:40-50, 13:58-18:59; Ex.1002, ¶¶110-112; Ex.1001, 18:30-43; Ex.1004, 279.

Accordingly, a POSITA would recognize Cheng's process forms 1,2-alkanediols with carbon chain lengths of 2 to 12 carbon atoms, overlapping the claimed carbon chain length of about 5 to about 20. Ex.1002, ¶113. When combined with Wright '788's teaching of bio-1-alcohols having carbon chain lengths of 4 to 23 atoms, Cheng teaches a process to convert Wright '788's bio-1-alcohols to bio-1,2-alkanediols having a carbon chain length of at least 4 to 12 carbon atoms. Ex.1002, ¶113.

3. Claims 2-5

The relevant teachings of Cheng for this limitation were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(2); *see also* Ex.1010*,* 11:35-41 and 13:40-43; Ex.1002, ¶115.

Wright '788 includes embodiments describing the production of shorter chain bio-alkenes, e.g., bio-1-hexene (6 carbon atoms), to longer chain bio-alkenes, e.g., 1-hexadecene (16 carbon atoms). Ex.1009, [0022] and claims 11-12; Ex.1002, ¶114. In addition, Wright '788 teaches bio-1-alkenes of any chain length from 4 and 23 carbon atoms, including bio-1-hexene (6 carbon atoms) and bio-1-octene (eight carbon atoms). Ex.1009, [0003] and [0016]-[0017]; Ex.1002, ¶114.

Thus, a POSITA would appreciate that using Wright '788's bio-1-hexane or bio-1-octane in Cheng's conversion process would result in bio-1,2-hexanediol or bio-1,2-octanediol, respectively. Ex.1002, ¶116. In sum, a POSITA would recognize the combination of Cheng and Wright '788 forms bio-1,2-alkanediols with carbon chain lengths of at least 4 to 12 carbon atoms, thereby teaching the subject matter of each claim, for claims 2, 3, 4, and 5. Ex.1002, ¶116.

4. Claim 6

As stated above, the EPO and the explicit disclosure of Wright '788 describes bio-1-alkenes, including bio-1-alkenes with carbon chain lengths of 6 to 16 carbon atoms in length. Ex.1009, [0022] and claims 11-12; Ex.1011, at 1.

Furthermore, Wright ’788 characterizes its invention as “a catalyst system and approach that lead to high regiochemical dehydration of 1-bioalcohols” in a reactor chamber to “optimize bio-1-alkene production.” Ex.1009, [0027] and [0030]; Ex.1002, ¶117. In one example, Wright describes “the dehydration of bio-1-butanol” with a γ-alumina catalyst in a fixed-bed continuous flow reactor to produce “bio-1-butene.” Ex.1009, [0034]; Ex.1002, ¶117.

Finally, the published claims of Wright ’788 disclose a “bio-1-alkene product, comprising: at least one bio-1-alcohol; at least one desired catalyst, wherein said bio-1-alcohol is subjected and heated to at least one desired catalyst; …to produce bio-1-alkene product.” Ex.1009, Claim 1; Ex.1002, ¶118.

Therefore, Cheng in view of Wright ’788 teaches a process of dehydrating a bio-1-alcohol by heating the bio-1-alcohol in a reactor with a catalyst to create a bio-1-alkene that is subsequently converted to a bio-1,2-alkanediol. Ex.1002, ¶119.

5. Claim 7

Wright discloses using a “fixed-bed continuous flow reactor” as one example for implementing his process to dehydrate a bio-1-alcohol to a bio-1-alkene. Ex.1009, [0034]; Ex.1002, ¶120.

6. Claim 9

Wright ’788 discloses, in some embodiments, the catalyst is “a γ-alumina catalyst,” while in other embodiments, “the catalyst is $ZnAl_2O_4$.” Ex.1009,[0020],

[0024], claim 7, and claims 19-20; Ex.1002, ¶121. Wright '788 also teaches the catalyst can be a combination of γ-alumina and zinc oxide ($ZnAl_2O_4$). Ex.1009, [0019], [0022] and claim 21-22; Ex.1002, ¶121.

7. Claims 10-11

As discussed with claim 1, Wright '788 explains, "[e]mbodiments of the invention…produce the respective α-olefin with 92-99% regiochemical selectivity." Ex.1009, [0008], [0016] ("high selectivity (>92%)") and [0018] ("high selectivity (>95%)"); Ex.1002,¶122. A POSITA understands that Wright '788's regioselectivity for bio-1-butene is 94-95%, which would also be achieved for longer carbon chain bio-alkenes, such as 1-hexene. Ex.1009, [0034] at Table 1; Ex.1002, ¶¶123-125. A POSITA would understand that dehydration of longer chain bio-1-alcohols of Wright '788 would give the same regioselectivity as that observed for the dehydration of bio-1-butanol. Ex.1002, ¶124; *see also* Ex.1029.

8. Claim 24

Wright '788 discloses distilling the bio-alkene product to refine it by separating it from water. Ex.1009, [0032]; Ex.1002, ¶126. A POSITA would have refined the bio-1-alkene from Wright '788 prior to converting it to a bio-1,2-alkanediol in order to purify the input material to Cheng's process thereby improving the efficiency and yield of Cheng's process. Ex.1002, ¶127.

