

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Schlumberger Technology Corp.
Petitioner,

v.

Halliburton Energy Services, Inc.,
Patent Owner.

Case IPR2018-00736

U.S. Patent No. 7,228,904

PETITION FOR *INTER PARTES* REVIEW

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1001	U.S. Patent No. 7,228,904
1002	Declaration of Dr. Mukul Sharma
1003	Curriculum Vitae of Dr. Mukul Sharma
1004	File History of U.S. Patent No. 7,044,220 (excluding references)
1005	U.S. Patent No. 3,173,484 (“Huitt”)
1006	U.S. Patent No. 6,328,105 (“Betzold”)
1007	<i>New “beads” help acidizing, fracturing</i> , THE OIL AND GAS JOURNAL, 1965
1008	U.S. Patent No. 3,316,965 (“Watanabe”)
1009	U.S. Patent No. 6,749,025 (“Brannon”)
1010	U.S. Patent No. 6,599,863 (“Palmer”)
1011	Montgomery, C.T., and Smith, M.B., <i>Hydraulic fracturing—History of an enduring technology</i> , J. PET. TECH., 2010, 62:26–32.
1012	U.S. Patent No. 5,226,479 (“Gupta”)
1013	U.S. Patent No. 5,501,274 (“Nguyen”)
1014	U.S. Patent No. 5,591,700 (“Harris”)

- 1015 U.S. Patent No. 6,214,773 (“Harris”)
- 1016 Holditch, S.A. and Ely, J., *Successful Stimulation of Deep Wells Using High Proppant Concentrations*, J. PETROLEUM TECH., 959–964 (1973).
- 1017 NOT USED
- 1018 U.S. Patent No. 4,387,769 (“Erbstoesser”)
- 1019 U.S. Patent No. 7,044,220
- 1020 File History of U.S. Patent No. 7,228,904 (excluding references)
- 1021 U.S. Patent No. 5,439,055 (“Card”)

I. Introduction

Schlumberger Technology Corporation (“Schlumberger”) requests IPR of claims 1–20 of U.S. Patent No. 7,228,904 (“the ’904 patent”), assigned to Halliburton Energy Services, Inc. (“Halliburton”).

The ’904 patent is directed to a fracturing method for oil and gas wells. Fracturing—a *seventy year old* technology—typically involves two steps after drilling a wellbore into a rock formation: (1) transporting a fracturing fluid down the wellbore; and (2) applying enough pressure to fracture the surrounding rock formation. Generally the fracturing fluid contains “proppant” particles such as sand that form a matrix and remain in place, holding the newly-created fracture open. Fracturing’s goal is to increase the permeability of the rock formation, allowing oil or gas to flow more easily into the wellbore for extraction.

The ’904 patent claims only well-known steps of using a proppant matrix composition including a degradable component. When this component degrades, it forms voids, *i.e.*, empty spaces, in the proppant matrix, thereby increasing the permeability of the proppant matrixes and retaining high conductivity for the flow of oil or gas into the wellbore. But, the concept of using a degradable material intermixed with proppant in order to increase permeability and conductivity of the resulting proppant matrix was well-known in the art long before June 2003, and therefore claims 1–20 should be canceled as unpatentable.

II. Mandatory Notices—Rule 42.8(a)(1)

Schlumberger provides notice of the following:

A. Real Parties-in-Interest

Schlumberger Technology Corporation and the following entities are real parties-in-interest: Schlumberger Holdings Corporation, Schlumberger B.V., Schlumberger, Ltd., Schlumberger Services, Inc., Compagnie d'Operations Petrolieres Schlumberger, Services Petrolier Schlumberger SA, and Schlumberger SA.

B. Related Matters

Petitioner is concurrently filing a petition for *inter partes* review directed to claims 56–73 the '904 patent's parent, U.S. Patent No. 7,044,220 (“the '220 patent”).

C. Lead and Backup Counsel and Service Information

Pursuant to 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4), and 42.10(a), Schlumberger designates as lead counsel:

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D. Fee for *Inter Partes* Review

The Office is authorized to charge the fee required by 37 C.F.R. § 42.15(a) for this Petition to Deposit Account No. 15-0030. Any additional fees that might be due are also authorized.

III. Certification of Grounds for Standing—Rule 42.104(a)

Petitioner certifies that the '904 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting review on the grounds identified in this Petition.

IV. Overview of Challenge and Relief Requested—Rule 42.104(b)

Petitioner requests *inter partes* review and cancelation of claims 1–20 of the '904 patent, which is subject to pre-AIA 35 U.S.C. § 103.

A. Prior Art Patents and Printed Publications

Review of the '904 patent is requested in view of the following prior art. None of this prior art was cited during original prosecution of the '904 patent, although Betzold was cited against the parent '220 patent during prosecution.

EX1006 – U.S. Patent No. 6,328,105 to Betzold (“Betzold”), issued December 11, 2001, prior art under § 102(b).

EX1008 – U.S. Patent No. 3,316,965 to Watanabe (“Watanabe”), issued May 2, 1967, prior art under § 102(b).

EX1010 – U.S. Patent No. 6,599,863 to Palmer et al. (“Palmer”), filed August 20, 1999 and issued July 29, 2003, prior art under § 102(e).

B. Grounds for Challenge

Petitioner requests cancelation of the challenged claims under the following statutory grounds:

1. Claims 1–20 are unpatentable under 35 U.S.C. § 103 as obvious over Watanabe and Betzold; and

2. Claims 1–20 are unpatentable under 35 U.S.C. § 103 as obvious over Palmer.

Section VIII demonstrates that there is a reasonable likelihood that Petitioner will prevail for each of the statutory grounds. *See* 35 U.S.C. § 314(a). Petitioner’s arguments are supported by a Declaration from Dr. Mukul Sharma (EX1002), Chairman of the Department of Petroleum and Geosystems Engineering at the University of Texas at Austin. Dr. Sharma has a Ph.D. in petroleum engineering, an M.S. in chemical engineering, and is a renowned expert in the field with over 32 years of relevant experience, as detailed in his C.V. (EX1003; *see* EX1002, ¶¶1–9.) This petition includes material from Dr. Sharma’s declaration, including the claim “charts” presented below, which are shorter versions of the analysis presented in Dr. Sharma’s declaration.

C. Grounds Based on Watanabe and Betzold Do Not Invoke 35 U.S.C. 325(d)

Section 325(d) grants the Board discretion to deny petitions if they are based on “the same or substantially the same prior art or arguments previously [] presented to the Office.” 35 U.S.C. § 325(d). Also, the Board may not institute unless a petitioner demonstrates a reasonable likelihood of prevailing. 35 U.S.C. § 314(a).

When evaluating a petition applying art that was before the examiner during prosecution, the Board typically looks at six factors: (1) the similarity of the now-asserted art and the art before the examiner, (2) the extent the art was considered during examination, including whether it was the basis for a rejection, (3) the cumulative nature of the asserted art and the art considered during examination, (4) whether the petitioner explained how the Examiner erred, (5) the overlap between the petitioner's arguments and the arguments made during examination, and (6) the extent that additional evidence and facts in the petition warrant reconsideration of the prior art. *Juniper Networks, Inc. v. Mobile Telecomms. Techs., LLC*, IPR2017-00642, Paper 24 (July 27, 2017).

Here, the Board should grant review even though the Examiner considered Betzold during prosecution of the '904 patent's parent, the '220 patent, as an anticipatory reference. All of the factors, other than the fact the Examiner applied Betzold, weigh in Schlumberger's favor. First, this petition does not present the same or substantially the same art or arguments that were before the Examiner during prosecution. Unlike the Examiner's Betzold rejection, the petition primarily relies on Watanabe, which is not cumulative and which teaches all the elements in the independent claims. Betzold is used only in the alternative and for certain dependent claims, and even then, only for claim elements that were undisputed during prosecution.

Further, the Examiner focused on the wrong portion of Betzold when finding that it lacked disclosure of a particular claim element. Specifically, Halliburton obtained allowance by arguing that Betzold’s *coated proppant particles* did not teach a composite particle:

Applicants respectfully submit that Betzold does not anticipate claim 19 since Betzold does not disclose degradable materials that are composites. Although the Examiner asserts that Betzold teaches “a proppant composition or composite” (*e.g., coated proppant particles*), Applicants respectfully submit that Betzold does not disclose or teach the use of a degradable material that is a composite, as that term is defined by Applicants in their disclosure. Applicants have explicitly defined the term “composite” to refer to a degradable material wherein “the degradable material [is] mixed with [an] inorganic or organic compound.”

(EX1004, 49–50 (*italics emphasis added*)). The Examiner subsequently allowed the claims in the ’220 application, and the claims in this patent issued without any rejections over the prior art. *See* Section V.C.

Betzold’s coated proppants, however, do not correspond to the recited degradable composite material. Rather, Betzold’s coated *proppant particles* correspond to the claimed *proppant particles*, and it is Betzold’s “removable particles” that correspond to the claimed “composite particles” that are removed to leave voids in the proppant matrix. (EX1006, Abstract, 3:50–52; 3:67–4:15.)

Betzold’s removable particles may “comprise any particulate material which will remain substantially intact during fracturing but which will later dissolve, decompose or otherwise react in a manner such that that they can be substantially removed.” (*Id.*, 3:39–43.) They can include “degradable polymers,” inorganic materials such as metal, and various additives. (*Id.*, 3:43–4:15.) As such, they correspond to the claimed composite materials—and there is nothing in the record indicating that the Examiner considered these teachings in Betzold at all, much less in this new light.¹

Accordingly, the Board should reach the merits of this petition rather than deny institution under § 325(d).

V. Background

A. State of the Art

Hydraulic fracturing has been used for approximately 70 years to increase the flow rate of natural gas and oil from reservoir rock formations by creating cracks in those rocks and rock formations. Fracturing may occur often far below the earth’s surface, and the goal is to create a more conductive path connecting a larger volume of natural gas or oil in the reservoir to the wellbore. (EX1002, ¶¶ 12–13.)

Hydraulic fracturing is accomplished by injecting fracturing fluid into a formation at an injection rate such that the pressure of the fluid at the formation is

¹ In any event, this petition relies primarily on Watanabe’s independent teaching of composite particles, not Betzold’s.

higher than the pressure required to fracture the formation. This elevated pressure causes a crack or fracture to develop in the rock, and continued fluid injection into the well then causes the fracture to increase in size. The fracturing fluid often contains a proppant, particles that will prop open the crack after hydraulic pressure is released and prevent the fracture from re-closing. Sand and ceramic proppants are most commonly used in fracturing. (*Id.*, ¶¶ 14–17, 20.)

