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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte R. PAUL WOODS, CRAIG R. SMITH, DAN KRAMER,
HEIKE ENKE, KERSTIN BAIER, ULF DUHRING, KARL ZIEGLER,
WOLFGANG LOCKAU, MARIANNE GRUNDEL, JOHN COLEMAN,
and CHRISTINE OESTERHELT

Appeal 2014-000811
Application 12/368,060¹
Technology Center 1600

Before ERIC B. GRIMES, JACQUELINE T. HARLOW, and
KRISTI L. R. SAWERT, *Administrative Patent Judges*.

SAWERT, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 from the rejection of claims 1–3, 6, 8, 9, and 14–17. We have jurisdiction under 35 U.S.C. § 6(b). We affirm-in-part and reverse-in-part.

¹ Appellants identify Algenol Biofuels Incorporated as the real party in interest. Appeal Br. 3.

STATEMENT OF THE CASE

Claims 1–3, 6, 8, 9, and 14–17 are on appeal and stand rejected² as follows:

- A. Claims 1–3, 6, 8, 9, and 14–17 under 35 U.S.C. § 112, second paragraph, for indefiniteness;
- B. Claims 1–3, 6, 8, 9, 14, and 15 under 35 U.S.C. § 112, first paragraph, for lack of written description;
- C. Claims 1–3, 6, 8, 9, 14, and 15 under 35 U.S.C. § 112, first paragraph, for lack of enablement;
- D. Claims 1–3, 6, 8, 9, 14, and 15 under 35 U.S.C. § 103(a) for obviousness over Deng³ in view of Wahlund,⁴ Spreitzer,⁵ and Amichay;⁶ and
- E. Claims 1–3, 6, 8, 9, and 14–17 under 35 U.S.C. § 103(a) for obviousness over Deng in view of Wahlund, Spreitzer, and Amichay, Duhring,⁷ and further in view of Kaneko.⁸

Final Off. Act. 3–17.

² The Examiner also objected to claims 6, 8, and 14. *See* Final Off. Act. 3, 17. Appellants state that they amended claims 6 and 14 when filing the Appeal Brief “pending entry into the record,” Appeal Br. 5, but the Examiner states that the rejections on appeal are applied to the claims “as submitted in a communication filed on 8/7/2012,” Ans. 2. Thus, we understand that the Examiner did not enter the amendments made at the time the Appeal Brief was filed.

³ *Applied and Environmental Microbiology*, 65(2):523–528 (1999).

⁴ *Am. Chem. Soc. Div. Fuel Chem.*, 41:1403–1406 (1996).

⁵ *Annu. Rev. Plant Biol.*, 53:449–475 (2002).

⁶ *Plant Molecular Biology*, 23:465–476 (1993).

⁷ *PNAS*, 103(18):7054–7058 (2006).

⁸ GenBank Accession No. BA000022 (May 20, 2006).

Independent claim 1 is illustrative of the claimed subject matter on appeal. Claim 1 provides:

1. A genetically modified cyanobacteria host cell which produces ethanol (C_2H_5OH) and oxygen (O_2) comprising:
 - a. a first genetic modification which changes the enzymatic activity or affinity of an endogenous host cell enzyme, wherein the first genetic modification is an overexpressed ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO); and
 - b. a second genetic modification which introduces an overexpressed pyruvate decarboxylase enzyme associated with the formation of ethanol.

Appeal Br. 32.

DISCUSSION

A. Indefiniteness

The Examiner rejected claims 1–3, 6, 8, 9, and 14–17 under 35 U.S.C. § 112, ¶ 2, for failing to particularly point out and distinctly claim the subject matter applicant regards as the invention. “[A] claim is indefinite when the boundaries of the protected subject matter are not clearly delineated and the scope is unclear.” *Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. § 112 and for Treatment of Related Issues in Patent Applications*, 76 Fed. Reg. 7164 (Feb. 9, 2011) (“Indefiniteness Guidelines”); *see also* MPEP § 2173.02; *In re Packard*, 751 F.3d 1307, 1310 (Fed. Cir. 2014) (“[W]e affirm the Board’s findings as to indefiniteness under the MPEP standard properly applied by the USPTO . . .”). The Examiner sets forth several rationales for rejecting

the claims for indefiniteness. Because we agree with some, but not all, of those rationales, we reverse the rejection as to claims 1–3, 6, and 15–17, but affirm the rejection as to claims 8, 9, and 14. We address each rejected claim in the order presented by the Examiner below.

