

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
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29 APR 2015

Applicant's or agent's file reference
32897-745601

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US15/14943

International filing date (day/month/year)

08 February 2015 (08.02.2015)

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27 February 2014 (27.02.2014)

International Patent Classification (IPC) or both national classification and IPC

IPC(8) - B01J 23/02; C07C 1/24, 11/02 (2015.01)

CPC - B01J 23/02; C07C 1/24, 11/02

Applicant
COBALT TECHNOLOGIES, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Date of completion of this opinion

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Authorized officer

Shane Thomas

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Form PCT/ISA/237 (cover sheet) (January 2015)

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - ☒ the international application in the language in which it was filed.
 - ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a)).
3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed:
 - ☐ in the form of an Annex C/ST.25 text file.
 - ☐ on paper or in the form of an image file.
 - b. ☐ furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
 - ☐ in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - ☐ on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-46	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-46	NO
Industrial applicability (IA)	Claims	1-46	YES
	Claims	NONE	NO

2. Citations and explanations:

Claims 1-26, 28, 30-31, 33-43, and 45-46 lack an inventive step under PCT Article 33(3) as being obvious over US 2012/0238788 A1 (WRIGHT) in view of US 2008/0081909 A1 to Drent, et al. (hereinafter 'Drent').

As per claim 1, Wright discloses a method for dehydrating a 1-alcohol to a 1-alkene (a method for dehydrating bio-1-alcohol to a bio-1-alkene product; paragraph [0018]), comprising: contacting and heating a 1-alcohol with at least one catalyst (the bio-1-alcohol is subjected and heated to at least one desired catalyst; paragraph [0018]) that comprises a modified inorganic support (catalyst is a gamma-alumina catalyst that has been modified by reaction with base such as sodium or potassium hydroxide; paragraph [0020]) at a WHSV of about 1.01 hr⁻¹ to about 10 hr⁻¹ (controlling dwell time a rate of about 0.01 to about 1.0 per mass of said catalyst/hour (WHSV); paragraph [0018]), wherein said 1-alcohol is in a mixture with about 1 ppm to about 93 weight percent water (the bio-1-alcohol having from 1 ppm to 90 percent water; paragraph [0018]), thereby producing the corresponding 1-alkene with greater than about 90 percent regioselectivity (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]). Wright does not disclose a calcium-modified inorganic support. Drent discloses a catalyst that comprises a calcium-modified inorganic support (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided a calcium-modified inorganic support, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 2, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein the 1-alcohol is a C₄ to C₆ 1-alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 3, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said 1-alcohol is 1-butanol alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 4, Wright and Drent, in combination, disclose a method according to claim 3. Wright further discloses wherein said 1-alkene is 1-butene (bio-1 alkene it is bio-1-butene; paragraph [0019]).

As per claim 5, Wright and Drent, in combination, disclose a method according to claim 2. Wright further discloses wherein said 1-alcohol is 1-butanol, 1-pentanol, 1-hexanol, 3-methyl-1-butanol, 2-methyl-1-butanol, 4-methyl-1-pentanol, 3-methyl-1-pentanol, or 2-methyl-1-pentanol alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 6, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said 1-alcohol is a bio-1-alcohol alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 7, Wright and Drent, in combination, disclose a method according to claim 6. Wright further discloses wherein the bio-1-alcohol is a C₄ to C₆ 1-alcohol alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 8, Wright and Drent, in combination, disclose a method according to claim 7. Wright further discloses wherein said bio-1-alcohol is bio-1-butanol alcohol (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 9, Wright and Drent, in combination, disclose a method according to claim 8. Wright further discloses wherein said 1-butene is bio-1-butene (bio-1 alkene it is bio-1-butene; paragraph [0019]).

As per claim 10, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein the 1-alcohol is an alcohol of general formula R₁R₂CH(CH₂)₂OH, where R₁ and R₂ are independently H or a C₁ to C₂₀ alkyl radical, or contain one or more aromatic rings containing exclusively carbon or a mixture of carbon and heteroatoms, or a nitrile, alkene, or ketone functional group, or a combination thereof (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

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As per claim 11, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein the 1-alcohol is an alcohol of general formula $\text{HO}(\text{CH}_2)_n(\text{CH}_3)$ with n being any integer from 1 to 22 (bio-1-alcohol it is bio-1-butanol; paragraph [0019]).