9. Claim 25

The relevant teachings of Cheng for this limitation were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(8); *see also* Ex.1010, Examples 2-5, 14:61-17:63, and 15:25-36; Ex.1002, ¶128. A POSITA would utilize Cheng's distillation teaching in the combination of Cheng and Wright '788 to refine the bio-1,2-alkanediol into a purer 1,2-bio-alkanediol product for use as a more efficient input into additional chemical processes. Ex.1002, ¶128.

10. Claim 26

Claim 26 is similar to claim 6 but adds in limitations for "in water" and "under a purge gas." Wright '788 teaches claim 6 as described above. In addition, Wright '788 discloses dehydrating a "bio-1-alcohol having from 1 ppm to 90% water, …with at least one purge gas at a rate of about 0.01 to about 1.0 per mass of said catalyst/hour to produce bio-1-alkene with high selectivity (>95%)." Ex.1009, [0018]; Ex.1002, ¶129; *see also* [0021-0022] (discussing dehydration of bio-1-alcohol where "the purge gas is nitrogen, argon, or a mixture of the two gases").

Therefore, the combination of Cheng and Wright '788 teaches a process wherein the bio-1-alcohol in water is dehydrated by heating the bio-1-alcohol [i.e., bio-1-hexanol] with a catalyst [i.e., γ-alumina] under a purge gas [i.e., nitrogen, argon, or a mixture of the two gases].

11. Claims 28 and 29

The relevant teachings of Cheng for these limitations were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(10); *see also* Ex.1010, 14:60-15:67; Ex.1002, ¶130.

Therefore, based on the teachings of Cheng and the benefits of increasing yield, a POSITA would have achieved 60% to 99% or 72% to 99% yield in the combination of Cheng in view of Wright '788. Ex.1002, ¶131

E. Claims 1, 2-7, 9-11, 24-26, 28, 29, 35 and 36 are rendered obvious under 35 U.S.C.§ 103 by Furuya in view of Le

Furuya describes a process to convert the bio-α-olefins of Le to different bio-based compounds, such as 1,2-alkanediols. Ex.1002, ¶132. Furuya describes forming 1,2-alkanediols by oxidizing α-olefins to form an epoxy compound and hydrolyzing the epoxy compound to form 1,2-alkanediols. Ex.1013, 2:41-47,2:65-66; Ex.1002, ¶132. Le describes a process for preparing α-olefins (1-alkenes) having 6 to 9 carbon atoms from "renewable materials." Ex.1007, [0002]; Ex.1002, ¶132. Combining Furuya with Le would be obvious to a POSITA because Furuya removes objectionable odors associated with forming 1,2-alkanediols from 1-alkenes. Ex.1013, 1:49-67, 3:40-57, and 8:6-11:9.

A POSITA would recognize the advantages of using the natural feedstocks taught by Le to form the 1,2-alkanediols of Furuya. Ex.1002, ¶133. For example, a POSITA would be motivated to use bio-1-alkenes of Le (derived from natural

feedstocks) instead of petrochemically derived 1-alkenes given the desire to improve marketing and environmental impact while reducing reliance on oil. In addition, a POSITA would be motivated to use bio-1-alkenes of Le to reduce environmental impacts associated with fossil fuels. Ex.1007, [0009]-[0013]; Ex.1002, ¶133. Accordingly, it would be obvious to a POSITA to use the bio-1-alkenes of Le to produce bio-1,2-alkanediols according to the procedures outlined by Furuya. Ex.1002, ¶135.

1. Claim 1

Limitation 1.1

Furuya converts α-olefins (1-alkenes) having a carbon chain length of 4 or more carbon atoms to corresponding 1,2-alkanediols. Ex.1002, ¶136. For example, Furuya converts 1-octene (8 carbon atoms), 1-decene (10 carbon atoms), and 1-dodecene (12 carbon atoms) to 1,2-octanediol, 1,2-decanediol, and 1,2-dodecanediol, respectively. Ex.1013, 1:49-60, 2:41-3:11 and 3:40-57, *see also* 8:6-11:9; Ex.1002, ¶136. Furuya's carbon chain length of 4 or more carbon atoms for the α-olefins (1-alkenes) fully encompasses the claimed carbon chain length of "about 5 to about 20 carbon atoms." Ex.1002, ¶136.

To the extent that Furuya does not specifically characterize its α-olefins (1-alkenes) as "bio"-1-alkenes and the bio-1-alkenes having a "regioselectivity of at least about 80%," this is remedied by Le. Ex.1002, ¶137. As discussed in Ground 1,

Le teaches bio-1-alkenes derived from plant sources. Ex.1007, [0023], [0036]-[0037], [0053]-[0057], [0062]-[0063], [0086]-[0089] and [0101-0105]; Ex.1002, ¶137-138; *see also* Ex.1001, 3:26-56 and 13:53-55 (noting in the '803 patent, "bio" refers to "non-petrochemically derived"). Further, as previously discussed in Ground 1, Le teaches bio-1-alkenes having 6 to 9 carbon atoms, including bio-1-octene having 8 carbon atoms. Ex.1007, [0002], [0007], [0019]-[0020], [0059], [0094]-[0105], [0110]-[0114] and [0117]; Ex.1002, ¶139.

Finally, while Le does not use the word "regioselectivity," regioselectivity merely describes the preference of a process to form one specific regioisomer over another regioisomer. Ex.1002, ¶140-143. As previously explained with respect to Ground 1, a POSITA understands Le's disclosure to produce "a single isomer" viewed with Le's other disclosures to purify the materials to teach a regioselectively of greater than 95%, which is "at least about 80%." Ex.1007, [0012], [0021], [0068] and [0171]; Ex.1002, ¶140-143.