The first hydraulic fracturing fluids used were oil-based, but the industry trend has been toward using water-based fluids for fracturing because water-based fracturing fluids were cheaper, easier to handle, and performed better. Water-based fracturing fluids generally require a gelling agent in order to achieve sufficient viscosity. Guar gum and cellulose derivatives were used in this manner, often in combination with a cross-linker to link polymers together. Generally once the formation has been fractured and the proppant is in place, it is desirable to remove the gelled fluid in order to allow the oil or gas to flow. This is referred to as “breaking” the gelled fluid. (*Id.*, ¶¶ 18–19.)

The degree to which a well is stimulated by the fracturing process is largely dependent on the permeability and width of the propped fracture. Thus, the productivity of the well is a function of the fracture’s conductivity. (EX1001, 1:27–36.) Accordingly, although the basic fracturing process has remained largely unchanged for decades, various improvements are continuously being made. For

example, because sand is not capable of withstanding the high closure stresses encountered in some formations, higher-strength ceramic proppants were introduced to the market. (EX1002, ¶¶ 21–22.)

It is an old practice to consolidate proppant in a fracture, forming a proppant matrix that holds the fracture open so that oil (or gas) may be recovered from the formation. (*E.g.*, EX1008, 1:30–36 (describing “the fundamental process of hydraulic fracturing treatment”); EX1021, 1:37–45 (gradually releasing pressure “so that fracture closure pressure acting against the proppant builds gradually allowing proppant matrix to stabilize before fracturing fluid flowback and well production can carry significant quantities of the proppant out of the fractures.”). (EX1002, ¶ 23.) Resin-coated proppants and tackifying agents were developed to help keep the proppant consolidated in the fracture, even under high pressure. (*Id.*, ¶¶ 24–25.) The ’904 patent admits as much, explaining in the Background section that consolidating proppant in the fracture has long been accomplished by several different methods (EX1001, 1:37–46; *see also* EX1019, 1:14, 1:31–39.) Fiber-assisted proppant transport was also used in the prior art, which helps the proppant form a stable pack or matrix with the fiber without decreasing permeability or conductivity. (EX1002, ¶ 27.)

Various efforts have been made to increase the permeability of the proppant matrixes to retain high conductivity and therefore higher production. (*Id.*, ¶ 29.) The

'904 patent describes two well-known approaches to improve the conductivity and permeability afforded by a particular proppant matrix. In one, calcium carbonate or salt is added to the proppant, and after fluid is added to the wellbore, the calcium carbonate or salt is dissolved out of the matrix, leaving channels or voids in the matrix. In another, wax beads are added to proppant compositions, and the wax melts out of the proppant matrix as a result of the higher temperature in the formation. Although these approaches are partially successful, both have problems associated with incomplete removal of the non-proppant component. (EX1001, 1:57–2:7.) Accordingly, those skilled in the art continually experiment with new materials.

Another common approach to improve conductivity is to break the gelled fracturing fluid, as noted above. This technique also increases the permeability of the proppant matrixes when the gelled fluid is broken. (EX1002, ¶ 31.)

It was also known in the art to use a degradable material in place of a gelled or highly viscous fluid, such that voids or channels would be left in the proppant matrix when the degradable material degrades. For example, Union Oil Co. developed and commercialized petroleum-wax composite “Unibeads” at least as early as 1965 (*see* EX1007). After the beads degrade, they leave “a pattern of open spaces between the sand grains, glass beads or other propping agents, to guarantee free passage to reservoir fluids.” (EX1002, ¶ 32 (citing EX1007, 54).)

As another example, Huitt describes introducing a fracturing liquid containing two different types of particles. Both initially assist with propping open the fracture, and then one type of particle is removed, providing spacing between the remaining proppant particles and creating highly permeable flow channels. (EX1005, 1:50–63.) Betzold also describes a proppant composition containing bondable particles (which adhere to each other and form a matrix) and removable particles, increasing conductivity upon removal. (EX1006, 2:33–48; EX1002, ¶¶ 33–34.)

Accordingly, using a degradable material intermixed with proppant to increase permeability and conductivity of the resulting proppant matrix was well-known in the art long before June 2003, the earliest priority date of the '904 patent.

B. The '904 Patent

The '904 patent is directed to the same issue: enhancing fluid flow from proppant matrixes in formations by using a proppant composition containing (i) a proppant in combination with (ii) composite particles comprising a degradable material and a filler material. The degradable material is capable of degrading when in position in the formation, creating voids (*i.e.*, empty spaces) in the proppant matrix by its removal. (EX1001, 2:26–40.) The filler material is simply another material included in the composite particle that may serve a wide variety of purposes. (*Id.*, 9:35–67.)

According to the '904 patent, “[a]ny proppant particulates suitable for use in subterranean applications are suitable for use in the compositions and methods of the present invention,” including both resin-coated and uncoated proppant particles such as natural sand. (*Id.*, 4:10–23.) The proppant particulates form a proppant matrix, which the '904 patent defines as “a consolidation of proppant particulates within a fracture that may be adjacent to a well bore in a subterranean formation.” (*Id.*, 3:24–26.) The proppant matrix can be formed by any suitable mechanism, including resin coatings or tackifying agents, as well as interlocking particles. (*Id.*, 3:27–33.) But, as explained above, even uncoated proppant particles have long been used to form a proppant matrix to hold fractures open and allow the oil to flow out of the formation. (EX1002, ¶¶ 38–39.)

The composite particles preferably have a size and shape similar to that of the proppant particulates to help maintain uniformity, although a specific size or shape may be chosen for a particular application. (EX1001, 10:1–11:20.) According to the claims, the composite particles include a degradable material and a filler.

The degradable material can be a degradable polymer. (*Id.*, 7:55–59.) Suitable polymers include various polymers known in the art, although aliphatic polyesters (such as poly(lactide)) are preferred. (*Id.*, 8:19–46.) The filler material is simply another material included in the composite particle that may serve many purposes and may be as little as 0.5% of the composition of the composite particle. (*Id.*, 9:41–42.)

For example, the filler can enhance the mechanical properties of the composite particles or may react with degradation products (such as by neutralizing an acid). (*Id.*, 9:36–63.) Some fillers are also degradable. (*Id.*, 10:1–21.) Preferably, the filler material should complement the degradable material. (*Id.*, 9:64–67.)

C. Prosecution History

The '904 patent was allowed after only a single office action rejecting some claims based on the format of the claim language. (EX1020, 27–30.) To overcome the rejection, Halliburton amended certain dependent claims to recite “consisting of” in place of comprising. (*Id.*, 15–23.) The Office subsequently issued a notice of allowance without making any prior art rejections.

VI. The Person Of Ordinary Skill In The Art

A person of ordinary skill in the art (“POSA”) at the time of the purported invention (the 2003–2004 timeframe) would typically have at least a bachelor’s degree in petroleum, mechanical, or chemical engineering and several years of experience working with proppants. (EX1002, ¶ 70.) This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa. (*Id.*)

VII. Claim Construction

This Petition shows that the challenged claims are unpatentable when given their broadest reasonable interpretation (“BRI”) in light of the specification. Rule

42.100(b). This standard is different from—and broader than—that applied in district court. *Versata Dev. Grp., Inc. v. SAP Am., Inc.*, 793 F.3d 1306, 1327–28 (Fed. Cir. 2015).²

All terms are accorded their plain and ordinary meaning except for “degradable material” and “proppant matrix” for which Petitioner provides below a claim construction supported by its expert. Support for each proposed claim construction follows.

Claim Term	Proposed Construction
“ <i>degradable material</i> ” (claims 1–20)	“Any material capable of at least partially degrading downhole by any mechanism.”
“ <i>proppant matrix</i> ” (claims 1–20)	“A consolidation of proppant particulates within a fracture in a subterranean formation.”

A. “*degradable material*”

Independent claims 1, 14, and 19 recite a variation of “allowing the *degradable material* of the composite particles to degrade so as to form at least one void in the

² Schlumberger does not concede that the meanings of any claim terms are as broad under the *Phillips* rubric as they are under the BRI. Schlumberger reserves the right to argue alternative and/or narrower definitions in other proceedings.

proppant matrix.” The patent defines “degradable” to cover partial degradation by *any* mechanism:

The term “degradation” or “degradable” refers to at least the partial decomposition of the degradable material, and includes both homogeneous and heterogeneous forms of degradation. This degradation can be a result of, for example, a chemical or thermal reaction, or a reaction induced by radiation.

(EX1001, 7:23–29.) *Sinorgchem Co., Shandong v. ITC*, 511 F.3d 1132, 1136 (Fed. Cir. 2007) (“The [claim term] is set off by quotation marks — often a strong indication that what follows is a definition.”); *3M Innovative Properties Company v. Avery Dennison Corporation*, 350 F.3d 1365, 1369, 1371 (Fed. Cir. 2003) (patentee acting as lexicographer).

Reading this, a POSA would understand that the patent defines the term degradation broadly, covering partial and complete degradation by *any* mechanism—there is no requirement that the material degrades, for example, upon exposure to water. Accordingly, a POSA would understand that the broadest reasonable interpretation of “degradable material” is “any material capable of at least partially degrading downhole,” where the degradation can be accomplished via any mechanism. (EX1002, ¶¶ 75–78.)

Notably, the patent also states that “suitable degradable materials . . . *should* be capable of undergoing an *irreversible degradation* downhole.” (EX1001, 7:18–19

(emphasis added).) Using the word *should* to modify irreversible degradation indicates that irreversibility is not a requirement of degradability *per se*, but an optional feature. And because the claims recite “degradable,” not “irreversibly degradable,” irreversibility is not a requirement of the claims under their broadest reasonable interpretation.³ The ’904 patent also defines “irreversible” using the word “should” again:

The term “irreversible,” as used herein, means that the degradable material *should* not reform a solid or reconsolidate while downhole, *e.g.*, the degradable material *should* degrade in situ but *should* not recrystallize or reconsolidate in situ.”

(*Id.*, 7:19–23 (emphasis added).) Reading this definition, a POSA would conclude that “irreversibly” degradable materials *might* recrystallize or reconsolidate under certain conditions, but they are not expected to do so under at least some conditions in at least some particular wells. (EX1002, ¶¶ 79–81.)

Accordingly, a POSA would interpret “degradable material” as “any material capable of at least partially degrading downhole by any mechanism.” (*Id.*, ¶ 82.)