As per claim 12, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein the regioselectivity of 1-alkene production is greater than about 95 percent (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]).

As per claim 13, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein the regioselectivity of 1-alkene production is about 90 percent to about 99 percent (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]).

As per claim 14, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said 1-alkene comprises about 5 percent unreacted 1-alcohol (chemical yield of biobutenes (1-alkene) is shown to be about 96 percent which would correspond to about 4 percent unreacted 1-alcohol; paragraph [0034]).

As per claim 15, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said water is present at about 10 to about 70 weight percent (water in the bio-1-alcohol is 1 to 20 percent or 17 percent; paragraph [0017]).

As per claim 16, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said inorganic support comprises gamma alumina (catalyst is a gamma-alumina catalyst; paragraph [0020]).

As per claim 17, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said catalyst is further modified by treatment with at least one organosilane (catalyst is treated with a chlorosilane such as triphenylchlorosilane, diphenyldichlorosilane, phenyltrichlorosilane; paragraph [0019]).

As per claim 18, Wright and Drent, in combination, disclose a method according to claim 17. Wright further discloses wherein said organosilane comprises a chlorosilane (catalyst is treated with a chlorosilane such as triphenylchlorosilane, diphenyldichlorosilane, phenyltrichlorosilane; paragraph [0019]).

As per claim 19, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses comprising providing at least one purge gas (reaction conditions are controlled with a purge gas; paragraph [0018]).

As per claim 20, Wright and Drent, in combination, disclose a method according to claim 19. Wright further discloses wherein said purge gas comprises nitrogen and/or argon (reaction conditions are controlled with a purge gas which is nitrogen, argon, or a mixture of the two gases; paragraphs [0018], [0021]).

As per claim 21, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses wherein said heating comprises a temperature of about 200 degrees Celsius to about 440 degrees Celsius (the heating ranges for the dehydration range from about 300 degrees Celsius to about 420 degrees Celsius; paragraph [0021]).

As per claim 22, Wright and Drent, in combination, disclose the method according to claim 21. Wright further discloses wherein said heating comprises a temperature of about 300 degrees Celsius to about 420 degrees Celsius (the heating ranges for the dehydration range from about 300 degrees Celsius to about 420 degrees Celsius; paragraph [0021]).

As per claim 23, Wright and Drent, in combination, disclose a method according to claim 1. Wright further discloses comprising separating water from said 1-alkene, thereby producing a dried 1-alkene product (water is separated from the bioalkene product through different units; paragraphs [0032]-[0033]).

As per claim 24, Wright and Drent, in combination, disclose a method according to claim 23. Wright further discloses comprising contacting said dried 1-alkene product with a second catalyst to form oligomers (products from embodiments, dried 1-alkene product are placed in contact with a Ziegler-Natta catalyst and rapidly converted to alpha-olefin oligomers; paragraphs [0023], [0036]).

As per claim 25, Wright and Drent, in combination, disclose a method according to claim 24. Wright further discloses wherein said second catalyst is selected from a Ziegler-Natta catalyst and a mesoporous oligomerization catalyst (products from embodiments, dried 1-alkene product are placed in contact with a Ziegler-Natta catalyst and rapidly converted to alpha-olefin oligomers; paragraphs [0023], [0036]).

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As per claim 26, Wright and Drent, in combination, disclose a method according to claim 24. Wright further discloses comprising using said oligomers to produce a diesel fuel (alpha-olefin oligomers are subjected to hydrogenation to produce diesel fuels; paragraphs [0023], [0036]).

As per claim 28, Wright and Drent, in combination, disclose a method according to claim 24. Wright further discloses comprising using said oligomers to produce a jet fuel (alpha-olefin oligomers are subjected to hydrogenation to produce jet fuels; paragraphs [0023], [0036]).