Claims 1–3, 6, 8, 9, and 14–17

The Examiner states that the claims 1–3, 6, 8, 9, and 14–17 are indefinite for reciting “overexpressed ribulose . . . oxygenase,” “overexpressed pyruvate decarboxylase,” and “overexpressing a complete operon.” Final Off. Act. 3. The Examiner asserts that “[t]he terms ‘overexpressed’ and ‘overexpressing’ are indefinite in the absence of a basis for comparison.” *Id.* We disagree. Claim definiteness “requires a determination of whether *those skilled in the art* would understand what is claimed when the claim is read in light of the specification.” MPEP § 2173.02 (emphasis added). Here, we find that an ordinarily skilled artisan would readily understand that “overexpressed” and “overexpressing” refer to increased expression of the protein of interest over the wild type (i.e., non-genetically modified cyanobacteria) host cell. *See, e.g.,* Spec. 70 (¶ 473). The prior art cited by the Examiner also supports our finding that “overexpression” is a well-known term to those skilled in the art. For example, Duhring also describes overexpression in comparison to a wild type. Duhring 7055 (Fig. 2). Thus, we reverse this rejection.

Claims 8 and 9

The Examiner states that claim 8 and dependent claim 9 are indefinite for reciting “level of a first metabolic intermediate in the genetically

modified host cell compared to the level of the first metabolic intermediate in a host cell lacking the first genetic modification.” Final Off. Act. 3. The Examiner explains that, because the phrase “does not require the comparison to be made with the corresponding cyanobacterial host cell lacking the first modification but rather allows for the comparison to be made with any host cell lacking the first modification,” the claim is unclear as to whether the comparison host cell encompasses *any* host cell or only a *cyanobacteria* host cell. *Id.* at 3–4 (emphasis added). We agree.

Section 112 requires claims “to be cast in clear—as opposed to ambiguous, vague, indefinite—terms.” *Packard*, 751 F.3d at 1313. The USPTO must “test the claims for reasonable precision” in the context of the specification and the relevant subject matter to “ensur[e] that patent claims are clear and unambiguous.” *Id.* Indeed, “the patent drafter is in the best position to resolve the ambiguity in the patent claims, and it is highly desirable that patent examiners demand that applicants do so in appropriate circumstances so that the patent can be amended during prosecution rather than attempting to resolve the ambiguity in litigation.” *Halliburton Energy Servs., Inc. v. M-I LLC*, 514 F.3d 1244, 1255 (Fed. Cir. 2008). To this end, the Federal Circuit has explained:

when the USPTO has initially issued a well-grounded rejection that identifies ways in which language in a claim is ambiguous, vague, incoherent, opaque, or otherwise unclear in describing and defining the claimed invention, and thereafter the applicant fails to provide a satisfactory response, the USPTO can properly reject the claim as failing to meet the statutory requirements of § 112(b).

Packard, 751 F.3d at 1311.

Here, Appellants' response to the Examiner's rejection has only added to the ambiguity of the claims. Appellants assert that the Specification "provides a basis for comparison to a corresponding *cyanobacteria* host cell lacking the first genetic modification." Reply Br. 6 (emphasis added). But, Appellants then recite a passage from the Specification that refers merely to a "photoautotrophic ethanol producing host cell." *Id.* (citing Spec. 43:19–26). We note, however, that cyanobacteria are not the only photoautotrophic, ethanol-producing cells disclosed in the Specification. For example, as the Examiner explained, the comparison host cell could be *B. subtilis*. Ans. 18. Because the scope of the claims remains unclear, we affirm this rejection.