³ While irreversible degradation is not a requirement of the claims, the art presented herein teaches using irreversibly degradable materials.

B. “*proppant matrix*”

All independent claims recite a “proppant matrix.” The ’904 patent defines a proppant matrix:

The term “proppant matrix,” as used herein, refers to a consolidation of proppant particulates within a fracture that may be adjacent to a well bore in a subterranean formation.

(EX1001, 3:24–27.) This definition is generally consistent with how a POSA would understand the term “proppant matrix.” It does not specify how the proppant is placed into the fracture or the type of proppant used. (EX1002, ¶ 83.)

Notably, the patent’s definition acknowledges that a proppant matrix, *i.e.*, a consolidation of proppant in a fracture, “*may* be adjacent to a well bore.” The use of the word “may” here implies that being adjacent to the wellbore is not a requirement. Rather, the consolidated proppant may be in a fracture away from the wellbore, but it will still be a proppant matrix under the patent’s express definition. (*Id.*, ¶ 84.)

It should also be understood that, while resin-coated proppant and/or tackifying agents may help the proppant stay in a fracture until it is held in place mechanically by the formation itself when pressure is released (EX1001, 3:27–33), this is not required by the independent claims. Indeed, dependent claim 2 recites using a curable resin, tackifying agent, or interlocking proppant particles, among other things, to help the proppant stay in the fracture. It was also well-known in

the art to use fiber-assisted proppant transport to help place the proppant in the fracture and form a stable pack without decreasing permeability or conductivity. (*See, e.g.*, EX1010, 1:31–45.) It was also well-known in the art to consolidate uncoated proppant particles in a fracture without the aid of any of these things. (EX1002, ¶ 85; EX1008, 1:30–36; EX1021, 1:37–45.)

Accordingly, a POSA would interpret “proppant matrix” as “a consolidation of proppant particulates within a fracture in a subterranean formation.” (EX1002, ¶ 86.)

VIII. Identification of How the Challenged Claims Are Unpatentable

Pursuant to Rule 42.104(b), this section demonstrates that the challenged claims are unpatentable. (EX1002, ¶¶ 87–271.)

A. Ground 1: Claims 1–20 are Obvious Over Watanabe and Betzold

Watanabe and Betzold render obvious every element of claims 1–20, as explained below. (*Id.*, ¶¶ 97–190.)

1. Overview

Watanabe teaches every element of the independent claims and most of the dependent claims. In the event the Board disagrees that Watanabe’s uncoated proppant forms a proppant matrix, Betzold expressly provides that teaching.

Although Watanabe teaches forming a proppant matrix by consolidating proppant in a fracture, a POSA would have been motivated to combine Watanabe’s

teachings with Betzold’s teachings of an improved coated proppant. As Betzold explains, “conductivity of proppant-filled fractures continues to be a problem” and “[a] resin-coated proppant particle generally has a greater crush resistance than the core substrate material and can be used at greater depths or may be used at the same depth with increased relative conductivity.” (EX1006, 2:4–5; 1:38–41.) Betzold’s resin-coated particles “bond” together to form “a substantially permanent, self-supporting matrix that is interspersed with removable particles...to form an especially strong matrix” for enhanced fracture conductivity—and therefore better production. (*Id.*, 2:33–63; EX1002, ¶¶ 99–103.)

Watanabe and Betzold are directed to the same subject matter: improving proppant performance by using a temporary or removable degradable particle that leaves a void when it is degrades, thus improving permeability. (EX1002, ¶ 99.) Further, both Watanabe and Betzold contemplate fracturing using water-based and oil-based fracturing fluids. (EX1008, 12:43–57 (fracturing and consolidating proppant in the fracture with various fracturing fluids); EX1006, 3:55–60 (likewise contemplating water-based and oil-based fracturing fluids).)

Watanabe describes the conventional proppant agent and the temporary or removable degradable particle as (i) a permanent propping agent (such as sand) used in combination with (ii) a temporary propping agent (which is a hydrocarbon-polymer particle). (EX1008, 3:45–50 (two types of particles); 3:67–4:19 (describing

hydrocarbon-polymer particle and its degradation).) Betzold describes these components as (i) bondable particles (such as resin-coated sand) used in combination with (ii) a removable particle (which can be any suitable dissolvable particle or degradable polymer). (EX1006, abstract; 3:16–23 (describing resin coating); claim 19.)

With regard to the first component, both Watanabe and Betzold teach that conventional proppant agents can be used. (EX1008, 15:16–22 (“Permanent propping materials which typically are used in combination with the hydrocarbon-polymer spheroid particles of this invention are strong hard solids which are chemically inert and resistant to solvent action and elevated downhole temperatures, preferred materials being solids such as ground nut shells, e.g., walnut shells, peach seeds, plastic, coarse sand, or the like.”); EX1006, 3:3–41 (describing various bondable particles disclosed in prior art or commercially available).)

A POSA would recognize that Betzold’s bondable particles could be used as Watanabe’s permanent propping agent to obtain the benefits of the resin coating, including forming a strong matrix as explained in Betzold. (EX1002, ¶¶ 102–103.) The benefits of resin coating proppants in general were well-known in the art (as detailed in Betzold, EX1006, 1:36–44 (Background); 2:33–63 (Summary of the Invention)), and thus a POSA would be motivated to use Betzold’s resin-coated bondable particles to achieve these known advantages, namely, less particle

flowback, greater crush resistance, reduced fines generation, and forming a strong matrix—all of which help improve production by increasing conductivity. (EX1006, 1:33–45; EX1002, ¶ 103.) Furthermore, because Betzold describes specific commercially-available bondable particles, a POSA would be motivated to use Betzold’s bondable particles in Watanabe’s composition for convenience. (EX1002, ¶ 103.) Indeed, this would merely be a substitution of one known type of conventional propping agents for another known type of conventional propping agents. Because the properties and characteristics of various resin-coated proppants were well-known (especially commercially-available ones), a POSA would be able to successfully implement Betzold’s resin-coated proppants when practicing Watanabe. (*Id.*, ¶ 104; *see also* EX1006, 3:17–41 (detailing resin-coated proppants known in the art); 1:53–57 (explaining when sand and ceramic proppants are chosen for various pressures).)

Thus, a POSA could and would have replaced Watanabe’s permanent propping agent with Betzold’s bondable particles, especially in view of the teachings of these references, which emphasize that these are essentially well-known, and even off-the-shelf, components with benefits known in the art, including an improved matrix, reduced fines, and greater crush resistance. (*Id.*, ¶ 105; EX1006, 1:36–44; 2:33–63.) And, Watanabe’s permanent propping agents and Betzold’s bondable particles both function to prop open the fracture. (*Id.*, ¶ 105.) In other words, a POSA would have

been able to carry out this replacement with a reasonable expectation of success and would have obtained predictable results, rendering claims 1–20 obvious. (*Id.*)

For ease of reference, the claims are divided into individual elements such as 1[a], 1[b], etc. below where appropriate.

2. Claim 1

Claim 1[a]: A method comprising:

To the extent this preamble is limiting, it is taught by Watanabe, which describes methods of using its improved propping agent to enhance the permeability of a proppant matrix by injecting the particles into the desired position. (EX1008, 13:5–18 (using the particles as temporary propping agents and mixing the particles with a carrier fluid and then using the resulting mixture in conventional fracturing operations); EX1002, ¶ 107.)

Claim 1[b]: providing a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles;

Watanabe teaches a proppant matrix composition in accordance with the '904 patent. Although Watanabe does not use the term “proppant matrix,” a POSA would understand that Watanabe forms a “proppant matrix” with its composition of proppant particles and composite particles as that term is defined in the '904 patent, and does so by consolidating proppant particles within a fracture in a subterranean formation. (EX1002, ¶ 108.)

Specifically, Watanabe's proppant corresponds to the claimed proppant particulates and Watanabe's temporary propping agents correspond to the claimed composite particles. Both are components of the '904 patent's "proppant matrix composition." (EX1008, 3:45–50 ("...improved temporary propping agent which, when used in combination with other permanent propping agents in fracturing operations, can be dissolved away leaving a maximum permeability in the propped fracture or fissure for formation oil flow"); EX1002, ¶ 109.)

Watanabe's temporary propping agents (*i.e.*, the claimed composite particles) are hydrocarbon-polymer particles including a degradable material (*i.e.*, the polymer) and a hydrocarbon component, in addition to other additives and materials, and thus are composite particles. (*See, e.g.*, EX1008, 3:67–72; EX1002, ¶ 109.) Watanabe's composite particles and proppant particulates together make up a proppant matrix composition that forms a proppant matrix (as required by claim 1[d]) when placed and consolidated in the fracture:

A still further advantage in fracturing in combination with sand or other permanent propping agents with these hydrocarbon-polymer spheroids is that, while the spheroids do not prevent the sand from being crushed when the pressure is first released on the fracture, the deformable characteristics of my hydrocarbon-polymer particles or spheroids tend to maintain the crushed pieces of sand closely packed together.

(EX1008, 14:43–50; *see also* 1:40–41, 3:45–55 (temporary propping agent will dissolve away leaving the permanent proppant in place); 3:55–61 (temporary propping agents “hold[] the sand closely together and in place, thus not losing the effectiveness of the permanent propping agent by crushing and shifting”); 12:43–57 (fracturing and consolidating proppant in the fracture with various fracturing fluids); EX1002, ¶ 110.) The pieces of sand “closely packed together” and the sand held “closely together” are descriptions of a consolidation of proppant within a fracture in a subterranean formation, consistent with the definition of “proppant matrix” discussed above and disclosed in the ’904 patent.⁴ Thus, Watanabe teaches a proppant matrix composition. (EX1002, ¶ 111.)

Even if Watanabe is not considered to teach a “proppant matrix composition,” and “proppant matrix” is interpreted to require a consolidating agent, it would have been obvious to a POSA to use the resin-coated bondable particles of Betzold in place of Watanabe’s permanent propping agent together with Watanabe’s temporary propping particles to form a strong, self-supporting matrix with improved

⁴ If “proppant matrix” is construed more narrowly to require a consolidation of proppant that “may be adjacent to the wellbore,” this is also taught by Watanabe because the proppant necessarily packs adjacent to the wellbore (and along the fracture) as the fractures are filled with proppant, creating a matrix adjacent to the wellbore. (EX1002, ¶ 111.)

conductivity. (*See, e.g.*, EX1006, 2:37–40 (“the bondable particles, when in place in a subterranean formation, adhere to one another to form a substantially permanent, *self-supporting matrix* that is interspersed with removable particles”); 4:49–53 (same); EX1002, ¶ 112.)) Thus using Betzold’s resin-coated particles would consolidate to form a proppant matrix as defined in the ’904 patent. (EX1001, 1:40–44.)