As per claim 30, Wright and Drent, in combination, disclose a method according to claim 24. Wright further discloses comprising using said oligomer to produce a lubricant (oligomers useful in preparing biolubricants; paragraph [0023]).

As per claim 31, Wright and Drent, in combination, disclose a method according to claim 30. Wright further discloses wherein said lubricant comprises a viscosity of about 1 to about 10,000 cSt at 25 degrees Celsius (oligomers useful in preparing biolubricants with viscosities in the range of 1 to 10,000 cSt at 25 degrees Celsius; paragraph [0023]).

As per claim 33, Wright discloses a method for dehydrating a 1-alcohol to a 1-alkene (a method for dehydrating bio-1-alcohol to a bio-1-alkene product; paragraph [0018]), comprising: contacting and heating a 1-alcohol with at least one catalyst (the bio-1-alcohol is subjected and heated to at least one desired catalyst; paragraph [0018]) that comprises a modified inorganic support (catalyst is a gamma-alumina catalyst that has been modified by reaction with base such as sodium or potassium hydroxide; paragraph [0020]), thereby producing the corresponding 1-alkene with greater than about 90 percent regioselectivity. Wright does not disclose a calcium-modified inorganic support (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]).

Drent discloses a catalyst that comprises a calcium-modified inorganic support (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided a calcium-modified inorganic support, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes

As per claim 34, Wright and Drent, in combination, disclose a method according to claim 33. Wright further discloses wherein said 1-alcohol is in a mixture with about 1 ppm to about 93 weight percent water (the bio-1-alcohol having from 1 ppm to 90 percent water; paragraph [0018]).

As per claim 35, Wright and Drent, in combination, disclose a method according to claim 33. Wright further discloses wherein the catalyst is contacted with the 1-alcohol at a WHSV of about 1.01 hr⁻¹ to about 10 hr⁻¹ (controlling dwell time a rate of about 0.01 to about 1.0 per mass of said catalyst/hour (WHSV); paragraph [0018]).

As per claim 36, Wright and Drent, in combination, disclose a method according to claim 33. Wright further discloses wherein said catalyst is further modified by treatment with at least one organosilane (catalyst is treated with a chlorosilane such as triphenylchlorosilane, diphenyldichlorosilane, phenyltrichlorosilane; paragraph [0019]).

As per claim 37, Wright discloses a method for dehydrating a 1-alcohol to a 1-alkene (a method for dehydrating bio-1-alcohol to a bio-1-alkene product; paragraph [0018]), comprising: contacting and heating a 1-alcohol with at least one catalyst (the bio-1-alcohol is subjected and heated to at least one desired catalyst; paragraph [0018]) that comprises an inorganic support that is modified by an element (catalyst is a gamma-alumina catalyst that has been modified by reaction with base such as sodium or potassium hydroxide; paragraph [0020]) and at least one organosilane (catalyst is treated with a chlorosilane such as triphenylchlorosilane, diphenyldichlorosilane, phenyltrichlorosilane; paragraph [0019]), thereby producing the corresponding 1-alkene with greater than about 90 percent regioselectivity (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]). Wright does not disclose an inorganic support that is modified by a Group 2 element. Drent discloses a catalyst that comprises an inorganic support that is modified by a Group 2 element (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method as previously disclosed by Wright, in order to have provided an inorganic support that is modified by a Group 2 element, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 38, Wright and Drent, in combination, disclose a method according to claim 37. Wright does not disclose wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba. Drent discloses wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method as previously disclosed by Wright, in order to have provided wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 39, Wright and Drent, in combination, disclose a method according to claim 37. Wright further discloses wherein said 1-alcohol is in a mixture with about 1 ppm to about 93 weight percent water (the bio-1-alcohol having from 1 ppm to 90 percent water; paragraph [0018]).

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As per claim 40, Wright and Drent, in combination, disclose a method according to claim 37. Wright further discloses wherein the catalyst is contacted with the 1-alcohol at a WHSV of about 1.01 hr-1 to about 10 hr-1 (controlling dwell time a rate of about 0.01 to about 1.0 per mass of said catalyst/hour (WHSV); paragraph [0018]).