Claim 14

The Examiner rejected claim 14 for indefiniteness. Claim 14 depends from claim 1. As noted above, claim 1 requires the "first genetic modification" to be "an overexpressed ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO)," and the "second genetic modification" to "introduce[] an overexpressed pyruvate decarboxylase enzyme associated with the formation of ethanol." Claim 14 further limits the "first genetic modification" to "the group consisting of (a) integrating a conjugative, self-replicating pVZ plasmid containing a *rbcLXS* operon present as transcriptional fusion with a pyruvate decarboxylase from *Zymomonas mobilis*, into the genetically modified *Synechocystis* host cell, (b) overexpressing only small subunits and large subunits of ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO), (c) overexpressing a complete operon including a Chaperonin for ribulose-1,5-

bisphosphate carboxylase/oxygenase (RubisCO), and (d) random or site directed mutagenesis of ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO).” Appeal Br. 35.

The Examiner finds member (a) of the Markush group, i.e., “integrating . . . plasmid containing a rbcLXS operon present as a transcriptional fusion with a pyruvate decarboxylase from *Zymomonas*,” confusing because both the “first genetic modification” and the “second genetic modification” require the expression of pyruvate decarboxylase. “Therefore,” the Examiner explains, “it is unclear how . . . the first modification [can] comprise the second modification, or whether the expression of two pyruvate decarboxylases is required.” Final Off. Act. 4. We agree with the Examiner that the claim is unclear under *Packard*.

We acknowledge Appellants’ argument that the claim merely refers to a specific embodiment of the invention described in the Specification, i.e., the integration of a conjugative, self-replicating pVZ plasmid into *Synechocystis* containing either the rbcLXS operon alone or the rbcLXS operon as transcriptional fusion together with the pyruvate decarboxylase from *Zymomonas*. See Spec. 109. We further acknowledge Appellants’ arguments that the claim intends to refer to a plasmid containing both the first genetic modification and the second genetic modification, as described in the Specification. Appeal Br. 13–14. The problem with claim 14, however, is that it purports to limit the “first genetic modification,” not the “second genetic modification.” Again, claims must issue from the USPTO in “clear and unambiguous” form. *Packard*, 751 F.3d at 1313. And because claim 14 is not clear, we must affirm this rejection.

The Examiner next states that element (c) of the Markush group, i.e., overexpressing a complete operon including a Chaperonin for ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO),” is indefinite because “unclear as to which complete operon is being overexpressed.” Final Off. Act. 4. As to this rejection, we agree with Appellants that the Specification provides a definition of “complete operon” for RubisCO overexpression. *See* Appeal Br. 14. Specifically, the Specification describes the “complete operon” as an operon that comprises genes encoding a RubisCO large subunit, a RubisCO small subunit, and a RubisCO chaperonin. Thus, we reverse this basis for rejection.

The Examiner finds that “into *the* genetically modified *Synechocystis* host cell,” recited in member (a) of the Markush group, lacks proper antecedent basis. Final Off. Act. 4 (emphasis added). We agree. A claim term lacks antecedent basis when the claim “contains no earlier recitation or limitation” of that term. MPEP § 2173.05(e). Here, neither claim 1 nor claim 14 first limit the cyanobacteria of claim 1 to “a” genetically-modified *Synechocystis* host cell. And because cyanobacteria are not necessarily *Synechocystis*, we agree with the Examiner that claim 14 is unclear. Thus, we affirm this basis for rejection.

Finally, the Examiner asserts that it is unclear how “random or site-directed mutagenesis of ribulose . . . oxygenase,” recited in member (d) of the Markush group, properly depends from claim 1. Final Off. Act. 5. The “first genetic modification” in claim 1, from which claim 14 depends, results in “an overexpressed ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO).” The Examiner states that an ordinarily skilled artisan would

understand that “first genetic modification” to require the transformation of an exogenous RubisCO, but the same “first genetic modification” in claim 14 requires modification of an endogenous RubisCO. Final Off. Act. 5. We disagree with the Examiner that “first genetic modification” of claim 1 requires the transformation of an exogenous RubisCO. Indeed, as discussed below, the broadest reasonable interpretation of claim 1 encompasses any modification that results in the overexpression of RubisCO. Section (d) of claim 14 limits the “first genetic modification” to random or site directed mutagenesis of RubisCO. Put differently, random or site directed mutagenesis of RubisCO is one modification that may result in overexpression of RubisCO. Although we acknowledge that the claim is very broad, mere breadth is not indefiniteness. *In re Gardner*, 427 F.2d 786, 788 (CCPA 1970). Thus, we reverse this basis for rejection.