A POSA would have been motivated to use Betzold’s resin-coated particles in Watanabe’s composition, and could do so with a reasonable expectation of success, for the reasons discussed above in Section VIII.A.1. Additionally, the ’904 patent specifically describes proppant matrixes as known in the prior art, and in particular, using a resin coating to help form a proppant matrix. (EX1001, 1:40–44; *see also* EX1019, 1:34–37; EX1002, ¶¶ 113–114.)

Accordingly, Watanabe alone, or with Betzold, renders obvious this limitation. (EX1002, ¶ 115.)

Claim 1[c]: the composite particles comprising a degradable material and a filler material;

Watanabe’s temporary propping agents are composite hydrocarbon-polymer particles that include a degradable material (*i.e.*, the polymer) mixed with a filler material (*i.e.*, the hydrocarbon and other additives). (*Id.*, ¶ 116.)

Watanabe describes several types of suitable polymers, including amides (nylon), phenolic resins, and polyethylene. (EX1008, 5:7–56.) Watanabe also

explains how a POSA could choose an appropriate polymer for a particular application or condition. (*Id.*, 3:67–4:11; 12:5–15.) Watanabe’s polymers are a degradable material, as they are oil-soluble. (*E.g., id.*, 12:5–9; 14:54–60.) Further, although the claims do not require it, a POSA would have recognized that these polymeric compounds (such as ethylene/vinyl acetate copolymers) are *irreversibly* degradable as that term is defined in the ’904 patent. (EX1001, 7:19–23; EX1002, ¶ 117.)

As noted above, the filler material is simply another material included in the composite particle that can serve many purposes. It does not need to be a sizable fraction of the particle—the patent explains in some embodiments it is only 0.5% of the particle. (EX1001, 9:36–67.) The filler material, *i.e.*, the hydrocarbon component of Watanabe’s particles, is any number of the organic compounds described in Watanabe, including light aliphatic hydrocarbons, oils, waxes, greases, and polycyclic hydrocarbons. (EX1008, 4:37–5:6.) These hydrocarbon components of Watanabe’s hydrocarbon-polymer particles also degrade, as they are oil-soluble. (*E.g., id.*, 12:5–9; 14:54–60.) Although not required by the claims, this is consistent with the ’904 patent’s description of degradable filler material. (EX1001, 10:1–21; EX1002, ¶ 118.)

Watanabe also teaches that other fillers may be combined with the degradable polymer. For example, Watanabe describes the benefits of coating the particles with

finely divided coating solids, including calcium carbonate. (EX1008, 7:57–8:14.) The '904 patent describes calcium carbonate as a suitable inert filler. (EX1001, 11:39–44; EX1002, ¶ 119.)

In another example, Watanabe teaches adding other substances to impart a specific property. (EX1008, 16:8–14.) Although not required by the claims, this is consistent with the '904 patent's description of a filler that complements the degradable material. (EX1001, 9:36–67; EX1002, ¶ 120.)

Accordingly, Watanabe, alone or with Betzold, renders teaches or renders obvious “composite particles comprising a degradable material and a filler material.” (EX1002, ¶ 121.)

Claim 1[d]: introducing the proppant matrix composition into a fracture in a subterranean formation so as to form a proppant matrix in the fracture; and

According to the '904 patent, consolidating proppant in the fracture forms a proppant matrix. (EX1001, 3:21–24.) Watanabe teaches introducing the proppant matrix composition into a fracture in a subterranean formation so as to form a proppant matrix in the fracture. (EX1008, 3:45–50 (“...an improved temporary propping agent which, when used in combination with other permanent propping agents in fracturing operations, can be dissolved away leaving a maximum permeability in the propped fracture or fissure for formation oil flow”); EX1002, ¶ 122.)

Watanabe teaches introducing the proppant matrix composition into the fracture in a subterranean formation. (EX1008, 12:54–58 (“Then a carrier fluid with a propping agent slurried therein, either containing a permanent prop alone or containing both permanent and temporary props, is used to place the suspended propping agent in the fracture”); 13:28–33; EX1002, ¶ 122.)

As explained above with regard to claim 1[b], the consolidated proppant in the fracture is a proppant matrix. (EX1008, 14:43–50; *see also* 3:55–61 (temporary propping agents “hold[] the sand closely together and in place, thus not losing the effectiveness of the permanent propping agent by crushing and shifting”); EX1002, ¶¶ 123–124.) Thus, Watanabe teaches forming a proppant matrix in a fracture.

Should the Board determine that Watanabe does not teach forming a proppant matrix, it would have been obvious to use Betzold’s resin-coated bondable particles with Watanabe’s hydrocarbon-polymer particles to form a stronger matrix as discussed in Section VIII.A.1. (*See, e.g.*, EX1006, 2:37–40; 4:49–53; EX1002, ¶ 125.)

Thus, Watanabe, alone or with Betzold, renders obvious this limitation. (EX1002, ¶ 126.)

Claim 1[e]: allowing the degradable material of the composite particles to degrade so as to form at least one void in the proppant matrix.

The ’904 patent explains that “allowing the degradable material of the composite particles to degrade so as to form at least one void in the proppant matrix”

simply means allowing sufficient time to pass for the degradable material to degrade, resulting in empty spaces or voids where the degradable material once was. (*See, e.g.,* EX1001, 7:29–33 (“After the requisite time period dictated by the characteristics of the particular degradable material utilized in the composite particles of this invention, voids are created in the proppant matrix”).)

Watanabe teaches using its temporary proppant particles to introduce voids (*i.e.*, empty spaces) into the proppant matrix when the particles degrade, “leaving a maximum permeability in the propped fracture or fissure for formation oil flow.” (EX1008, 3:45–50 (emphasis added); EX1002, ¶¶ 127–128.) And, Watanabe notes it is important to use an appropriate amount of temporary propping agent so that after removal, the remaining propping agent has sufficient strength to hold the fracture open to the maximum amount possible, *i.e.*, in view of the voids created. (EX1008, 15:7–13; EX1002, ¶ 128.)

Betzold also teaches that its removable particles introduce a plurality of voids (*i.e.*, empty spaces) into the proppant matrix via degradation of the particles. (EX1006, 2:40–47 (“The removable particles...can then be removed from the matrix...As a result of this removal, the interstitial spaces in the matrix left behind increase in size, thereby achieving higher matrix porosity and hence higher conductivity in the fracture as a whole.”; EX1002, ¶ 129.)

Thus, Watanabe, alone or with Betzold, renders obvious this limitation.

(EX1002, ¶ 130.)

3. Claim 2

Claim 2: The method of claim 1 wherein at least one of the proppant particulates comprises a component selected from the group consisting of: curable resins; tackifying agents; interlocking proppant particulates; epoxy resins; furan resins; phenolic resins; furfuryl aldehyde resins; furfuryl alcohol resins; non-aqueous tackifying agents; aqueous tackifying agents; silyl modified polyamides; natural sand; ground nut hulls; man-made proppant particulates; bauxite; ceramics; polymeric particulates; low density particulates; and combinations thereof.

Watanabe teaches “[p]ermanent propping materials which typically are used in combination with the hydrocarbon-polymer spheroid particles of this invention are ... ground nut shells, *e.g.*, walnut shells, peach seeds, plastic, coarse sand, or the like.” (EX1008, 15:16–22.) Betzold also teaches that proppant particles are “commonly made of sand, glass, bauxite, ceramic, and shells.” (EX1006, 1:33–35; EX1002, ¶ 131.)

Betzold teaches bondable proppants comprising a curable resin. (*Id.*, 3:17–29; *see also* 1:33–41.) Betzold notes specific commercial substrates as examples of resin-coated bondable particles, including well-known, commercially-available products where the curable resin is a phenolic resin. (EX1002, ¶ 132.)

Thus, Watanabe, alone or with Betzold, renders obvious numerous options recited in claim 2, including at least curable resins, phenolic resin, natural sand, ground nut hulls, bauxite, and ceramic. (*Id.*, ¶ 133.)

4. Claim 3

Claim 3: The method of claim 1 wherein at least one of the composite particles has a physical shape of a platelet, shaving, fiber, flake, ribbon, rod, strip, spheroid, toroid, pellet, or tablet.

Watanabe teaches this claim element (which requires just one of the options), teaching generally spheroid temporary proppant particles and that “other shaped particles are operable for any temporary propping service.” (EX1008, 14:63–69.) Thus, Watanabe, alone or with Betzold, renders obvious claim 3. (EX1002, ¶¶ 134–135.)

5. Claim 4

Claim 4: The method of claim 1 wherein at least one of the proppant particulates have sizes in the range of from about 4 to 100 U.S. mesh.

Watanabe teaches that permanent propping agents normally range in size from 4 to about 100 mesh, and commonly-used proppant sizes range from 8–12 mesh or from 12–20 mesh. (EX1008, 15:33–35). And, Betzold teaches that proppant particles range from about 6 to 200 mesh. (EX1006, 1:33–35). Watanabe and Betzold’s ranges disclose and also overlap substantially with the range recited in claim 4, rendering it obvious. *See, e.g., In re Geisler*, 116 F.3d 1465, 1469–71 (Fed. Cir. 1997). Thus, Watanabe, alone or with Betzold, renders obvious claim 4. (EX1002, ¶¶ 136–137.)

6. Claim 5

Claim 5: The method of claim 1 wherein the proppant matrix composition comprises a component selected from the group consisting of: acid reactive materials; inert fillers; and combinations thereof.

As noted above, Watanabe specifically teaches composite particles including inert fillers. For example, Watanabe describes coating the particles with finely divided coating solids, including calcium carbonate. (EX1008, 7:57–8:14.) The '904 patent describes calcium carbonate as a suitable inert filler. (EX1001, 11:39–44.) Thus, Watanabe, alone or with Betzold, renders claim 5, which includes “inert fillers” as an option. (EX1002, ¶¶ 138–139.)

7. Claim 6

Claim 6: The method of claim 1 wherein the composite particles are present in an amount of from about 0.1% to about 30% based on the weight of the proppant particulates in the proppant matrix composition.