Limitation 1.2

As a preliminary matter, and as detailed above, Patent Owner admits that converting the bio-1-alkene to a bio-1,2-alkanediol having a carbon chain length of about 5 to about 20 carbon atoms is well known and the claims encompass any known process to do so. Ex.1001, 18:30-43; Ex.1002, ¶144; Ex.1004, 279.

Furuya discloses a known process for converting 1-alkenes, with carbon chain lengths of at least 8, 10, and 12, to a 1,2-alkanediol with a carbon chain length of at least 8, 10, and 12. Ex.1013, 1:49-60, 2:41-3:11 and 3:40-57, *see also* 8:6-11:9; Ex.1002, ¶145. Furuya provides a specific example of forming 1,2-octanediol from 1-octene. Ex.1013, 8:6-31; Ex.1002, ¶146. Furuya's process for synthesizing 1,2-octanediol is as follows:

> 381 g (3.4 mol) α-olefin having eight carbon atoms and 218 g (4.5 mol) of 95% formic acid were charged into a 2000 ml four-neck glass flask with a stirrer, a thermometer, and a nitrogen inlet. Then, 261 g (4.6 mol) of 60% hydrogen peroxide was added dropwise at 60° C. for two hours. After the completion of dropping, the reactant was aged at 60° C. for eight hours. After the reactant was left to stand and a lower aqueous layer was removed, 192 g (1.2 mol) of 25% aqueous sodium hydroxide was added to the reactant. The reactant was stirred at 60° C. for 30 minutes for saponification and was left to stand. A lower aqueous layer was then removed. After the saponification and removal of the aqueous layer were performed one more time, the product was washed with hot water and hexane to yield 380 g of 1,2-octanediol.

Ex.1013, 8:6-31; *see also* 8:33-45 (describing the process of using α-olefins to produce 1,2-decanediol and 1,2-dodecanediol); Ex.1002, ¶146.

A POSITA understands that this process would predictably yield 1,2-alkanediols having longer and shorter chain lengths based on the 1-alkene used as starting material. Ex.1013, 8:6-45; *see also* 2:65-66 (describing the alkanediol used

has at least 4 carbon atoms) and 8:6-11 (describing the process using α-olefin's having 8, 10, and 12 carbon atoms); Ex.1002, ¶147. For example, a POSITA understands that Furuya's process for converting 1-octene to 1,2-octanediol refers to a diol chain length of 8 carbon atoms. Ex.1002, ¶147. As such, a POSITA understands Le's bio-1-alkenes having 6 to 9 carbon atoms can be converted with Furuya's process into bio-1,2-alkanediols with corresponding carbon chain lengths of 6 to 9 carbon atoms. Ex.1002, ¶147.

2. Claims 2-5

As discussed above with respect claims 2-5 for Ground 1, Le teaches bio-1-alkenes having 6 to 9 carbon atoms, including bio-1-octene having 8 carbon atoms. Ex.1007, [0002], [0007], [0019]-[0020], [0059], [0094]-[0105], [0110]-[0114] and [0117]; Ex.1002, ¶148-153. While Le gives an example of dehydrating bio-2-octanol into a mixture of bio-1-octene and bio-2-octene, Le's teachings are not limited to this example. *See* Ex.1007, [0106]-[0109]; Ex.1002, ¶149.

Likewise, as discussed above, Furuya describes converting 1-alkenes having a carbon chain length greater than 4 to a corresponding 1,2-alkanediol. Ex.1013, 1:49-60, 2:41-3:11, 3:40-57; *see also* 8:6-11:9; Ex.1002, ¶151-152. Likewise, a POSITA understands that this process would predictably yield 1,2-alkanediols having longer and shorter chain lengths based on the 1-alkene used as starting material. *Id*.; *see also* Ex.1013, 2:65-66 (providing the alkanediol used has at least 4

carbon atoms); Ex.1013, 8:6-31 (providing the α-olefin's having 8, 10, and 12 carbon atoms). As such, a POSITA understands Le's bio-1-alkenes having 6 to 9 carbon atoms can be converted with Furuya's process into bio-1,2-alkanediols with corresponding carbon chain lengths of 6 to 9 carbon atoms. Ex.1002; Ex.1002, ¶153.

3. Claim 6

As discussed above with respect to claim 6 for Ground 1, Le teaches a process for dehydrating a bio-1-alcohol into a bio-1- alkene by heating it withing the exemplary temperature range of 250 to 400 °C. Ex.1007, [0023], [0036]-[0037], [0053]-[0057], [0062]-[0063], [0065-0066], [0086]-[0089], [0101]-[0105], [0119] and [0171]; Ex.1002, ¶154-158.

Therefore, a POSITA understands that Le teaches dehydrating a bio-1-alcohol (e.g., bio-1-hexanol to bio-1-nonanol derived from plant oil) by heating the bio-1-alcohol in a reactor (e.g., at 250 to 400 °C) with a catalyst (e.g., a γ-alumina catalyst) to form a bio-1-alkene (e.g., bio-1-hexene to bio-1-nonene). Ex.1002, ¶158.

4. Claims 7 and 9-11

The relevant teachings of Le for these limitations were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(C)(4-6); *see also* Ex.1007, [0062]-[0064], [0066], [0119] and [0171]; Ex.1002, ¶159-161.