Claim 16

The Examiner rejects claim 16 for reciting “95% identity to *Synechocystis* . . . (SEQ ID NO: 65).” Final Off. Act. 5. Claim 16 recites that “the nucleic acid encoding said ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO) has at least 95% identity to *Synechocystis rbcL-rbcX-rbcS* (SEQ ID NO: 65).” Appeal Br. 35. The Examiner asserts that “*Synechocystis rbcL-rbcX-rbcS*” by itself is unclear, and that “it is unclear if the sequence in parenthesis is the reference sequence which needs to be used to determine the ‘at least 95% identity’ recited.” Final Off. Act. 5. We agree with Appellants that this claim is sufficiently clear to an ordinarily skilled artisan in view of the Specification. *See* Appeal Br. 15. First, the Sequence Listing lists SEQ ID NO: 65 as the DNA

sequence of the three genes *rbcL-rbcX-rbcS* from *Synechocystis* in order. Second, because SEQ ID NO: 65 is the DNA sequence of *rbcL-rbcX-rbcS*, one of one skilled in the art would understand that the claimed nucleic acid has at least 95% identity to the sequence disclosed as SEQ ID NO: 65. Thus, we reverse this rejection.

Claim 17

Finally, the Examiner states that claim 17 is indefinite for reciting “*the rbcL gene*,” “*the rbcS gene encodes*,” and “*the rbcX gene encodes*,” without proper antecedent basis. Final Off. Act. 5–6. Claim 17 recites that “the *rbcL* gene encodes rubisco large subunit protein having at least 95% identity to SEQ ID NO: 66; the *rbcS* gene encodes a rubisco small subunit protein having at least 95% identity to SEQ ID NO: 68, and the *rbcX* gene encodes a rubisco chaperonin having at least 95% identity to SEQ ID NO: 67.” Appeal Br. 35. We disagree, as *rbcL*, *rbcS*, and *rbcX* have antecedent basis in claim 16, from which claim 17 depends. Thus, we reverse this rejection.

B. Written Description

The Examiner rejected claims 1–3, 6, 8, 9, 14, and 15 under 35 U.S.C. § 112, ¶ 1, for lack of written description. Final Off. Act. 6–7. The first paragraph of § 112 requires that the specification contain a written description of the claimed invention. 35 U.S.C. § 112, ¶ 1 (2011). “[T]he hallmark of written description is disclosure.” *Ariad Pharms., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (*en banc*). The written description requirement is met when the specification “conveys to those

skilled in the art that the inventor had possession of” and “actually invented” the claimed subject matter. *Id.*

For claims encompassing a genus, sufficient written description “requires the disclosure of either a representative number of species falling within the scope of the genus or structural features common to the members of the genus so that one of skill in the art can ‘visualize or recognize’ the members of the genus.” *Id.* at 1350 (quoting *Regents of the Univ. of California v. Eli Lilly & Co.*, 119 F.3d 1559, 1568–69 (Fed. Cir. 1997)). Functional claim language may meet the written description requirement when there is a “known or disclosed correlation between function and structure.” *Enzo Biochem, Inc. v. Gen-Probe Inc.*, 323 F.3d 956, 964 (Fed. Cir. 2002) (quotation omitted). But in the absence of a structure-function correlation, the written description requirement demands “a precise definition, such as by structure, formula, chemical name, physical properties, or other properties, of species falling within the genus sufficient to distinguish the genus from other materials.” *Ariad*, 598 F.3d at 1350.

We find that a preponderance of the evidence supports the Examiner’s finding of a lack of written description. The claimed invention encompasses a genetically-modified cyanobacterial host cell that overexpresses RubisCO enzyme. *See* Appeal Br. 32 (claim 1). Thus, as the Examiner explained and we agree, the claims encompasses *any* modification that results in overexpression of RubisCO. Final Off. Act. 6–7. But, as the Examiner also found and we agree, the Specification only provides written description support for two such modifications: increasing the copy number of a nucleic acid encoding a RubisCO enzyme, and placing a nucleic acid encoding a

RubisCO enzyme under the control of a strong heterologous promoter. *Id.* at 7. We find that the disclosure of only two modifications to support a claim to any and all modifications does not amount to “a representative number of species falling within the scope of the genus.” *Ariad*, 598 F.3d at 1350.