Watanabe teaches that the temporary propping agent particles comprise “not more than half of the total number of propping agent particles.” (EX1008, 15:14–16.) This does not give a precise recommended amount by weight, but would be routinely optimized by a POSA, and could overlap the “0.1% to about 30% by weight” of claim 6. (EX1002, ¶ 140.)

Furthermore, Betzold suggests that the removable particles be used in a range of from about 10% to about 30% by volume, rather than by weight. (EX1006, 5:10–17.) Based on the types of particles described in Betzold, 10% to about 30% by volume overlaps with the “0.1% to about 30% by weight” of claim 6. (EX1002, ¶

141.) Dr. Sharma used the density of sand (disclosed as a proppant in Betzold, EX1006, 1:33) and the density of polyester (Betzold discloses polyester polymers, *id.*, 3:51), and found that Betzold’s volume range for these components discloses a range of 5.7% to 21.8% by weight. (EX1002, ¶¶ 142–146 (providing detailed analysis and calculations).) This overlaps substantially with the range recited in claim 6, rendering it obvious. *See, e.g., In re Geisler*, 116 F.3d at 1469–71.

Even if the values in Watanabe and Betzold do not overlap with the recitation of claim 6, a POSA would have been motivated to choose an amount within this range. Notably, the ’904 patent simply explains that a POSA should choose relative amounts that avoid creating “an undesirable percentage of voids” rendering the proppant matrix ineffective to maintain the integrity of the fracture. (EX1001, 11:55–12:3.) A POSA reading Watanabe and Betzold would likewise be able to choose appropriate relative amounts. Both discuss precisely the same concern; namely, using an appropriate amount of degradable material so that the propping agent retains sufficient strength. (EX1008, 15:7–13; EX1006, 5:18–42.) Thus, a POSA would have been motivated to select an amount of composite particles from about 0.1% to about 30% based on the weight of the proppant particulates to maximize the number of voids and thus maximize conductivity, while retaining sufficient strength in the matrix. (EX1002, ¶ 147.) Moreover, the composite particles have the same function—degrading to create voids in the matrix—regardless of precise

concentration, and a POSA would be able to optimize the concentration for a particular application using known techniques while successfully achieving voids in the matrix. (*Id.*, ¶ 148.)

Thus, Watanabe, alone or with Betzold, renders obvious claim 6. (*Id.*, ¶ 149.)

8. Claim 7

Claim 7: The method of claim 1 wherein at least one of the composite particles comprises a material selected from the group consisting of: degradable polymers; aliphatic polyester homopolymers; random aliphatic polyester copolymers; block aliphatic polyester copolymers; star aliphatic polyester copolymers; hyperbranched aliphatic polyester copolymers; and combinations thereof.

Watanabe describes several types of suitable degradable polymers for use in its composite particles, including amides (nylon), phenolic resins, and polyethylene.

(EX1008, 5:7–56; *see also* 12:5–12; 14:54–60.) Thus, Watanabe, alone or with

Betzold, renders obvious claim 7, which includes degradable polymers as one option.

(EX1002, ¶¶ 150–151.)

9. Claim 8

Claim 8: The method of claim 1 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters; poly(lactides); poly(glycolides); poly(ε-caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

Watanabe teaches numerous types of degradable materials suitable for use in its composite particles, including polyester amides (EX1008, 5:7–12, referring to nylon, which a POSA would recognize to be a polyamide) and polyacrylates (*id.*, 5:18–26, copolymers of ethylene and ethylacrylate or methylacrylate). Thus, Watanabe, alone or with Betzold, renders obvious claim 8, which recites poly(acrylates) and polyamides as options. (EX1002, ¶¶ 152–153.)

10. Claim 9

Claim 9: The method of claim 1 wherein the filler of at least one of the composite particle comprises a material selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica; magnesium oxide; mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

As noted above, Watanabe describes coating the composite particles with finely divided coating solids, including calcium carbonate, which would be a filler. (EX1008, 7:57–8:14.) Thus, Watanabe, alone or with Betzold, renders obvious claim 9, which recites calcium carbonate as one option. (EX1002, ¶¶ 154–155.)

11. Claim 10

Claim 10: The method of claim 1 wherein at least one of the composite particles comprises a component selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica, magnesium oxide, mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

This claim is obvious for the same reasons as claim 9 above.

12. Claim 11

Claim 11: The method of claim 1 wherein the proppant matrix composition is blended and then transported to a drill site.

Watanabe teaches that the composite particles (*i.e.*, temporary propping agents) are mixed with permanent propping agents (*see e.g.*, EX1008, 3:45–50), and then used at a drill site (*see id.*, referring to “fracturing operations”). Similarly, Watanabe’s Example XIX describes a slug of oil containing blended proppant and composite particles injected into a fracture. (*Id.*, 26:69–75.) But, Watanabe does not explicitly teach that the proppant matrix is blended and then transported to the drill site. (EX1002, ¶ 157.)

Regardless, as would be known to a POSA, a conventional way of using a proppant matrix composition would be to blend the components and transport the blended composition to the drill site. (*Id.*, ¶ 158.) Indeed, Watanabe specifically teaches that transport characteristics would be considered by a POSA. (EX1008, 18:73–19:13 (noting that coated particles may be more suitable for transport); *see also* Example VIII (describing storage and transport).) Accordingly, a POSA would choose to blend the proppant matrix composition ahead of time—selecting particles with appropriate transport characteristics based on Watanabe—and then transport the proppant matrix composition to the drill site for use and would be motivated to do so for efficiency reasons because the composition would be ready to use on-site. (EX1002, ¶ 158.) Moreover, the ’904 patent does not associate anything special with

this process, and simply describes it as one way of blending and using the proppant matrix composition. (EX1001, 11:45–54.)

Thus, Watanabe, alone or with Betzold, renders obvious claim 11. (EX1002, ¶ 159.)

13. Claim 12

Claim 12: The method of claim 1 wherein the proppant matrix composition is prepared and used on-the-fly at the drill site.

As noted above, Watanabe teaches that the composite particles (*i.e.*, temporary propping agents) are mixed with permanent propping agents (*see e.g.*, EX1008, 3:45–50), and then used at a drill site (*see id.*, referring to “fracturing operations”).

Similarly, Example XIX describes a slug of oil containing blended proppant and composite particles injected into a fracture. (*Id.*, 26:69–75.) But, Watanabe does not explicitly teach that the proppant matrix composition is prepared and used on-the-fly at the drill site. (EX1002, ¶ 160.)

As would be known to a POSA, a conventional way of using the proppant matrix composition would be to blend the components at the drill site and use them on-the-fly. (*Id.*, ¶ 161.) A POSA may be motivated to choose this approach for convenience based on the composition of the composite particles (if the particles would not be suitable for storage together with the proppant, for example), or if the components were transported from different locations. (*Id.*) Moreover, the ’904 patent does not associate anything special with this process, and simply describes it as

one way of blending and using the proppant matrix composition. (EX1001, 11:45–54.)

Thus, Watanabe, alone or with Betzold, renders obvious claim 12. (EX1002, ¶ 162.)

14. Claim 13

Claim 13: The method of claim 1 wherein the proppant matrix composition is a component of a fracturing treatment fluid.

Watanabe teaches that the proppant matrix composition is a component of a fracturing treatment fluid. (EX1008, 12:54–58 (“Then a carrier fluid with a propping agent slurried therein, either containing a permanent prop alone or containing both permanent and temporary props, is used to place the suspended propping agent in the fracture”); *see also* 13:28–33; *see also* 13:12–17 (“The hydrocarbon-polymer particles of this invention are conveniently mixed with a carrier fluid in the same manner as other propping agents, and the resulting mixture is then employed in conventional fracturing operations...”)). Similarly, Example XIX describes a slug of oil containing blended proppant and composite particles injected into a fracture as a fracturing treatment fluid. (*Id.*, 26:69–75; EX1002, ¶ 163.)

Thus, Watanabe, alone or with Betzold, renders obvious claim 13. (*Id.*, ¶ 164.)

15. Claim 14

Claim 14[a]: A method comprising:

See discussion of claim 1[a] above.

Claim 14[b]: providing a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles,

See discussion of claim 1[b] above.

Claim 14[c]: the composite particles comprising a degradable material and a filler material;

See discussion of claim 1[c] above.

Claim 14[d]: allowing the proppant matrix composition to form a proppant matrix;

According to the '904 patent, consolidating the proppant in the fracture forms a proppant matrix. (EX1001, 3:21–24.) Watanabe teaches this. (EX1008, 14:43–50; *see also* 1:40–41, 3:45–55 (temporary propping agent will dissolve away leaving the permanent proppant in place); 3:55–61 (temporary propping agents “hold[] the sand closely together and in place, thus not losing the effectiveness of the permanent propping agent by crushing and shifting”); 12:43–57.) As explained above, the pieces of sand “closely packed together” and the sand held “closely together” are descriptions of a consolidation of proppant within a fracture in a subterranean formation, consistent with the definition of “proppant matrix” in the '904 patent. Thus, Watanabe teaches allowing the proppant matrix composition to form a proppant matrix. (EX1002, ¶¶ 168–169.)

And, also as explained above, even if Watanabe is not considered to teach allowing the proppant matrix composition to form a proppant matrix, it would have been obvious to a POSA to use the resin-coated bondable particles of Betzold in place

of Watanabe's permanent propping agent (*see, e.g.*, EX1006, 3:16–23) together with Watanabe's temporary propping particles to form a strong, self-supporting matrix with improved conductivity. A POSA would have been motivated to use Betzold's resin-coated particles together with Watanabe's temporary propping agents, and could do so with a reasonable expectation of success, for the reasons discussed above in Section VIII.A.1. (EX1002, ¶ 170.)

Thus, Watanabe, alone or with Betzold, renders obvious this limitation. (*Id.*, ¶ 171) *See also* discussion of claim 1[d] above.

Claim 14[e]: allowing the degradable material of the composite particle to degrade so as to form a void in the proppant matrix; and

See discussion of claim 1[e] above.

Claim 14[f]: allowing a fluid to flow through the proppant matrix.

According to the '904 patent, allowing a fluid to flow through the proppant matrix refers to the enhanced conductivity related to creating voids in the matrix. (*See, e.g.*, EX1001, 3:3–13.) Watanabe describes using a temporary propping agent that degrades away, leaving voids that allow fluid to flow more freely through the proppant matrix. (EX1008, 3:45–50 (“... an improved temporary propping agent which, when used in combination with other permanent propping agents in fracturing operations, can be dissolved away leaving a maximum permeability in the propped fracture or fissure for formation oil flow”); 14:53–60 (“The temporary propping elements, i.e., the hydrocarbon-polymer particles, can be removed readily from

around the permanent propping agent particles by the flow of produced well crude...”); EX1002, ¶ 173.)