5. Claim 24

Le teaches the bio-1-alkene can be purified using known techniques, including "a distillation step." Ex.1007, [0067]; *see also* [0173] (describing an example with step of purifying 1-heptene); Ex.1002, ¶169. A POSITA would have refined the bio-1-alkene from Le before converting it to a bio-1,2-alkanediol to purify the input material to Furuya's process, thereby improving the efficiency and yield. Ex.1002, ¶169-170.

6. Claim 25

Furuya describes distilling 1,2-octanediol, 1,2-decanediol, and 1,2-dodecanediol. Ex.1013, 8:63-9:3. Further, Furuya explains that because the alkanediol produced typically has a smell, "the alkanediol composition is usually purified by distillation, which is a common purification method." *Id.,* 1:52-56. A POSITA would likewise utilize this distillation step in the combination of Le and Furuya to refine the bio-1,2-alkanediol to reduce odor. Ex.1002, ¶171.

7. Claim 26

As discussed previously with respect to claim 26 for Ground 1, Le teaches dehydrating a bio-alcohol in the presence of a catalyst under an inert purge gas. Ex.1007, [0065]-[0066]; Ex.1002, ¶172. Further, water used earlier in the cracking process would still be present with the bio-1-alcohol during the dehydration step. Ex.1007, [0169]-[0171]; Ex.1002, ¶172. In addition, the bio-1-alcohol will also be

in water because the dehydration process generates water in the mixture being dehydrated. Ex.1007, [0062]; Ex.1002, ¶172.

8. Claims 28 and 29

Fuyura starts with "381g (3.4 mol)" of 1-octene with a molecular weight of 112, which provides the quoted 3.4 mol. Ex.1013, 8:18-19. The product of the hydroxylation yields 380 grams of 1,2-octanediol, which has a molecular weight of 144. 380 grams of 1,2-octanediol is 2.64 mol. Ex.1002, ¶173. The product 2.64 mol divided by the starting material of 3.4 mol provides 77.6 % yield, which is within the range recited in both claims 28 and 29. Ex.1002, ¶173.

9. Claim 35

> **35. The process of claim 1, wherein the bio-alkene is converted to the bio-1,2-alkanediol having a carbon chain length of about 5 to about 20 carbon atoms by reacting the bio-alkene in the presence of at least one of a peracid and a hydroxide to form a reaction product, and contacting the reaction product with water and a base to form the bio-1,2-alkanediol.**

As discussed above with respect to claim 1, Le in view Furuya forms a bio-1,2-alkanediol. The process described in Furuya reacts the 1-alkene with formic acid and hydrogen peroxide. Ex.1013, 8:6-31. A POSITA understands that adding formic acid and hydrogen peroxide to the 1-alkene, as described by Le and Furuya, would lead to a reaction product including a bio-1,2-epoxyalkane. Ex.1002, ¶174. A POSITA recognizes that formic acid and hydrogen peroxide are "at least one of a peracid and hydroxide." Ex.1002, ¶174.

After creation of a bio-1,2-epoxyalkane, Furuya adds aqueous sodium hydroxide (e.g., water and sodium hydroxide) to the solution for complete conversion to bio-1,2-alkanediol. Ex.1013, 8:6-31; Ex.1002, ¶175. Therefore, Furuya also teaches "contacting the reaction product [bio-1,2-epoxyalkane] with water and a base [sodium hydroxide] to form the bio-1,2-alkanediol." Ex.1002, ¶175.

10. Claim 36

> **The process according to claim 35, wherein the bio-alkene is converted to the bio-1,2-alkanediol by reacting the bio-alkene in the presence of at least one of formic acid or acetic acid and a peroxide to form a bio-1,2-epoxyalkane having an epoxy ring, and contacting the 1,2-epoxyalkane with water and sodium hydroxide to form the bio-1,2-alkanediol.**

As discussed above with respect to claim 1, Le in view Furuya forms a bio-1,2-alkanediol. The process described in Furuya reacts the 1-alkene with formic acid and hydrogen peroxide. Ex.1013, 8:6-31. A POSITA understands when adding formic acid and hydrogen peroxide to the 1-alkene that a bio-1,2-epoxyalkane having an epoxy ring would temporarily form. Ex.1002, ¶174. A POSITA recognizes that formic acid and hydrogen peroxide are "at least one of a peracid and hydroxide." Ex.1002, ¶175.

After creation of a bio-1,2-epoxyalkane with an expoxy ring, Furuya adds aqueous sodium hydroxide (e.g., water and sodium hydroxide) to the solution for complete conversion to bio-1,2-alkanediol. Ex.1013, 8:6-31; Ex.1002, ¶175.

Therefore, Furuya also teaches "contacting the 1,2-epoxyalkane with water and a base [sodium hydroxide] to form the bio-1,2-alkanediol." Ex.1002, ¶175.

F. Claims 1-7, 9-11, 24-26, 28, 29, 35 and 36 are rendered obvious under 35 U.S.C.§ 103 by Furuya in view of Wright '788.

Furuya describes converting 1-alkenes to their corresponding 1,2-alkanediols. Ex.1013, 2:41-47 and 2:65-66. Wright '788 describes dehydrating bio-1-alcohols to their corresponding bio-1-alkenes with 92-99% regiochemical selectivity. Ex.1009, [0003] and [0018]. It would be obvious to a POSITA to use the bio-1-alkenes of Wright to form bio-1,2-alkanediols according to the methods set forth in Furuya. Ex.1002, ¶176.