We are not persuaded otherwise by Appellants’ argument that “[t]here is no requirement in patent law that the application provide written description for ‘any’ modification to achieve the claimed embodiment.” Appeal Br. 17. Although we agree that the Specification need not describe each and every possible modification, the Federal Circuit nonetheless dictates that “an adequate written description of a claimed genus requires more than a generic statement of an invention’s boundaries.” *Ariad*, 598 F.3d at 1349.⁹ Here, Appellants have generically provided the outer boundaries of the claimed “first genetic modification” through the use of functional language (i.e., any modification that results in overexpression of

⁹ We must follow the Federal Circuit’s *en banc* decision in *Ariad*, and note that, to the extent that earlier cases may conflict (i.e., *In re Vaeck*, 947 F.2d 488, 496 (Fed. Cir. 1991) and *In re Angstadt*, 537 F.2d 498 (CCPA 1976)), those cases do not control the written description analysis here. We also note that *Vaeck* and *Angstadt* are inapposite because those cases address enablement, not written description. We also find Appellants’ reliance on *Tilghman v. Proctor*, 102 U.S. 707, 728 (1880), Reply Br. 10, similarly deficient. *Tilghman* does not stand for the broad proposition that the Specification need only describe one species in every case. Indeed, the Federal Circuit has explained that determining compliance with the written description requirement is a fact-intensive inquiry, that “depend[s] on the nature and scope of the claims and on the complexity and predictability of the relevant technology.” *Ariad*, 598 F.3d at 1351. Here, there can be no serious dispute that the broad claims are directed to a highly complex and unpredictable technology.

RubisCO), but have failed to show in the Specification that they actually possessed a representative number of those modifications. Indeed, as the Examiner explained and Appellants do not appear to dispute, the claimed invention encompasses “modifications such as the addition of any type of compound/chemical that would enhance expression, modifications to the regulatory region of any cyanobacterial RubisCO gene to increase expression, and expression of unknown proteins which would act as inducers of RubisCO expression,” none of which are disclosed in the Specification. Final Off. Act. 7. We find that “[c]laiming all [modifications] that achieve a result without defining what means will do so is not in compliance with the description requirement; it is an attempt to preempt the future before it has arrived.” *Fiers v. Revel*, 984 F.2d 1164, 1171 (Fed. Cir. 1993).

In sum, Appellants have not disclosed a representative number of “first genetic modifications,” and the Specification provides insufficient relevant identifying characteristics of the modifications to show that Appellants “had possession of” and “actually invented” the claimed subject matter. *Ariad*, 598 F.3d at 1351. Thus, we agree with the Examiner that the claims lack adequate written description.

C. Enablement

The Examiner also rejected claims 1–3, 6, 8, 9, 14, and 15 under 35 U.S.C. § 112, ¶ 1, for lack of enablement. Final Off. Act. 10–13. The first paragraph of § 112 requires that the specification enable a person of ordinary skill in the art “to make and use the invention.” 35 U.S.C. § 112, ¶ 1 (2011). The enablement requirement is met when the skilled artisan, having read the

specification, could practice the claimed invention without “undue experimentation.” *In re Wands*, 858 F.2d 731, 736–37 (Fed. Cir. 1988). “Whether undue experimentation is needed is not a single, simple factual determination, but rather is a conclusion reached by weighing many factual considerations,” including:

(1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims.

Id. at 737 (“the *Wands* factors”).

The Examiner considered all the *Wands* factors, and discussed the implications of several with respect to the claimed invention. Ans. 7–10. We find that a preponderance of the evidence supports the Examiner’s analysis of the *Wands* factors and adopt them as our own. We also agree with the Examiner’s ultimate determination that, although the Specification reasonably enables “a genetically engineered cyanobacterial cell transformed with a nucleic acid encoding a RubisCO, an alcohol dehydrogenase and a pyruvate decarboxylase,” the Specification “does not reasonably provide enablement for a genetically modified cyanobacterial cell modified in any way to increase the expression of an endogenous RubisCO.” Final Off. Act. 7.