Betzold also uses removable particles to increase the size of the interstitial spaces left in the matrix, creating higher conductivity, thus allowing fluid to flow. (EX1006, 4:58–65.) Betzold also notes the importance of balancing the concentrations of bondable particles and removable particles to maintain sufficient strength of the matrix, *i.e.*, to create a desirable number of voids in the proppant matrix while maintaining sufficient strength, and that a POSA can modify the number of voids appropriately, depending on the particular formation and relevant factors. (*Id.*, 5:18–42.) A POSA would have been motivated to use Betzold’s resin-coated particles in Watanabe’s composition, and could do so with a reasonable expectation of success, for the reasons discussed above. (EX1002, ¶ 174.)

Thus, Watanabe, alone or with Betzold, renders obvious “allowing a fluid to flow through the proppant matrix.” (*Id.*, ¶ 175.)

16. Claim 15

Claim 15: The method of claim 14 wherein at least one of the proppant particulates comprises a curable resin anchor [sic] a tackifying agent.

As is apparent from the file history, this claim includes a typo and “anchor” should be “and/or.” (EX1020 at 18.) Betzold teaches bondable proppants comprising a curable resin. (EX1006, 3:17–29; *see also* 1:33–41.) A POSA would have been motivated to use Betzold’s resin-coated particles in Watanabe’s composition, and

could do so with a reasonable expectation of success, for the reasons discussed above. (EX1002, ¶ 176.) Accordingly, Watanabe and Betzold render obvious claim 15. (*Id.*, ¶ 177.)

17. Claim 16

Claim 16: The method of claim 14 wherein the degradable material in at least one of the composite particles does not substantially degrade until after the proppant matrix has substantially formed.

Although Watanabe does not explicitly explain that the degradable material does not substantially degrade until after the proppant matrix has substantially formed, this would be understood by a POSA. Specifically, Watanabe teaches leaving voids in the proppant matrix when the temporary propping agent degrades, *i.e.*, the matrix formed before the agent degraded. (EX1008, 3:45–50; 15:7–13; EX1002, ¶ 178.)

Moreover, Betzold explicitly explains that the removable particles can be removed from the matrix “after formation of the matrix.” (EX1006, 2:35–47.) A POSA would have been motivated to use Betzold’s resin-coated particles in Watanabe’s composition, and could do so with a reasonable expectation of success, for the reasons discussed above. (EX1002, ¶ 179.)

Thus, Watanabe, alone or with Betzold, renders obvious claim 16. (*Id.*, ¶ 180.)

18. Claim 17

Claim 17: The method of claim 14 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters;

poly(lactides); poly(glycolides); poly(ϵ -caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

See discussion of claim 8 above.

19. Claim 18

Claim 18: The method of claim 14 wherein the filler of at least one of the composite particle comprises a component selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica, magnesium oxide, mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

See discussion of claim 9 above.

20. Claim 19

Claim 19[a]: A method comprising:

See discussion of claim 1[a] above.

Claim 19[b]: providing a treatment fluid that comprises a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles,

See discussion of claim 1[b] above. Although claim 1[b] does not specifically address providing the proppant matrix composition in a treatment fluid, Watanabe teaches that the proppant matrix composition is a component of a fracturing treatment fluid. (EX1008, 12:54–58 (“Then a carrier fluid with a propping agent slurried therein, either containing a permanent prop alone or containing both permanent and

temporary props, is used to place the suspended propping agent in the fracture”); *see also* 13:28–33; *see also* 13:12–17.) Similarly, Example XIX describes a slug of oil containing blended proppant and composite particles injected into a fracture as a fracturing treatment fluid. (*Id.*, 26:69–75.) Thus, Watanabe and Betzold render obvious claim 19[b]. (EX1002, ¶¶ 184–185.)

Claim 19[c]: the composite particles comprising a degradable material and a filler material;

See discussion of claim 1[c] above.

Claim 19[d]: contacting at least a portion of a subterranean formation with the treatment fluid under conditions effective to create or enhance at least one fracture in the subterranean formation; and

Watanabe describes using the treatment fluid comprising the composite particle and proppant in fracturing operations, *i.e.*, under conditions effective to create or enhance at least one fracture in the subterranean formation. (EX1008, 3:45–50 (“... an improved temporary propping agent which, when used in combination with other permanent propping agents in fracturing operations, can be dissolved away leaving a maximum permeability in the propped fracture or fissure for formation oil flow”); 12:54–58 (“Then a carrier fluid with a propping agent slurried therein, either containing a permanent prop alone or containing both permanent and temporary props, is used to place the suspended propping agent in the fracture”); *see also* 13:28–33; *see also* 13:12–17.) Similarly, Example XIX describes a slug of oil containing blended proppant and composite particles injected into a fracture as a fracturing

treatment fluid. (*Id.*, 26:69–75.) Accordingly, Watanabe and Betzold render obvious this limitation. (EX1002, ¶¶ 187–188.)

Claim 19[e]: allowing the proppant matrix composition to form a proppant matrix having at least one void therein.

See discussion of claim 14[d] (with regard to allowing the proppant matrix composition to form a proppant matrix) and claim 1[e] (with regard to forming at least one void in the proppant matrix) above.

21. Claim 20

Claim 20: The method of claim 19 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters; poly(lactides); poly(glycolides); poly(ϵ -caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

See discussion of claim 8 above.

B. Ground 2: Claims 1–20 Would Have Been Obvious Over Palmer

Palmer teaches every element of claim 1–20, or the element would have been an obvious modification of Palmer’s teachings, as explained below. (*Id.*, ¶¶ 191–271.)

Palmer is directed to a multi-purpose degradable particulate used in fracturing fluids. The particulate includes a degradable polymer that acts as a breaker material and can also improve proppant transport. (EX1010, 2:48–55.) Palmer teaches that

“composite particles” including various natural and synthetic materials may be employed as its degradable particulates. (*Id.*, 4:49–59.)

Palmer teaches fracturing’s goal is to provide “flow channels to facilitate production of the hydrocarbons to the wellbore.” (*Id.*, 1:15–19.) And, as explained in Palmer, improved recovery is an ongoing goal when proppant matrixes are used. (*Id.*, 1:31–45.) Breaking a gel helps allow hydrocarbon flow through the fracture and proppant matrix. (*Id.*, 2:3–10.) Palmer teaches using a degradable particulate material as an improved breaker, where the particulate degrades, leaving behind a void, and also breaks the gel, leaving the matrix behind. (*Id.*, 10:26–36.) Accordingly, the particulate’s removal creates a desirable number of voids in the proppant matrix.

In a few instances, Palmer’s disclosure may not use the same terminology as the claim limitation, but Dr. Sharma explains (when necessary) why the limitation would have been understood by a POSA to be disclosed by Palmer and thus obvious thereover.

The ground based on Palmer is not cumulative or redundant with the ground based on Watanabe, alone or in view of Betzold, because they use different mechanisms. Specifically, Watanabe’s degradable temporary propping agents are soluble in the carrier fluid, and are used with a conventional propping agent and used specifically for creating voids in the matrix. Betzold’s bondable proppant is used to

provide a superior matrix. In contrast, Palmer's a multi-purpose solid particulate breaker material with delayed breaking or degradation characteristics is used as a breaker material and for proppant transport, and also results in improved conductivity through the matrix. Thus, the references take different approaches for achieving the same ends. As a result, the grounds presented in this petition are not redundant.

For ease of reference, the claims are divided into individual elements such as 1[a], 1[b], etc. below where appropriate.

1. Claim 1

Claim 1[a]: A method comprising:

To the extent this preamble is limiting, Palmer teaches methods of using its degradable particulates to enhance the permeability of a proppant matrix. (EX1010, 10:8–36; EX1002, ¶ 196.)

Claim 1[b]: providing a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles;

Palmer teaches the claimed proppant matrix composition. Specifically, Palmer teaches enhancing the permeability of a proppant matrix using a solid degradable particulate in combination with a proppant, explaining that decomposition of the solid degradable particulate matter removes it from the deposit, so that “a matrix or pack of

such and proppant...is left in the fracture.” (EX1010, 10:26–36.) Palmer also teaches forming matrixes with fibers. (*Id.*, 1:31–45; *see also* claims 4 and 11.)⁵

Palmer also explains that the composition can include at least a plurality of proppant particulates and at least a plurality of solid particulates. (*Id.*, 2:56–66 (solid particulates provided in a fracturing fluid with proppant and gellant); 6:19–23; 9:61–65; 9:39–59 (various proppants).)

Palmer’s solid degradable particulates can be composite particles selected for their delayed reactivity and/or degradation characteristics, and may include mixtures of various well-known polymers including polyamides, polyesters, etc. (*Id.*, 3:66–4:49.) Palmer explicitly teaches that “composite particles” including various natural and synthetic materials may be employed. (*Id.*, 4:49–59.)

Thus, Palmer renders obvious this limitation. (EX1002, ¶¶ 197–200.)

Claim 1[c]: the composite particles comprising a degradable material and a filler material;

Palmer’s particulates are selected for their delayed reactivity and/or degradation characteristics, and may include mixtures of various well-known degradable polymers including polyamides, polyesters, etc. (EX1010, 3:66–4:49.)

⁵ And, the ’904 patent admits that proppant matrixes were well-known. (EX1001, 1:37–46.) The ’220 patent also admits that proppant matrixes are prior art. (EX1019, 1:14, 1:31–39.)

Regardless of the composition, Palmer's particulates degrade or decompose in a downhole environment, effectively removing the particulate matter while the degradation products effectively break the gel. (*Id.*, 3:8–28; EX1002, ¶ 201.)

As noted above, the filler material is simply another material included in the composite particle that can serve many purposes, and does not need to be a sizable fraction of the composite particle. (EX1001, 9:36–67 (describing an embodiment with 0.5% filler).) Palmer teaches that the particulate can be a composite of two degradable materials, with a core and a sheath having different degradation times. (*Id.*, 4:49–54.) In that instance, one component would be considered the degradable material and the other component would be considered the filler material. (EX1002, ¶ 202.) This is consistent with the '904 patent's description that the filler material can be degradable. (EX1001, 10:1–21.)