Furuya describes methods for producing alkanediols that reduce by-products and therefore reduce objectionable odors in the final alkanediol product, making the alkanediol more appropriate for cosmetic use. Ex.1013, 1:17-22. Furuya provides that the alkanediol made with its process "has at least four carbon atoms" and can have varying carbon chain lengths, including an exemplary process producing 1,2-octanediol from 1-octene. *Id.,* 2:65-66 and 8:6-46.

A POSITA would recognize the advantages of using the natural feedstocks taught by Wright '788 to form the 1,2-alkanediols of Furuya. Ex.1002, ¶¶177-178. For example, a POSITA would be motivated to use bio-1-alkenes of Wright '788 (derived from natural feedstocks) instead of petrochemically derived 1-alkenes given the desire in the field to improve marketing and environmental impact while

reducing reliance on oil. In addition, a POSITA would be motivated to use bio-1-alkenes of Wright '788 to reduce perceived environmental impacts associated with fossil fuels. Ex.1009, [0003] and [0017]- [0018]; Ex.1002, ¶178. Accordingly, it would be obvious to a person of skill in the art to use the bio-1-alkenes of Wright '788 to produce bio-1,2-alkanediols according to the procedures outlined by Furuya. Ex.1002, ¶179.

Combining Wright with Furuya would be obvious to a POSITA because Furuya solves a problem of objectionable odors associated with forming 1,2-alkanediols from 1-alkenes, a known solution to a known problem. Ex.1002, ¶180; Ex.1013, 1:49-67, 3:40-57 and 8:6-11:9.

1. Differences in Grounds 3 and 4

Ground 4 relies on the same conversion of 1-alkene to 1,2-alkanediol taught by Furyua as discussed above in Ground 3. As such, the arguments for Ground 4 relies on the prior analysis in Ground 3 regarding Cheng's conversion of 1-alkene to 1,2-alkanediol.

The difference for Ground 4 is that the bio-1-alkene taught by Wright '788 is used in Furuya's conversion process instead of the bio-1-alkene taught by Le. Thus, the relevant teachings from Wright '788 and how they are combined with Furuya's previously discussed teachings are provided below.

2. Claim 1

Limitation 1.1

The relevant teachings of Furuya for this limitation were previously analyzed with respect to Ground 3 and equally applicable here. *See supra* Section VIII(E)(1); *see also* Ex.1013, 1:49-60, 2:41-3:11, 3:40-57 and 8:6-11:9; Ex.1002, ¶¶181-183.

To the extent that Furuya does not specifically characterize its α-olefins (1-alkenes) as "bio"-1-alkenes and the bio-1-alkenes having a "regioselectivity of at least about 80%," this is remedied by Wright '788. As discussed with respect to Ground 2, Wright '788 teaches bio-1-alkenes. Ex.1009, [0027] and [0030]; Ex.1011, 1; Ex.1002, ¶184. Further, Wright '788 teaches bio-1-alkenes having 4 to 23 carbon atoms, including bio-1-hexene or bio-1-octene having 6 or 8 carbon atoms respectively. Ex.1009, [0003], [0016]-[0017], [0022], [0027] and [0034] and claims 11-12; Ex.1002, ¶185. Finally, Wright '788 teaches producing the bio-1-alkenes with high regioselectivity of 92% to 99%. Ex.1009, [0008] and [0016]; Ex.1002, ¶¶185-187. A POSITA would understand that dehydration of longer chain bio-1-alcohols of Wright '788 would give the same regioselectivity as that observed for the dehydration of bio-1-butanol. Ex.1002, ¶204; *see also* Ex.1029.

Limitation 1.2

The relevant teachings of Furuya for this limitation were previously analyzed with respect to Ground 3 and equally applicable here. *See supra* Section VIII(E)(1);

see also Ex.1013, 1:49-60, 2:41-3:11, 3:40-57 and 8:6-45; Ex.1002, ¶¶188-190; Ex.1001, 18:30-43; Ex.1004, 279.

Accordingly, a POSITA would recognize Furuya's process forms 1,2-alkanediols with carbon chain lengths of at least 8, 10, and 12 carbon atoms, overlapping the claimed carbon chain length of about 5 to about 20. Ex.1002, ¶191. When combined with Wright '788's teaching of bio-1-alcohols having carbon chain lengths of 4 to 23 atoms, Furuya teaches a process to convert Wright '788's bio-1-alcohols to bio-1,2-alkanediols having a carbon chain length of at least at least 8, 10, and 12 carbon atoms. Ex.1002, ¶191.

3. Claim 2-5

The relevant teachings of Furuya for this limitation were previously analyzed with respect to Ground 3 and equally applicable here. *See supra* Section VIII(E)(2); *see also* Ex.1013, 1:49-60, 2:41-3:11, 3:40-57 and 8:6-31; Ex.1002, ¶¶192-194.

Wright '788 includes embodiments describing the production of shorter chain bio-alkenes, e.g., bio-1-hexene (6 carbon atoms), to longer chain bio-alkenes, e.g., 1-hexadecene (16 carbon atoms). Ex.1009, [0022] and claims 11-12. In addition, Wright '788 teaches bio-1-alkenes of any chain length from 4 and 23 carbon atoms, including bio-1-hexene (6 carbon atoms) and bio-1-octene (eight carbon atoms). *Id.*, [0003] and [0016]-[0017].