On appeal, Appellants rely the Federal Circuit’s decision in *Invitrogen v. Clontech*, 429 F.3d 1052 (Fed. Cir. 2005) to argue that practicing the claimed invention would not require undue experimentation. *See* Appeal Br. 19–20. Specifically, Appellants argue that because the Specification enables

one “mode of making and using the invention,” the legal requirement of enablement is met. Appeal Br. 19 (quoting *Invitrogen*, 429 F.3d at 1071). Appellants point to the Specification as providing “[a]n example of enablement . . . that discloses ethanologenic cyanobacterial cells that overexpress RubisCO that exhibited increased RubisCO activity.” Appeal Br. 20.

The claims in *Invitrogen* were directed to a genetically engineered polypeptide (“reverse transcriptase” or “RT”), “without regard for the method used to mutate the genes” to create the polypeptide. 429 F.3d at 1070. It was undisputed that, at the time the application leading to the patent-in-suit was filed, skilled artisans “knew several techniques for altering genetic sequences, including deletion and point mutations.” *Id.* The patent-in-suit described how to obtain a genetically engineered RT by deletion mutation, but not point mutation. *Id.* The Federal Circuit agreed with the district court that the full scope of the claims was sufficiently enabled. *Id.* at 1071. In particular, the court noted that the enablement requirement was met for the compound claim because the combination of the “mode of making” disclosed in the specification and genetic-modification techniques already known in the art reasonably allowed for the skilled artisan to make and use the genetically modified RT without undue experimentation. *Id.*

This case is different. Here, the claims are drawn to a genetically modified cell that overexpresses RubisCO and pyruvate decarboxylase. *See* Claim 1, *supra*. In the case of a genetically modified polypeptide, skilled artisans know several techniques for genetically modifying the underlying

genetic sequence. But, in the case of a genetically modified cell, many factors may lead to overexpression of a particular enzyme, including currently unknown upstream factors that influence the expression of RubisCO and pyruvate decarboxylase. *See* Ans. 23–25. Thus, we determine that the disclosure of one method for causing overexpression of RubisCO and pyruvate decarboxylase does not adequately enable claims encompassing *all* methods for doing so.

With respect to the “infinite number of compounds” that may result in overexpression, Appellants again state that *Angstadt* does not require “disclosure of a test with every species covered by a claim.” Appeal Br. 20 (quoting *Angstadt*, 537 F.2d at 502). But Appellants’ argument—that disclosure of *one* method for making a claimed product enables *all* methods for making a claimed product in *all* cases—amounts to a per se rule that neither *Invitrogen* nor *Angstadt* supports. The claims in *Invitrogen* were sufficiently limited to genetically modified sequences, and the disclosure of one means of creating those sequences (along with extensive knowledge of other techniques in the art) sufficiently enabled the full scope of the claims. But here, the claims are directed to genetically modified cells that overexpress certain enzymes by *any* means (not limited to genetic-modification of those enzymes’ genetic sequences). Put differently, there is a difference in kind between the claims of *Invitrogen* and the claims on appeal that limits *Invitrogen*’s application here. And in *Angstadt*, the written description disclosed a representative number of species within the claimed genus; here, only one method is disclosed. For these reasons, the enablement rejection is affirmed.

D. Obviousness

The Examiner rejected claims 1–3, 6, 8, 9, and 14–15 under 35 U.S.C. § 103(a) for obviousness over Deng in view of Wahlund, Spreitzer, and Amichay; and claims 1–3, 6, 8, 9, and 14–17 under 35 U.S.C. § 103(a) for obviousness over Deng in view of Wahlund, Spreitzer, Amichay, Duhring, and further in view of Kaneko.

Upon review of the Examiner’s rejections, Appellants’ arguments, and the prior art, we determine that the weight of the evidence does not support the obviousness rejections. Thus, we reverse the rejection of claims 1–3, 6, 8, 9, and 14–17 for obviousness.

The primary prior-art reference, Deng, provides “the first study in which oxygenic photoautotrophic microorganisms,” i.e., cyanobacteria, “have been genetically engineered to produce ethanol.” Deng 523. Specifically, Deng introduced the coding sequences for pyruvate decarboxylase (*pdh*) and alcohol dehydrogenase (*adh*) from the bacterium *Zymomonas mobilis* into a *Synechococcus* cyanobacterium, thus creating “a novel pathway for fixed carbon utilization which results in the synthesis of ethanol.” *Id.* Deng does not disclose that overexpression of RubisCO can increase production of ethanol. Thus, the Examiner relied on the secondary references to teach that overexpression of RubisCO would have been obvious to a skilled artisan. *See* Final Off. Act. 10.