Further, although the claims do not require it, a POSA would have recognized that many of these polymeric compounds (such as polyamides, polyesters and copolymers of these) are *irreversibly* degradable as that term is defined in the '904 patent. (EX1001, 7:19–23; EX1002, ¶ 202.)

Palmer's particulates can also include other types of filler materials such as commercially available additives, fillers, or coatings, as long as these additional components do not interfere with the required activity. (EX1010, 4:51–59; EX1002, ¶ 203.)

Accordingly, Palmer renders obvious this limitation. (EX1002, ¶ 204.)

Claim 1[d]: introducing the proppant matrix composition into a fracture in a subterranean formation so as to form a proppant matrix in the fracture; and

According to the '904 patent, the proppant matrix forms by consolidation of the proppant matrix composition within the fracture. (EX1001, 3:21–24.) Palmer teaches introducing the proppant matrix composition into a fracture in a subterranean formation so as to form a proppant matrix in the fracture. Palmer explains that the solid particulate is provided in a fracturing fluid with a gellant and proppant, forming a fracturing fluid suspension, and this suspension is pumped downwell and deposited as a gelled suspension in the subterranean formation under fracturing conditions. (EX1010, 2:56–66; EX1002, ¶ 205.)

Once downwell, this composition forms a proppant matrix. Palmer, 10:26–36 (explaining that “a matrix or pack of such and proppant...is left in the fracture”); *see also* 1:33–42 (describing forming proppant matrixes in general and benefits thereof).

Palmer's teachings are consistent with the definition of "proppant matrix" discussed above and disclosed in the '904 patent.⁶ (EX1002, ¶ 206.)

Thus, Palmer renders obvious this limitation. (EX1002, ¶ 207.)

Claim 1[e]: allowing the degradable material of the composite particles to degrade so as to form at least one void in the proppant matrix.

As explained in the '904 patent, "allowing the degradable material of the composite particles to degrade so as to form at least one void in the proppant matrix" simply means allowing sufficient time to pass for the degradable material to degrade, resulting in empty spaces or voids where the degradable material once was. (*See, e.g.,* EX1001, 7:29–33 ("After the requisite time period dictated by the characteristics of the particular degradable material utilized in the composite particles of this invention, voids are created in the proppant matrix").)

Palmer explains that the purpose of degrading the solid particulates is to help break the gel in the fracture in order to accomplish flow through the fracture and proppant pack, *i.e.*, matrix. (EX1010, 2:3–10.) Although Palmer may not state in so

⁶ If "proppant matrix" is construed more narrowly to require a consolidation of proppant that "may be adjacent to the wellbore," this is also taught by Palmer because the proppant packs adjacent to the wellbore (and along the fracture) as the fractures are filled with proppant, creating a matrix adjacent to the wellbore. (EX1002, ¶ 206.)

many words that its particulates degrade away to “form at least one void in the proppant matrix,” a POSA would understand that is what Palmer is describing when Palmer states that “the decomposition or reaction of the solid particulate matter in effect ‘remov[es]’ organic polymeric particulate matter from the deposit” leaving behind in the fracture a “matrix” of proppant and durable fibers/platelets. (EX1010, 10:26–36; EX1002, ¶¶ 208–209.)

Accordingly, Palmer renders obvious this limitation. (EX1002, ¶ 210.)

2. Claim 2

Claim 2: The method of claim 1 wherein at least one of the proppant particulates comprises a component selected from the group consisting of: curable resins; tackifying agents; interlocking proppant particulates; epoxy resins; furan resins; phenolic resins; furfuryl aldehyde resins; furfuryl alcohol resins; non-aqueous tackifying agents; aqueous tackifying agents; silyl modified polyamides; natural sand; ground nut hulls; man-made proppant particulates; bauxite; ceramics; polymeric particulates; low density particulates; and combinations thereof.

Palmer teaches that “the precise nature of the proppant employed is not critical,” and describes numerous conventional proppants including resin-coated sand or ceramic proppant and bauxite. (EX1010, 9:39–60.) Accordingly, although the claim requires only one, Palmer teaches many of the options recited in claim 2, including curable resins, natural sand, bauxite, and ceramic. (EX1002, ¶¶ 211–212.)

3. Claim 3

Claim 3: The method of claim 1 wherein at least one of the composite particles has a physical shape of a platelet, shaving, fiber, flake, ribbon, rod, strip, spheroid, toroid, pellet, or tablet.

Palmer teaches that “all possible shapes” of particulates can be used, including fibers and platelets. (EX1010, 3:1–2.) And, Palmer describes straight fibers having a round cross-section as a suitable example. (*Id.*, 5:40–41.) A POSA would recognize these fibers as particles having a rod-like shape. Accordingly, Palmer renders obvious claim 3. (EX1002, ¶¶ 213–214.)

4. Claim 4

Claim 4: The method of claim 1 wherein at least one of the proppant particulates have sizes in the range of from about 4 to 100 U.S. mesh.

Palmer teaches that normally the proppant will have an average article size less than about 8 mesh and greater than 60 or 80 mesh, or sized mixtures may be used. Palmer, 9:52–58. This overlaps substantially with the range recited in claim 4 rendering it obvious. *See, e.g., In re Geisler*, 116 F.3d at 1469–71. Accordingly, Palmer renders obvious claim 4. (EX1002, ¶¶ 215–216.)

5. Claim 5

Claim 5: The method of claim 1 wherein the proppant matrix composition comprises a component selected from the group consisting of: acid reactive materials; inert fillers; and combinations thereof.

As noted above, Palmer’s particulates can include filler materials such as commercially available additives, fillers, or coatings, as long as these additional components do not interfere with the required activity. (EX1010, 4:51–59.) As a POSA would recognize, if a component does not interfere with the required activity,

it would be considered an inert filler. Accordingly, Palmer renders obvious claim 5, which includes “inert fillers” as one option. (EX1002, ¶¶ 217–218.)

6. Claim 6

Claim 6: The method of claim 1 wherein the composite particles are present in an amount of from about 0.1% to about 30% based on the weight of the proppant particulates in the proppant matrix composition.

Palmer teaches that the amount of particulate used is from 0.02% up to 10% of the fluid by weight. (EX1010, 5:1–6.) And, the proppant is suggested to be added in a concentration of from 0.5 or 1 lb/gallon to about 25 lb/gallon. (*Id.*, 9:49–52.) This does not give a precise recommended amount by weight, overlaps the “0.1% to about 30% by weight” of claim 6. (EX1002, ¶ 219.) Dr. Sharma used water as the fracturing fluid in an illustrative example, and found that Palmer’s volume range for these components results in 0.0067% to 167% or 0.00668% to 186% by weight (depending on how Palmer’s “fluid by weight” is construed). (EX1002, ¶¶ 220–228 (providing detailed analysis and calculations).) These ranges overlap almost completely with the range recited in claim 6, rendering it obvious. *See, e.g., In re Geisler*, 116 F.3d at 1469–71.

Even if the values in Palmer do not overlap with the recitation of claim 6, a POSA would have been motivated to choose an amount within this range. As noted above, the ’904 patent simply explains that the relative amounts should be chosen to avoid creating “an undesirable percentage of voids” rendering the proppant matrix

ineffective to maintain the integrity of the fracture. (EX1001, 11:55–12:3.) A POSA would have had the same concern, and would have been motivated to select an amount of composite particles from about 0.1% to about 30% based on the weight of the proppant particulates in the proppant matrix composition in order to maximize the number of voids while retaining sufficient strength in the matrix. (EX1002, ¶ 229.) Moreover, the composite particulates have the same function—degrading to create voids in the matrix—regardless of precise concentration, and a POSA would be able to optimize the concentration for a particular application using known techniques while successfully achieving voids in the matrix. (*Id.*, ¶ 230.)

Accordingly, Palmer renders obvious claim 6. (*Id.*, ¶ 231.)

7. Claim 7

Claim 7: The method of claim 1 wherein at least one of the composite particles comprises a material selected from the group consisting of: degradable polymers; aliphatic polyester homopolymers; random aliphatic polyester copolymers; block aliphatic polyester copolymers; star aliphatic polyester copolymers; hyperbranched aliphatic polyester copolymers; and combinations thereof.

Palmer describes several types of suitable degradable polymers for use in its composite particles. (*E.g.*, EX1010, 3:66–4:59 (describing particulates and their degradation).) Thus, Palmer teaches a composite particle comprising a degradable polymer. Accordingly, Palmer renders obvious claim 7, which recites degradable polymers as one option. (EX1002, ¶¶ 232–233.)

8. Claim 8

Claim 8: The method of claim 1 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters; poly(lactides); poly(glycolides); poly(ϵ -caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

Palmer teaches examples of degradable polymers including cellulose, *i.e.*, a polysaccharide (EX1010, 4:37) and polyesters (*id.*, 4:39) in its particulates. As is known to a POSA, many polyester polymers are aliphatic polyesters. Accordingly, Palmer renders obvious claim 8, which recites both polysaccharides and aliphatic polyesters as options. (EX1002, ¶¶ 234–235.)

9. Claim 9

Claim 9: The method of claim 1 wherein the filler of at least one of the composite particle comprises a material selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica; magnesium oxide; mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

Palmer's solid particulates function as breakers. (EX1010, 3:66–4:2 (describing gel-breaking action of the particulates).) And, it would have been obvious to a POSA to include a filler consisting of an anhydrous salt cross-linker based on Palmer. (EX1002, ¶¶ 236–237.) Palmer teaches using cross-linking agents including several types of anhydrous salts. (EX1010, 9:9–22.) Given that Palmer

specifically teaches the benefits of a breaker compound (*i.e.*, Palmer's particulate) having more than one function (*id.*, 2:24–32), it would have been obvious for a POSA to add an anhydrous salt to the degradable polymer particulate so that it would function as both a cross-linker and a breaker. (EX1002, ¶ 237.) This is particularly true in view of the fact that Palmer teaches that composite materials are desirable, and can include a particle with a core and sheath structure where the core and sheath degrade over different periods of times. (EX1010, 4:49–54.) Accordingly, a POSA would understand that the sheath could include an anhydrous salt, degrading downhole whereby the degradation products create a cross-linked gel at the appropriate location to transport proppant while still allowing sufficient fluidity for pumping (EX1010, 1:59–2:10 (describing delayed crosslinking and subsequent gel breaking); 7:59–8:5), and then the core could degrade later, breaking the gel created by the anhydrous salt at an appropriate time. (EX1002, ¶ 237.) Thus, a POSA would have been motivated to use Palmer's anhydrous salts as a filler material. (*Id.*)

Given the detailed disclosure of Palmer and the established practice of using anhydrous salt cross-linkers, gelled fluids, and breakers, a POSA would have been able to use one of Palmer's composites containing both an anhydrous salt and a breaker with a reasonable expectation of success. Accordingly, Palmer renders obvious claim 9, which recites breakers and anhydrous salts as options. (*Id.*, ¶ 238–239.)