Thus, a POSITA would appreciate that using Wright '788's bio-1-hexane or bio-1-octane in Furuya's conversion process would result in bio-1,2-hexanediol or bio-1,2-octanediol, respectively. Ex.1002, ¶¶194-195. In sum, a POSITA would recognize the combination of Furuya and Wright '788 forms bio-1,2-alkanediols with carbon chain lengths of at least 4 to 12 carbon atoms, thereby teaching the subject matter of each claim, for claims 2, 3, 4, and 5. Ex.1002, ¶¶194-195.

4. Claim 6

As stated above, the EPO and the explicit disclosure of Wright '788 describes bio-1-alkenes, including bio-1-alkenes with carbon chain lengths of 6 to 16 carbon atoms in length. Ex.1009, [0022] and claims 11-12; Ex.1011, at 1; Ex.1002, ¶196.

Furthermore, Wright '788 characterizes its invention as "a catalyst system and approach that lead to high regiochemical dehydration of 1-bioalcohols" in a reactor chamber to "optimize bio-1-alkene production." *Id.*, [0027] and [0030]; Ex.1002, ¶197. In one example, Wright describes "the dehydration of bio-1-butanol" with a γ-alumina catalyst in a fixed-bed continuous flow reactor to produce "bio-1-butene." *Id.*, [0034].

Finally, the published claims of Wright '788 disclose a "bio-1-alkene product, comprising: at least one bio-1-alcohol; at least one desired catalyst, wherein said bio-1-alcohol is subjected and heated to at least one desired catalyst; …to produce bio-1-alkene product." *Id.*, Claim 1; Ex.1002, ¶198.

Therefore, Furuya in view of Wright ’788 teaches a process of dehydrating a bio-1-alcohol by heating the bio-1-alcohol in a reactor with a catalyst to create a bio-1-alkene that is subsequently converted to a bio-1,2-alkanediol. Ex.1002, ¶199.

5. Claims 7 and 9-11

The relevant teachings of Wright ’788 for these limitations were previously analyzed with respect to Ground 2 and equally applicable here. *See supra* Section VIII(B)(5-7); *see also* Ex.1009, [0008], [0016], [0018-0020], [0022], [0024], [0034], claim 7 and claims 19-22; Ex.1002, ¶¶200-205.

6. Claims 24

Wright ‘788 discloses distilling the bio-alkene product to refine it by separating it from water. Ex.1009, [0032]. A POSITA would have refined the bio-1-alkene from Wright ’788 prior to converting it to a bio-1,2-alkanediol in order to purify the input material to Furuya’s process thereby improving the efficiency and yield of Furuya’s process. Ex.1002, ¶206.

7. Claims 25

The relevant teachings of Furuya for this limitation were previously analyzed with respect to Ground 1 and equally applicable here. *See supra* Section VIII(E)(8); *see also* Ex.1013, 1:52-56 and 8:63-9:3; Ex.1002, ¶207. A POSITA would utilize Furuya’s distillation teaching in the combination of Furuya and Wright ’788 to refine the bio-1,2-alkanediol to reduce odor. Ex.1002, ¶207.

8. Claim 26

Claim 26 is similar to claim 6 but adds in limitations for "in water" and "under a purge gas." Wright '788 teaches claim 6 as described above. In addition, Wright '788 discloses dehydrating a "bio-1-alcohol having from 1 ppm to 90% water, …with at least one purge gas at a rate of about 0.01 to about 1.0 per mass of said catalyst/hour to produce bio-1-alkene with high selectivity (>95%)." Ex.1009, [0018]; *see also* [0021-0022] (discussing dehydration of bio-1-alcohol where "the purge gas is nitrogen, argon, or a mixture of the two gases"). Ex.1002, ¶208

Therefore, the combination of Furuya and Wright '788 teaches a process wherein the bio-1-alcohol in water is dehydrated by heating the bio-1-alcohol [i.e., bio-1-hexanol] with a catalyst [i.e., γ-alumina] under a purge gas [i.e., nitrogen, argon, or a mixture of the two gases].

9. Claims 28 and 29

The relevant teachings of Furuya for these limitations were previously analyzed with respect to Ground 3 and equally applicable here. *See supra* Section VIII(E)(10); *see also* Ex.1013, 8:18-19; Ex.1002, ¶209. Therefore, a POSITA would have understood Furuya teaches 60% to 99% or 72% to 99% yield in the combination of Furuya in view of Wright '788. Ex.1002, ¶209.

10. Claims 35-36

The relevant teachings of Furuya for these limitations were previously analyzed with respect to Ground 3 and equally applicable here. *See supra* Section VIII(E)(11); *see also* Ex.1013, 8:6-31; Ex.1002, ¶210.

A POSITA understands that adding formic acid and hydrogen peroxide to the 1-alkene, as described by Wright '788 and Furuya, would lead to a reaction product including a bio-1,2-epoxyalkane. Ex.1002, ¶210. A POSITA recognizes that formic acid and hydrogen peroxide are "at least one of a peracid and hydroxide." Ex.1002, ¶210. Therefore, Furuya teaches "contacting the reaction product [bio-1,2-epoxyalkane] with water and a base [sodium hydroxide] to form the bio-1,2-alkanediol." Ex.1002, ¶211.

A POSITA also understands when adding formic acid and hydrogen peroxide to the 1-alkene that a bio-1,2-epoxyalkane having an epoxy ring would temporarily form. Ex.1002, ¶210. Therefore, Furuya also teaches "contacting the 1,2-epoxyalkane with water and a base [sodium hydroxide] to form the bio-1,2-alkanediol." Ex.1002, ¶211.