As per claim 41, Wright discloses a catalyst composition for producing 1-alkenes from 1-alcohols (a catalyst for dehydrating bio-1-alcohol to a bio-1-alkene product; paragraph [0018]) with high regioselectivity (produce bio-1-alkene with high selectivity of greater than 95 percent; paragraphs [0018], [0034]), comprising: an inorganic support that is modified with at least one element (catalyst is a gamma-alumina catalyst that has been modified by reaction with base such as sodium or potassium hydroxide; paragraph [0020]) and at least one organosilane (catalyst is treated with a chlorosilane such as triphenylchlorosilane, diphenyldichlorosilane, phenyltrichlorosilane; paragraph [0019]). Wright does not disclose an inorganic support that is modified by a Group 2 element. Drent discloses a catalyst that comprises an inorganic support that is modified by a Group 2 element (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided an inorganic support that is modified by a Group 2 element, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 42, Wright and Drent, in combination, disclose a catalyst composition according to claim 41. Wright does not disclose wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba. Drent discloses wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided wherein the Group 2 element comprises at least one of Mg, Ca, Sr, and Ba, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 43, Wright and Drent, in combination, disclose a catalyst composition according to claim 41. Wright does not disclose wherein the Group 2 element is Ca. Drent discloses wherein the Group 2 element is Ca (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided wherein the Group 2 element is Ca, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

As per claim 45, Wright and Drent, in combination, disclose a catalyst composition according to claim 41. Wright further discloses wherein the inorganic support is gamma alumina (catalyst is a gamma-alumina catalyst; paragraph [0020]) or zinc aluminate (solid support is zinc aluminate; claim 20).

As per claim 46, Wright and Drent, in combination, disclose a catalyst composition according to claim 41. Wright further discloses produced by a method comprising: a) modifying an inorganic support with at least one element to produce a first modified inorganic support, wherein the first modified inorganic support comprises said at least one element (gamma alumina powder is modified (the wash would leave an element on the support) with a base, such as sodium or potassium hydroxide, wash and dried; paragraphs [0020], [0034]; claim 18); b) heat-treating the first modified inorganic support to produce a heat-treated first modified inorganic support (base treated inorganic solid support is dried under a heated stream; claim 18); c) contacting the heat-treated first modified inorganic support with at least one organosilane to produce a second modified inorganic support (first base treated inorganic solid support is treated with at least one organosilane; paragraphs [0019]-[0020]; claim 18), wherein the second modified inorganic support comprises said at least one element and said at least one organosilane, or fragment thereof (gamma-alumina catalyst that has been modified (comprises) by reaction with base and then modified (comprises) with an organosilane; paragraph [0020]); and d) heat-treating the second modified inorganic support to produce the catalyst composition (second treated inorganic solid support is heated and dried; claim 18). Wright does not disclose an inorganic support that is modified by a Group 2 element. Drent discloses a catalyst that comprises an inorganic support that is modified by a Group 2 element (a dehydration step is carried out with a promoted alumina catalyst e.g. CaOAl₂O₃, Ca₂O₃Al₂O₃, calcium is a group 2 element; paragraph [0061]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided an inorganic support that is modified by a Group 2 element, as previously disclosed by Drent, to provide a catalyst that controls the reaction to produce alpha olefins, or 1-alkenes.

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Claims 27 and 29 lack an inventive step under PCT Article 33(3) as being obvious over Wright, in view of Drent, and in further view of WO 2013/106065 A1 to the Government of the United States of America as Represented by the Secretary of the Navy (hereinafter 'Navy').

As per claim 27, Wright and Drent, in combination, disclose a method according to claim 26. Wright further discloses wherein said diesel fuel comprises a flashpoint of about 38 to about 100 degrees Celsius, a Cetane rating of about 45 to about 60 (oligomers useful in preparing high flashpoint biodiesel fuels, which includes flashpoints in the range of 61 to 100 degrees Celsius and Cetane rating of 45 to 60; paragraph [0023]). Wright does not disclose an aromatic content of less than about 0.5 weight percent. Navy discloses a diesel fuel with an aromatic content of less than about 0.5 weight percent (oligomeric mixture, suitable for diesel and jet fuels, from 1-butene over a catalyst contains no aromatic hydrocarbons; paragraphs [0033]-[0034]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided a diesel fuel with an aromatic content of less than about 0.5 weight percent, as previously disclosed by Navy, to achieve an environmentally friendly fuel.