10. Claim 10

Claim 10: The method of claim 1 wherein at least one of the composite particles comprises a component selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica, magnesium oxide, mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

This claim appears to overlap substantially with claim 9. Accordingly, *see* discussion of claim 9 above.

11. Claim 11

Claim 11: The method of claim 1 wherein the proppant matrix composition is blended and then transported to a drill site.

As would be known to a POSA, a conventional way of using the proppant matrix composition would be to blend the components and transport the blended composition to the drill site. (EX1002, ¶ 241.) Indeed, Palmer specifically teaches that the suspensions may be blended offsite (and thus later transported to the drill site). (EX1010, 7:1–2.) Moreover, the '904 patent does not does not associate anything special with this process, and simply describes it as one way of blending and using the proppant matrix composition. (EX1001, 11:45–54.) Accordingly, Palmer renders obvious claim 11. (EX1002, ¶¶ 242–243.)

12. Claim 12

Claim 12: The method of claim 1 wherein the proppant matrix composition is prepared and used on-the-fly at the drill site.

As would be known to a POSA, a conventional way of using the proppant matrix composition would be to blend the components on-the-fly at the drill site. (EX1002, ¶ 244.) Indeed, Palmer specifically teaches that the suspensions may be blended on the fly. (EX1010, 6:65–7:1.) Moreover, the '904 patent does not associate anything special with this process, and simply describes it as one way of blending and using the proppant matrix composition. (EX1001, 11:45–54.) Accordingly, Palmer renders obvious claim 12. (EX1002, ¶¶ 245–246.)

13. Claim 13

Claim 13: The method of claim 1 wherein the proppant matrix composition is a component of a fracturing treatment fluid.

Palmer teaches that the proppant matrix composition, *i.e.*, the solid particulate and the proppant, can be included in a fracturing fluid. (EX1010, 2:56–66 (“...provided in a fracturing fluid”).) Accordingly, Palmer renders obvious claim 13. (EX1002, ¶¶ 247–248.)

14. Claim 14

Claim 14[a]: A method comprising:

See discussion of claim 1[a] above.

Claim 14[b]: providing a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles,

See discussion of claim 1[b] above.

Claim 14[c]: the composite particles comprising a degradable material and a filler material;

See discussion of claim 1[c] above.

Claim 14[d]: allowing the proppant matrix composition to form a proppant matrix;

According to the '904 patent, the proppant matrix forms by consolidating the proppant matrix composition within the fracture. (EX1001, 3:21–24.) Palmer teaches allowing the proppant matrix composition to form a proppant matrix. Palmer teaches enhancing the permeability of a proppant matrix using a solid degradable particulate in combination with a proppant, explaining that decomposition of the solid degradable particulate matter removes it from the deposit, so that “a matrix or pack of such and proppant...is left in the fracture.” (EX1010, 10:26–36.) Palmer also teaches forming matrixes with fibers. (*Id.*, 1:31–45; *see also* claims 4 and 11.) Thus, Palmer renders obvious this limitation. *See also* discussion of claim 1[d] above. (EX1002, ¶¶ 252–253.)

Claim 14[e]: allowing the degradable material of the composite particle to degrade so as to form a void in the proppant matrix; and

See discussion of claim 1[e] above.

Claim 14[f]: allowing a fluid to flow through the proppant matrix.

According to the '904 patent, allowing a fluid to flow through the proppant matrix refers to the enhanced conductivity related to creating voids in the matrix. (*See, e.g.*, EX1001, 3:3–13.) Palmer teaches that the goal of fracturing in general is to provide “flow channels to facilitate production of the hydrocarbons to the wellbore.” (EX1010, 1:15–19.) Improved recovery is an ongoing goal when

proppant matrixes are used. (*Id.*, 1:31–45.) Breaking a gel helps allow hydrocarbon flow through the fracture and proppant matrix. (*Id.*, 2:3–10.) And, Palmer teaches using a degradable particulate material as an improved breaker, where the particulate’s degradation removes the particulates and simultaneously breaks the gel, leaving the matrix behind. (*Id.*, 10:26–36.) The amount of particulate used is up to 10% of the fluid by weight, which a POSA would understand to be an amount sufficient to allow a fluid to flow through the proppant matrix in view of the other discussion in Palmer described. (*Id.*, 5:1–6; EX1002, ¶ 255.) Accordingly, Palmer renders obvious this limitation. (EX1002, ¶ 256.)

15. Claim 15

Claim 15: The method of claim 14 wherein at least one of the proppant particulates comprises a curable resin anchor [sic] a tackifying agent.

As is apparent from the file history, this claim includes a typo and “anchor” should be “and/or.” (EX1020 at 18.) Palmer teaches that resin-coated sand or ceramic proppant may be used. (EX1010, 9:9:46–47.) As would be understood by a POSA, most resin used as proppant coating is curable resin, and a POSA would be motivated to use a well-established product such as curable resin because its performance characteristics were well-known in the art. (EX1002, ¶ 257.) Thus, Palmer renders obvious claim 15. (*Id.*, ¶ 258.)

16. Claim 16

Claim 16: The method of claim 14 wherein the degradable material in at least one of the composite particles does not substantially degrade until after the proppant matrix has substantially formed.

Although Palmer does not explicitly explain that the degradable material does not substantially degrade until after the proppant matrix has substantially formed, this would be understood by a POSA because Palmer describes that the matrix is left behind after degradation. (EX1010, 10:26-36 (“the decomposition or reaction of the solid particulate matter in effect ‘removing’ organic polymeric particulate matter from the deposit. If additional particulate matter...or other materials are in the suspension deposited in the fracture, a matrix or pack of such and proppant...is left in the fracture”).) Moreover, Palmer refers to “delayed” degradation, and a POSA would understand that the matrix would substantially form before such delayed degradation. (*Id.*, 2:51–52; *see also* 4:8–12 (particulate should not degrade at a rate faster than desired); EX1002, ¶¶ 259–260.) Accordingly, Palmer renders obvious claim 16. (EX1002, ¶ 261.)

17. Claim 17

Claim 17: The method of claim 14 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters; poly(lactides); poly(glycolides); poly(ϵ -caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

See discussion of claim 8 above.

18. Claim 18

Claim 18: The method of claim 14 wherein the filler of at least one of the composite particle comprises a component selected from the group consisting of: anhydrous salts; glass; talc; calcium carbonate; mica, magnesium oxide, mineral fillers; barite; silica; ethylenediaminetetraacetic acid; oxidizers; breakers; sodium persulfate; magnesium peroxide; derivatives thereof; and combinations thereof.

See discussion of claim 9 above.

19. Claim 19

Claim 19[a]: A method comprising:

See discussion of claim 1[a] above.

Claim 19[b]: providing a treatment fluid that comprises a proppant matrix composition, the proppant matrix composition comprising at least a plurality of proppant particulates and at least a plurality of composite particles,

See discussion of claim 1[b] above. Although claim 1[b] does not specifically address providing the proppant matrix composition *in a treatment fluid*, Palmer teaches that the proppant matrix composition is a component of a fracturing treatment fluid. (See, e.g., EX1010, 2:56–66 (solid particulate is provided in a fracturing fluid with a gellant and proppant, forming a fracturing fluid suspension, and this suspension is pumped downwell and deposited as a gelled suspension in the subterranean formation under fracturing conditions); EX1002, ¶ 265.) Thus, Palmer renders obvious this limitation. (EX1002, ¶ 266.)

Claim 19[c]: the composite particles comprising a degradable material and a filler material;

See discussion of claim 1[c] above.

Claim 19[d]: contacting at least a portion of a subterranean formation with the treatment fluid under conditions effective to create or enhance at least one fracture in the subterranean formation; and

As noted above, Palmer teaches that the proppant matrix composition is a component of a fracturing treatment fluid that is used “under fracturing conditions.” (*See, e.g.*, EX1010, 2:56–66 (solid particulate is provided in a fracturing fluid with a gellant and proppant, forming a fracturing fluid suspension, and this suspension is pumped downwell and deposited as a gelled suspension in the subterranean formation under fracturing conditions) ; EX1002, ¶ 268.) Accordingly, Palmer renders obvious this limitation. (EX1002, ¶ 269.)

Claim 19[e]: allowing the proppant matrix composition to form a proppant matrix having at least one void therein.

See discussion of claim 14[d] (with regard to allowing the proppant matrix composition to form a proppant matrix) and claim 1[e] (with regard to forming at least one void in the proppant matrix) above.

20. Claim 20

Claim 20: The method of claim 19 wherein at least one of the composite particles comprises a material selected from the group consisting of: polysaccharides; chitins; chitosans; proteins; aliphatic polyesters; poly(lactides); poly(glycolides); poly(ϵ -caprolactones); poly(hydroxy ester ethers); poly(hydroxybutyrates); polyanhydrides; polycarbonates; poly(orthoesters); poly(acetals); poly(acrylates); poly(alkylacrylates); poly(amino acids); poly(ethylene oxides); poly ether esters; polyester

amides; polyamides; polyphosphazenes; copolymers thereof; and blends thereof.

See discussion of claim 8 above.

IX. Secondary Considerations

There are no secondary considerations known to Schlumberger that affect—let alone overcome—this strong case of obviousness. Should Halliburton proffer any in its preliminary response, Schlumberger should be given leave to file a reply.

X. Conclusion

For the foregoing reasons, Petitioner asks that *inter partes* review of the '904 patent be instituted and that claims 1–20 be canceled as unpatentable.

Respectfully submitted,

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Dated: March 5, 2018

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CERTIFICATE OF SERVICE

The undersigned certifies service pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(b) on Patent Owner by USPS Express Mail of a copy of this Petition for *Inter Partes* Review and supporting materials at the correspondence address of record for the '904 patent:

Robert A. Kent
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and also certifies that a copy of this Petition and supporting materials were served on Patent Owner's counsel both via email as well as via USPS Express Mail:

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CERTIFICATE OF COMPLIANCE

The undersigned certifies this document complies with the type-volume limitation of 37 C.F.R. § 42.24. The petition contains 13,994 words, as calculated by the Microsoft Word program excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a).

Dated: March 5, 2018

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