IX. BOARD SHOULD NOT DENY PETITION UNDER §325(d)

Any argument that the Board should deny this petition under 35 USC §325(d) based on previously presented prior art or arguments should be rejected. The Board analyzes whether to exercise its discretion under §325(d) according to the two-part framework set forth in *Advanced Bionics*. *Advanced Bionics, LLV v. MED-EL Elekromedizinische Geräte GmbH*, IPR2019-01469, Paper 6, 7 (precedential) (PTAB Feb. 13, 2020) (citing *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 (PTAB Dec. 15, 2017).

Both steps of the *Advanced Bionics* framework weigh against discretionary denial of this IPR petition as discussed below. First, most grounds in this petition rely on prior art that was never previously considered by the Office. Second, for the prior art that was previously considered the Examiner committed clear error, particularly in allowing claims for the '803 Patent that are broad enough to encompass one of the inventors' much earlier patents.

A. First Step of *Advanced Bionics*

The first step under Advanced Bionics considers "whether the same or substantially the same art [or arguments] previously was presented to the Office." *Advanced Bionics* at 7-8. The majority of the grounds in this petition (Ground 1-3) rely on the teachings of Le or Cheng, neither of which has ever been presented to the Office for consideration with respect to the '803 Patent. Neither Le nor Cheng

are cited on the face of the ’803 Patent and not listed in any IDS in the ’803 Patent prosecution history record. This *inter partes* review petition is the first instance in which Le or Cheng has been presented to the Office for consideration with respect to the subject matter claimed in the ’803 Patent. Nor does the record indicate any art substantially the same as Le or Cheng was presented to the Office.

Thus, the Office has never considered the teachings of Le with respect to using renewable natural sources to obtain 1-alcohols to dehydrate into bio-1-alkenes with 6-9 carbons. Ex.1007, [0015], [0024]-[0028] and [0037]. Nor has the Office ever considered Le’s disclosure that this reaction results in “a single isomer (an alpha-olefin)” which a POSITA understands as teaching a high regioselectivity greater than 95%. *Id*., [0068]; Ex.1002, ¶¶66-69.

Le’s teaching is particularly relevant since it teaches the alleged reason for allowance, namely a “bio-alkene” with high regioselectivity to use as a starting material. Ex.1004, 279. Le does not teach converting bio-1-alkenes into a 1,2-alkanediol, but that teaching is provided by either Cheng (Ground 1) or Furuya (Ground 2). Thus, Grounds 1 and 2 present the never before considered teaching of converting Le’s bio-1-alkene with high regioselectivity into a bio-1, 2-alkanediol.

Likewise, the Office has never considered the teachings of Cheng with respect to converting 1-alkenes with carbon chain lengths of 2 to 12 to a corresponding 1,2-

alkanediol. Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:20-41 and 13:40-50. Cheng does not teach the 1-alkene was derived from a natural source rather than petrochemically derived. However, Cheng's 1,2-alkanediol conversion is compatible with carbon lengths for known bio-1-alkenes with high regioselectivity including the 6-9 carbon chains length of Le's bio-1-alkene (Ground 1) and the 5-20 carbon chain length of Wright '788's bio-1-alkene (Ground 3). Thus, Grounds 1 and 3 present the never before considered teaching of converting known bio-1-alkenes with high regioselectivity and carbon chain lengths from 5 to 12 carbons into bio-1,2-alkanediols.

Ground 2-4 of this IPR petition rely on teachings of Furuya and Wright '788 that are substantially the same as previously presented to the Office. As explained above, Ground 2 (Le in view of Furuya) and Ground 3 (Cheng in view of Wright '788) combine the previously presented references with new references to provide arguments that have not been previously presented to the Office. For Ground 4, the Examiner previously considered both Furuya and Wright '788. However, as explained below with respect to *Advanced Bionics* step 2, the examiner erred in overlooking the claims of the '803 Patent encompassing the combined teachings of Furuya in view of Wright '788.

Thus, Grounds 1-3 rely on prior art and arguments that have never been previously presented to the Office while Ground 4 relies on prior art and arguments

that have been previously presented to the Office. Therefore, on the whole this Petition is directed to newly presented art and arguments even if certain prior art and argument has been previously presented to the Office. As such, this factor weighs against discretionary denial of this IPR petition.

B. Second Step of *Advanced Bionics*

If the Board finds the first step of *Advanced Bionics* is met, then the second step under *Advanced Bionics* considers whether the Examiner "erred in a manner material to the patentability of challenged claims." *Advanced Bionics* at 8. Here, there is clear error based on the Examiner's statements on allowance. The Examiner's allowance was based on limitations not claimed, contradicted Applicant's admissions, and overlooked the relevant teachings of the prior art.

While showing error in the Examiner's reason for allowance is sufficient under *Advanced Bionics* step 2, there is a substantial disconnect between the Examiner's reason for allowance and the arguments raised by the Applicant. Thus, to address other potential issues, Petitioner also addresses why Applicant's argument would have been error had the Examiner accepted them.

<u>Examiner's Reason for Allowance is Error</u>

As discussed in Section VI(B), the Examiner's allowance stated that the "closest prior art" failed to teach "additional base hydrolysis to obtain the final 1,2-alkanediol." Ex.1004, 293. This statement is error on its face given none of the issued

claims recite a limitation for "additional base hydrolysis." This language appears to come from a single example in the specification rather than the claims. *See* Ex.1001, 27:36-39. Instead, the independent claims merely recite "converting the bio-1-alkene to a bio-1,2-alkanediol" without any limitation on what conversion process is utilized.