Specifically, the Examiner relied on the disclosures of Wahlund and Spreitzer to “provide the motivation to [over]express a RubisCO nucleic acid.” *Id.* at 11. Wahlund inserted a plasmid expressing the *pdh* and *adh* genes into *Rhodobacter* to achieve the bioconversion of carbon dioxide to

ethanol. Wahlund 1403–04. Spreitzer provides an overview of RubisCO, and proposes that a “better” RubisCO enzyme could be created through genetic mutational approaches. Spreitzer 449, 465.

We decide this case by determining whether an ordinarily-skilled artisan would have been motivated to increase the production of ethanol in cyanobacteria, as taught by Deng, by overexpressing RubisCO. We agree with Appellants that the Examiner did not adequately set forth a persuasive reason explaining why a skilled artisan would have found it obvious to do so. *See* Appeal Br. 23–26.

As Appellants point out, no reference teaches overexpression of RubisCO. *Id.* at 23. The Examiner asserts, however, that

the teachings of Wahlund et al. and Spreitzer et al. provide the motivation to increase expression of RubisCO in view of the fact that Spreitzer et al. discloses that the first step in photosynthetic carbon dioxide assimilation is catalyzed by RubisCO and also in view of the fact that Wahlund et al. clearly indicate that (i) there are numerous types of bacteria able to carry out CO₂ fixation (like cyanobacteria) and that it would be desirable to find ways to use CO₂ for the production of value-added chemicals such as ethanol, and (ii) there is a considerable interest in coupling pyruvate formation with ethanol synthesis since pyruvate is a common metabolic intermediate of virtually all central metabolic pathways in bacteria able to carry [out] carbon dioxide fixation. As known in the art, CO₂ is a carbon source for photosynthetic organisms, such as cyanobacteria. It is reiterated herein that one of skill in the art would be motivated to increase the expression of RubisCO for increased CO₂ assimilation, which in turn would result in an increase in the levels of metabolic intermediates such as pyruvate, a key intermediate in the synthesis of ethanol.

Ans. 26. We find this explanation speculative at best. Although Spreitzer teaches that RubisCO catalyzes the fixation of carbon dioxide, that disclosure combined with the teachings of the other prior-art references does not amount to sufficient evidence that overexpression of RubisCO for the purpose of increasing ethanol production would have been obvious. Obviousness based on an “obvious to try” rationale requires “a finite number of identified, predictable solutions” and “known options within [the ordinarily skilled artisan’s] technical grasp.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007). Here, RubisCO is only one of several enzymes involved in photosynthesis, and the Examiner has not persuasively explained why the skilled artisan would choose RubisCO specifically (over, for example, pyruvate decarboxylase and alcohol dehydrogenase). Nor does the Examiner provide any evidence supporting the theory that overexpression of RubisCO would reasonably lead to the “anticipated success” of increased ethanol production. Instead, the Examiner strings together a series of “if-thens”: if RubisCO is overexpressed then CO₂ assimilation would increase, if CO₂ assimilation is increased then pyruvate levels would increase, and if pyruvate levels are increased, then ethanol production will increase. Ans. 13. This speculation does not establish obviousness by a preponderance of the evidence. For these reasons, the obviousness rejections are reversed.

SUMMARY

We affirm the final rejection of claim 8, 9, and 14 under 35 U.S.C. § 112, ¶ 2, for indefiniteness, but reverse the final rejection under this section of claims 1–3, 6, and 15–17.

We affirm the final rejection of claim 1 under 35 U.S.C. § 112, ¶ 1, for lack of written description. Claims 2, 3, 6, 8, 9, 14, and 15 fall with claim 1 as to this ground of rejection.

We affirm the final rejection of claim 1 under 35 U.S.C. § 112, ¶ 1, for lack of enablement. Claims 2, 3, 6, 8, 9, 14, and 15 fall with claim 1 as to this ground of rejection.

We reverse the final rejections of claims 1–3, 6, 8, 9, and 14–17 under § 103(a) for obviousness.

TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED-IN-PART