As per claim 29, Wright and Drent, in combination, disclose a method according to claim 28. Wright further discloses wherein said jet fuel comprises a flashpoint of about 38 to about 100 degrees Celsius, a cold flow viscosity of less than about 8.0 cSt at -20 degrees Celsius (oligomers useful in preparing high flashpoint biojet fuels, these include flashpoints from 61 to 1000 degrees Celsius and cold flow viscosities of <8.5 cSt at -20 degrees Celsius; paragraph [0023]). Wright does not disclose an aromatic content of less than about 0.5 weight percent. Navy discloses a jet fuel with an aromatic content of less than about 0.5 weight percent (oligomeric mixture, suitable for diesel and jet fuels, from 1-butene over a catalyst contains no aromatic hydrocarbons; paragraphs [0033]-[0034]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided a jet fuel with an aromatic content of less than about 0.5 weight percent, as previously disclosed by Navy, to achieve an environmentally friendly fuel.

Claim 32 lacks an inventive step under PCT Article 33(3) as being obvious over Wright, in view of Drent, and in further view of US 2010/0099936 A1 to Shin, et al. (hereinafter 'Shin').

As per claim 32, Wright and Drent, in combination, disclose a method of forming 1-butene according to claim 4. Wright further discloses a method of making a product, comprising contacting the 1-butene with a catalyst (products from embodiments, dried 1-alkene product are placed in contact with a Ziegler-Natta; paragraphs [0023], [0036]). Wright does not disclose making 1,3-butadiene, comprising contacting the 1-butene with a catalyst comprising Bi, Mo and Fe in a molar ratio of 1:1:0.5-1.25, and comprising a Bi₃FeMo₂O₁₂ phase and Fe₂(MoO₄)₃ phase. Shin discloses making 1,3-butadiene, comprising contacting 1-butene with a catalyst (a process of preparing 1,3-butadiene, which comprising conducting an ODH, oxidative dehydrogenation, of 1-butene in the presence of a catalyst; paragraph [0031]) comprising Bi, Mo and Fe in a molar ratio of 1:1:0.5-1.25 (the catalyst comprising Bi, Mo and Fe in a molar ratio of 1:0.6-1:0.1-1.25; paragraph [0023]), and comprising a Bi₃FeMo₂O₁₂ phase and Fe₂(MoO₄)₃ phase (catalyst compositions are shown with both a Bi₃FeMo₂O₁₂ phase and Fe₂(MoO₄)₃ phase; paragraphs [0043]-[0044]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified method, as previously disclosed by Wright, in order to have provided making 1,3-butadiene, comprising contacting the 1-butene with a catalyst comprising Bi, Mo and Fe in a molar ratio of 1:1:0.5-1.25, and comprising a Bi₃FeMo₂O₁₂ phase and Fe₂(MoO₄)₃ phase, as previously disclosed by Shin, to produce a marketable product with the 1-butene.

Claim 44 lacks an inventive step under PCT Article 33(3) as being obvious over Wright, in view of Drent, and in further view of US 2013/0245218 A1 to Moman, et al. (hereinafter 'Moman').

As per claim 44, Wright and Drent, in combination, disclose a catalyst composition according to claim 41. Wright does not disclose wherein the organosilane is diphenyldiethoxysilane. Moman discloses an organosilane is diphenyldiethoxysilane (modifying a catalyst with compounds such as silicon compounds including diphenyldiethoxysilane; paragraphs [0010]-[0011], [0013], [0037]-[0038]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified catalyst, as previously disclosed by Wright, in order to have provided wherein the organosilane is diphenyldiethoxysilane, as previously disclosed by Moman, to produce a catalyst with higher bulk density.

Claims 1-46 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.