This error is compounded in view of the Applicant's admission during prosecution. In order to overcome a 112 rejection that "claim 1 has omitted the essential steps required to fully convert the bio-1-alkene," the Applicant admitted that the steps to convert bio-1-alkene to bio-1,2-alkanediol were well-known in the art such that "[t]he Chemical pathway to convert the alkene to the alkane may be carried out by any known chemical pathway for this purpose." Ex.1004, 124 and 279. Notably, the '803 Patent's specification does not detail the chemical reactions used to the convert 1-alkene into 1,2-alkanediol which further supports this is an entirely conventional and well-known process. *McRO, Inc. v. Bandai Namco Games America Inc.*, 959 F.3d 1091, 1102 (Fed. Cir. 2020) ("a patent need not teach, and preferably omits, what is well known in the art.") (internal citation omitted).

Nonetheless, Cheng and Furuya both teach converting a 1-alkene into a 1,2-alkanediol as discussed in this IPR petition. *See* Ex.1010, 2:44-67, 6:29-67, 7:1-40, 7:47-8:9, 11:20-41 and 13:40-50; Ex.1013, 1:49-60, 2:41-3:11, 3:40-57. In view

of these teachings and the admission of the applicant, the Examiner erred in allowing the claims for failure to teach conversion of a 1-alkene to a 1,2-alkanediol.

Applicant's Arguments Leading to Allowance

Instead of the conversion, the Applicant argued the novelty of the invention lies in the "bio-alkene starting materials of high regioselectivity" Ex.1004, 279. Yet, Wright '788 discloses a bio-alkene with high regioselectivity (as does Le which the Examiner never considered).

The sole inventor of Wright '788 is Michael E. Wright, who is also one of four inventors for the '803 Patent. *Compare* Wright '788 to Ex.1001. However, Wright '788 has no legal relationship to the '803 Patent. Wright '788 was filed and published six years before the earliest provisional date of the '803 Patent. *Id*. The patent Wright '788 matured into was assigned to the United States of America as Represented by the Secretary of the Navy rather the instant Patent Owner, Inolex. *See* US Pat. No. 8,912,373.

Assuming the '803 Patent specification discloses any bio-1-alkenes that are not anticipated or rendered obvious by Wright '788, **those bio-1-alkenes are not claimed**. Instead, the claims of the '803 Patent are so broad that they claim the exact same about 5 to about 20 carbon chain bio-1-alkenes with high regioselectivity disclosed in Wright '788 as discussed above with respect to how Wright '788 discloses the limitations of the claims of the '803 Patent. *See supra* Section XIII(F).

In particular, Wright ’788 discloses that “the invention relates to a method for dehydrating bio-1-alcohol including… heating the bio-1-alcohol with at least one desired catalyst… to produce bio-1-alkene with high selectivity (>95%).” Ex.1009, [0018]; *see also* [0027] and [0030]. In addition, Wright ’788 discloses bio-alkenes with carbon chains at least from 4 to 23. Ex.1009, [0016]-[0017]; Ex.1002, ¶¶105-109. Some examples of bio-1-alcohols provided by Wright are “1-pentanol and/or 1-hexanol” whose corresponding bio-1-alkenes would be bio-1-pentene having 5 carbon atoms or bio-1-hexene having 6 carbon atoms. Ex.1009, [0022]; Ex.1002, ¶108. Finally, even if Wright ’788 only disclosed using his process to produce bio-1-butene, that would still be within the scope of “about 5 to about 20 carbon atoms” since “about 5” includes at least 4 carbon atoms as discussed in the claim construction section.

Moreover, it is not just this IPR petition which demonstrates this error, but also the PCT International Searching Authority that found Wright ’788 disclosed converting a bio-1-alcohol to a bio-1-alkene. Ex.1011, 1. This PCT opinion issued in April 2015, well before the ’803 Patent was filed yet this PCT opinion was never submitted to the Examiner during the prosecution of the ’803 Patent.

<u>New Evidence</u>

Finally, the Examiner never considered the additional evidence of the expert declaration submitted with this petition that explains why a POSITA understands Le

and Wright ’788 to disclose dehydration of bio-1-alcohols to produce bio-1-alkenes having between 5 and 20 carbon atoms which can be combined with Furuya or Cheng to convert the bio-1-alkenes into bio-1,2-alkanediols. As noted, the Examiner also never considered the PCT Opinion supporting that Wright discloses a bio-1-alkene.

Summary

The Examiner likely would not have allowed the claims of the ’803 Patent as issued if the Examiner considered the actual claim language, Applicant’s admissions, and the teachings of the prior art cited in this IPR petition. Additionally, the Examiner likely would not have allowed the claims if the Examiner had considered the additional evidence of the attached expert declaration and the PCT Written Opinion for Wright ’788. These material errors and additional evidence weigh strongly against discretionary denial.

X. CONCLUSION

In view of the foregoing, claims 1-7, 9-11, 24-26, 28, 29, 35 and 36 of the ’803 Patent are not patentable and Petitioner requests that IPR be instituted and these claims of the ’803 Patent be canceled.

Date: September 22, 2023

Respectfully submitted,

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CERTIFICATE OF SERVICE UNDER 37 CFR § 42.6(E)(4)

The undersigned hereby certifies that a copy of the accompanying Petition for Inter Partes Review, all accompanying exhibits, and the Power of Attorney has been served via Federal Express on September 22, 2023, upon the following correspondence address of record for the ’803 Patent:

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